Installing Mobile Radio

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See page 4
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ON THE COVER
(Story on page 98)
Today’s printed-circuit boards have many new features that make them easier to trace and service. The ones on our cover can be found in the 1940 lines of television receivers.
Color original by Habershon Studios, New York, N. Y.

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**News Briefs**

**STRATOVISION is planned for late 1960 in six Midwestern states, using an airplane circling Fort Wayne, Ind., to transmit educational TV courses. Flying 6 miles up, a DC-7 will pick up programs from Purdue University, rebroadcasting them on uhf channels to Michigan, Indiana and part of Illinois, Wisconsin and Kentucky, a 200-mile radius around Fort Wayne.**

The Midwest Council on Airborne Television Instruction has been formed at Purdue, and the Ford Foundation has promised over $4,000,000 initially. General Dynamics Corp. will provide two DC-7's. The technical adviser to the Council is C. E. Nobles, who originated the idea in the early 1940's. (Radio-Electronics, October, 1959, page 10.)

**WORLD-WIDE RADIO NET shared live symphonic music originating in Moscow, Geneva and New York with 20 countries on UN day, Oct. 24. UN radio in New York fed the program to Canada, Mexico and South America, contacting Europe via the Atlantic telephone cable. Listeners in New York report music from Geneva sounded better than many programs fed from other cities here over regular network lines. The program was flat to 8 kc, according to UN radio operations manager Joseph Nichols. Next year it's hoped to do the exchange program in stereo.**

**WORLD'S BIGGEST TRANSMITTER will go into action at a Navy base in Maine near the end of 1961. Beaming signals to submerged Polaris submarines, it will operate at 30 kc or lower because long waves penetrate salt water better than do high frequencies. Four conventional 500-kilowatt push-pull rf amplifiers will be used, allowing any one to be shut down for maintenance while 1,500,000 watts keep pounding out. Two separate antenna arrays, each with one tower almost 1,000 feet high, and 12 more reaching above 800 feet, will spread over 2 square miles of ground. Either antenna can be turned off while 60-cycle de-icing power is applied to melt ice up to 3 inches thick. The transmitter will also be useful in detecting hostile missiles as they leave launching sites overseas.**

The most powerful known station at present is also a Navy installation, at Jim Creek, Ore., rated at 350,000 watts. The USSR is believed to have a station called Goliath whose output is comparable. It was taken from the Germans after WWII.

**FM MULTIPLEx need not be used for storecasting background music, the Supreme Court ruled recently, backing up the Court of Appeals, which voided an FCC order putting background music onto multiplex from previous simplex. In simplex operation everybody gets the same program with subscribers to the storecast service getting the commercials silenced by an ultrasonically triggered tone. This could be a positive step toward FM-multiplexed stereo, allowing broadcasters to eat their cake (stereo) while keeping it (storecast).**

**AUDIO ANESTHETIC for dental patients puts music on random noise of levels selected by the patient—into headphones, blocking out pain sensation during drilling. Ritter & Co., Inc., Rochester, is developing production models of the system for sale to dentists in early 1960.**

The principle was worked out by a Boston dentist who found it killed the pain of dental work in about 90% of more than 2,000 test cases. The patient controls the sound level with a gain control in his lap. Ritter says the unit should sell for about $1,600, including phones, amplifier and tape deck.


**ELECTRONIC MAGAZINE, The Braille Technical Press, is now available on records for the blind ham, hi-fi enthusiast and electronics technician. It is published monthly on 16½-rpm ("Talking Book" speed) discs. Each issue has**

(Continued on page 10)
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NEWS BRIEFS (Continued from p. 6)

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The magazine has been used as a textbook in many schools and libraries and has been the electronics Bible for Braille readers all over the world. The new “Talking Book” edition makes it available to all interested, regardless of their ability to read Braille.

PASSIVE SATELLITES—100-foot balloons with aluminized surface—will be orbited about 1,000 miles up as relay stations for microwave communications and intercontinental TV transmission in tests by Bell Labs. Facilities are being built at Holmdel, N. J., and Goldstone, Calif., for experiments next year.

Transmitters using 85-foot parabolic dishes will beam 10-kw signals at the satellites at about 1,000 m.c. It is hoped reflection from a satellite will give a usable signal receivable with a parabola 2,300 miles away. The signal will be funneled into a maser amplifier. In this case a ruby crystal bathed in liquid helium. Bell engineers expect extremely low noise figures with this maser and a special horn collector used with the receiving dish—signal-to-noise ratios up to a hundred times better than presently obtainable. In this sort of work, much interference often comes from the heat of the earth.

Where the new transoceanic cables carry up to 100 phone conversations at a time, a single microwave channel of this kind would carry 900 phone circuits, or a full-width TV channel.

About 20 satellites would provide communication across the US 95% of the time. This many would be required because each light, large, passive satellites would drift, failing to stay in the regular orbits of heavy, small, active satellites presently orbiting, or the doughnut-shaped satellite envisioned by others (see What's New, page 54). However, as many microwave channels as desired could be focused on one satellite at one time, providing a virtual infinity of communications lines.

WEATHER-CONTROL network at the Panama Canal will connect 13 stations at spots virtually inaccessible to man which must be periodically checked to predict water level at the canal. The remote stations will automatically telemeter water-level and other data by vhf radio to the main meteorological station to aid decisions as to when to open and close the canal locks.

SHORTER-TUBE TREND continues with a new type of 25-inch picture tube which has a 114° deflection angle (uses standard 110° yoke and coils) and is minus the twin-panel bond-on safety glasses which present 23-inches carry. The 23-114 will thus be shorter than present tubes, and also somewhat cheaper, at least for the set maker. G-E has

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Colinor of Events

Midwest Symposium on Circuit Theory, Dec. 1-2, Brooks Memorial Union, Marquette University, Milwaukee, Wis.


National Conference of the IRE Professional Group on Vehicular Communications, Dec. 3-4, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

National Symposium on Reliability & Quality Control, Jan. 11-13, Statler-Hilton Hotel, Washington, D. C.

Hi-Fi Shows

Northwest Hi-Fi, Music and Stereo Show, Dec. 4-6, Hotel Leamington, Minneapolis, Minn.

IFH Hi-Fi Show, Jan. 13-17, Pan-Pacific Auditorium, Los Angeles, Calif.

National Hi-Fi Show, (sponsored by MIRA) Jan. 23-26, Cow Palace, San Francisco, Calif.

Details on all events supplied by sponsoring organizations.

RUSSIAN MICROWAVE development is seen threatening to catch up with that of the US, according to D. W. Atchley, Microwave Associates, Inc., who recently returned from a visit with the head of microwave research of the Institute of Radio Engineering and Electronics, Moscow. Dr. Zarem Chernov showed Mr. Atchley a traveling-wave tube which promises amplification of millimeter waves. In this "most unusual" tube, the electron beam interacts with a sheath of charged gas particles instead of with a wire helix. Another important tube he saw is called the Spivatron. This traveling-wave tube is a lightweight, efficient, broad-band amplifier which Mr. Atchley felt could be used in a communications satellite.

RADIO POCKET is predicted for men's clothing by a prominent Chicago appliance dealer. Based on his store's sales of transistor radios during the last World Series, Sol Polk of Polk Brothers believes even women's clothes may have special little pockets designed for tiny personal radios.

SPUTNIK SIGNAL allocations are being discussed at the current Geneva meeting of the International Telecommunications Union (ITU). The United States has asked that seven bands be set aside for space communications. The Russians are expected to oppose this request, saying that frequencies for space communication are available in bands now allocated to fixed and mobile aeronautical services.

Meanwhile, leading astronomers who had earlier expressed concern over the anticipated US request for only one frequency allocation for the new science of radio astronomy were praising the proposal finally made by the American delegation to the ITU. This new position indicates a request that 17 bands be set aside for probing interstellar space with huge radio telescopes. Frequencies are requested from 2.5 all the way up to 30,000 mc.

The ITU, meeting for several months once every 10 years, has over 5,000 proposals to deal with.

1,000-FOOT RADAR astronomy dish in Puerto Rico will be a fixed aluminum mesh basin sending pulses on 400 mc to explore the solar system and help develop defenses against ballistic missiles. Because it can pick up objects only a cubic yard in size at distances of 20,000 miles or more, the huge antenna will be useful in mapping the moon and sun.

3 NEW TV STATIONS brighten TV's slowest year to date (only 20 starters): KOMC, McCook, Neb. 8

KXGO-TV, Fargo, N. D. 11

WMUB-TV, Oxford, Ohio 14

KOMC picks up NBC-TV via microwave from parent KCKT, Great Bend, Kans., channel 2. WMUB-TV is an educational station and recently began its full time schedule after a period of intermittent programming.

KTES, Nacogdoches, Tex., channel 19, which left the air in July, failed to resume operation this fall as planned. New total of US operating stations is 562. This figure includes 472 vhf and 90 uhf. The noncommercial group now numbers 13.

ANTI-STATIC devices for keeping dust off discs, or for cleaning them may soon be found in things of RCA-Victor is putting a new "magic ingredient" 317-X, in their stereo discs, producing a staticless record with "Miracle Surface." It really works, costs no more and, RCA says, it'll last permanently.

Unconfirmed but persistent talk is that RCA will license or perhaps even give the secret process to the rest of the record industry. Congratulations to RCA-Victor for solving a long-standing problem!

MUSIC BY MACHINES is a step closer with the installation of an RCA Music Synthesizer at the Columbia University Electronic Music Center. Contained in several huge racks with programming via punched tape consoles, the synthesizer looks like a huge computer. It can simulate all known musical tones, plus virtually any musical (or otherwise!) sound which can be imagined by the "composer."

ELECTRICAL ENGINEERS graduating from Lehigh University this year get an average starting salary of $615 a month, exceeded only by beginning

(Continued on page 16)
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<tr>
<th>Name</th>
<th>Address</th>
<th>License</th>
<th>Weeks</th>
</tr>
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<tbody>
<tr>
<td>Ben Taylor</td>
<td>39 S. Franklin St., Chambersburg, Pa.</td>
<td>12</td>
<td></td>
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<tr>
<td>Ben Veece</td>
<td>P.O. Box 444, Joyl, Alabama</td>
<td>14</td>
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<tr>
<td>Donald R. Taylor</td>
<td>270 Park Terrace, Hartford 6, Conn.</td>
<td>12</td>
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<tr>
<td>Helios D. Obrienn</td>
<td>P.O. Box 275, Hampton, Kansas, Hawaii</td>
<td>13</td>
<td></td>
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<tr>
<td>Billy R. Kirby</td>
<td>Route 23, Southfield, N. C.</td>
<td>12</td>
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<tr>
<td>H. R. Beverly</td>
<td>16402 Hollywood, Los Angeles, Calif.</td>
<td>12</td>
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<tr>
<td>Donald H. Fordy</td>
<td>5654 Horace Blvd. (Cape City), Honolulu, Hawaii</td>
<td>12</td>
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<tr>
<td>James D. Murphy</td>
<td>400 S. Church St., East Troy, Wis.</td>
<td>12</td>
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engineers, who are averaging $525. Interest is increasing on the part of industry in young EE's as shown in the number of interviews conducted on the Lehigh campus. This year there were 618 interviews for the 49 graduates; last year's 44 had only 317.

Graduate chemical engineers started at an average of $460. The average for all students graduating was up 4% from the previous year, but the EE's were up 6% and the physics graduates got 12% move to start than in 1958.

FOREIGN TV is growing fast, much the way TV in this country did a few years ago. Over 1,000 transmitting stations and more than 30 million sets are in use outside this country, compared with 544 stations and over 50 million receivers in the US.

In the past 12 months, overseas sets jumped almost half; stations increased by over 60%. Biggest increases were in Italy, West Germany, Japan, Russia and France, but England and Canada still led the other countries in total sets and stations.

LOUDSPEAKING LIGHTHOUSE has a bank of 60 large cone speakers mounted in short horns as its fog warning alarm. Amplifiers in the 130-foot tower being put up at Dungeness, Kent, England, use only 3-kw of power to drive the speakers. Three different frequency tones are used simultaneously, making an alarm which can be heard 8 miles out to sea.

The new lighthouse will also have a small xenon arc discharge beacon about the size of a standard 300-watt bulb. It'll produce over half a million candlepower, three times as much as the present light which has an 8-foot lens. The tower can run unattended. It has an electronic fog-detection system which sets the foghorn into action when a ray of light beamed into the atmosphere is reflected into a photocell, and a dawn-and-dusk sensing setup.

FUEL CELL making 15 kw of electricity direct from propane gas drives an experimental tractor. This latest fuel cell was demonstrated by Allis-Chalmers in Milwaukee. It was also the first full-sized model.

Potential efficiency of the fuel cell is about 90%, compared with only 40% for Diesel engines. Propane, readily available from natural gas and crude oil, reacts in the fuel cell with an electrolyte to create dc.

Other fuel cells using hydrogen and oxygen have been described in this magazine. This particular model is made up of 1,008 individual fuel cells banked in four groups to allow various combinations of voltage and current. They create up to 20 horsepower in this tractor. The attack on fuel cells is through finding new catalysts to aid the reaction of the fuel with the electrolyte. Allis-Chalmers won't say what their catalyst is. In at least one other fuel cell the catalyst is platinum.
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*Trade Mark
Dear Editor:

Mr. Turner may have confused some readers with his explanation of the operation of "Electrostrictive Ceramics" (September, 1959) through his handling of the voltage, current, power and energy relations involved. It might appear to some from his explanation that electric devices consume less power than magnetic devices due to some fundamental properties. They may have some advantage in this respect, but the reasons are strictly practical, not the result of fundamental properties of the fields involved.

For example, suppose a clamped disc has a voltage applied. Current will flow from the source until it decays to zero. During this changing current flow, power is drawn. If the current is integrated over the entire time interval, we can determine the total energy required to produce an electric field in the dielectric. Since no work is done by the disc, the energy is stored in the electric field and may be recovered upon discharge of the capacitor (disc and electrodes).

Now assume that, instead of being clamped, the ceramic disc is free to flex upon application of voltage. If the disc is fixed to some object, such as a speaker cone, and moves against a restraining force, work will be accomplished and this will be reflected in an increased current or, more correctly, in an increase in the total energy.

In either case, clamped or free, after a sufficient time interval the electric field configuration will be the same under steady-state conditions, and any force produced by the disc may be obtained from the electric field with voltage and without accompanying current flow; therefore, with no further expenditure of power. The only difference between the clamped and unclamped disc is the energy drawn during the transient state.

Now consider the magnetostrictive case in which setting up a magnetic field distorts a piece of metal, just as the ceramic disc in an electric field. In the magnetic case, with the metal clamped, applying a current will produce a transient voltage while the field is building up. During this time power is drawn from the source. This power is stored in the magnetic field and is recoverable. Once the field reaches a steady state it may theoretically be sustained by current only, without application of voltage, thus costing no.

(Continued on page 24)
WHAT IS A CLASSIC?

It is an enduring work of excellence and authority. It can be a painting, a symphony or a novel. It can be a work of science or engineering, too.

Potential classics in science and engineering are being written today. Time alone can tell which of them will endure. Surely, they will be found among the books which are today accepted as leading authorities in their fields.

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DECEMBER, 1959

23
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INDUSTRIAL SERVICE?

Dear Editor:

Many of your articles have been encouraging service technicians to take on more commercial gear to service. I started servicing radios back in 1929... Often customers have asked me to work on medical and factory electronics equipment. Almost without exception I have met opposition from the manufacturers and supply houses. I would never advise a radio or TV technician to try to service commercial equipment. The manufacturers prefer to sell a salesman to make the service call, so he can persuade the user to replace the faulty gear with new equipment for many thousands of dollars.

As an example I have been attempting for 5 months to get parts and service instructions for a NATCO 3030-1 16 mm sound projector. I have called and written to several companies, but with no success at all. What would you suggest in a case like this? After every ordeal like this I swear I will never accept a service job for anything but radio, phono or TV.

Fairborn, Ohio

LESTER BERRY

This letter expresses the experience of a number of technicians. It is unfortunate that some companies are anxious to have their equipment serviced at the same time that many technicians are interested in servicing it, but they often can't seem to get together.

This situation is improving somewhat of late, but it is still too sticky.—Editor

S2 PREAMPLIFIER

Dear Editor:

I have just completed the “Transistor Preamp”, on page 46 of the February, 1958, RADIO-ELECTRONICS. This preamp works just as it was claimed in the article. Many manufacturers have asked me to send a copy, so I am sending it in hopes that it will help others. Thank you.

Flushing, N.Y.

DOUGLAS WEBER

END
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New FM/AM Tuner HF766 combines the renowned EICO HF100 preamplifier with excellent FM tuning facilities. Kit $99.95. Wired $114.95. Includes covers and F.E.T.

New HF-4 Stereo Amplifier provides clean 4W per channel or full total output. Inputs for ceramic/crystal stereo picks-ups, AM/FM stereo, FM/AIDS stereo, or position stereo/mono selector, Clutch-centered level & tone controls. Use with a pair of HF55 Speaker Systems for good quality, low-cost stereo. Kit $49.95. Wired $64.95.

HF12 Mono Integrated Amplifier provides complete "front end" facilities and true high fidelity performance in inputs for phone, tape head, TV tuner and crystal/ceramic cartridge. Preferred variable crossover, feedback type tube control circuit. Highly stable Williamstion-type power amplifier circuit. Power output, 12W continuous, 25W. Kit $34.95. Wired $45.95. Includes cover.

New HF53 3-Way Speaker System Semi-Kit complete, with factory-built 4" veneered plywood (4 sides) cabinet. Below-suspension, full-frequency excursion 12" woofer (32 cps res.). 8" mid-range speaker with high internal damping corner for smooth response, 0° cone tweeter. 1¼ cu. ft. ducted port enclosure. System G-1 1/2 for smoothest response & 150,000 cps clean, useful response, 16 ohms impedance. 20%, 50%, 100%. Unfinished birch $72.50. Walnut, mahogany or teak $87.50.

New HF55 3-Way Speaker System Semi-Kit complete with factors built 1½ veneered plywood (4 sides) cabinet. Below-suspension, 1½ excursion, 8" woofer (45 cps res.), 3½" cone tweeter. 1¼ cu. ft. ducted-port enclosure. System G-1 1/2 for smoothest response & 150,000 cps clean, useful response, 16 ohms impedance. 20%, 50%, 100%. Unfinished birch $72.50. Walnut, mahogany or teak $87.50.

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Billions of Electronic Facts

...Astounding Growth of Electronics Calls for New Strategy...

A n important government official, commenting on the chaos of electronic research, recently rebuked American research scientists for failing to make use of available Russian data. This occurred in early October, during the Chicago meeting of the National Electronics Conference, and was described in a news report:

"John C. Green, director, Office of Technical Services, Department of Commerce, said his office began translating Soviet scientific reports more than a year ago and, because of the impact of Russia's space ventures, had expected these translations to total 25% to 50% of its sales of science papers. Actually, he said, they amounted to only $50,000 out of the total of $500,000, or 10%.

Mr. Green offered several reasons—researchers don't want new sources of information because they are already floundering in reports; some still discount the worth of Russian data, and others simply don't know the Russian translations are available.

"What scientific research needs, Mr. Green declared, is a new professional—an 'information scientist'—to peruse the mountain of information and dispense relevant data to working researchers."

"Floundering in reports" is stating the condition far too mildly—"drowning in reports" would, in our opinion, be more to the point.

How could it be otherwise in an industry that mushrooms at such a fantastic rate of growth that it doubles its new inventions and devices every few years? What will the electronics field be like in 10 years, 25 years, 50 years hence?

Today we have millions of electronic facts available to our researchers. Soon there will be billions of facts—what then?

Several times in recent years, research teams have developed "new" devices, only to find that identical ones had been in use elsewhere for a different purpose. They had been fully described in technical papers, too.

Let us cite a specific example, which we may call The Great Electronic Cigarette Hoax. Recently, full-page ads in newspapers throughout the country announced the "new" "electronic," "ventilated," "warmed" or "air-conditioned" cigarette—a breakthrough in smoking. Just how new and revolutionary is this?

In the early 1800's, when the present writer was a young boy in Europe, one of the most hilarious jokes went as follows: You asked a friend to lend you his cigarette-paper book—usually Riz-La Croix brand. You then proceeded to roll your own cigarette. But instead of returning his book of cigarette papers, you substituted your own. This one you had "prepared" by placing it on a metal plate, wired to the hot side of a spark coil. The other side went to a sharp probe, which you carefully guided for 5 minutes over the cigarette book while the spark coil was "on." Result: every one of the fine cigarette papers was punctured with thousands of invisible holes.

Now, when your victim tried to smoke his cigarette with such a "super-aerated" paper, there was no smoke forthcoming no matter how furiously he drew and puffed, simply because the paper acted as an excellent sieve. All your friend got was air and frustration!

The idea was described in French and German books in the 80's, as well as in Practical Electrics, one of the writer's magazines (May, 1922, page 279).

Now the hoary old idea has been re-invented—as happens so often—by the cigarette manufacturers, who play the same, albeit attenuated, joke on their customers, simply using fewer holes in the cigarette paper. Carefully regulating the frequency of the holes along the shaft of the cigarette causes the smoker to get less smoke and more air—also less nicotine and tar. This really gives you a cigarette with an electronic carburetor. Of course, you no longer get your money's worth in tobacco, but then—sh-h—the cancer risk is less, too. This makes everybody happy—manufacturer and consumer as well. Hurrah for electronics!

Let us give cigarette manufacturers the benefit of the doubt and admit that they probably never heard of the ancient spark-coil-cigarette-paper joke; which is precisely the point of this article.

Useless, uncoordinated research is dogging every industry today. Duplication of research, effort and money is the order of the day. Will it stop before all of our progress is engulfed?

There seems to us only one sensible remedy—a National Facts Center of the Federal Government. Only the Government is big enough to build and run such a center. It would be far larger than even the Pentagon. Nor would the information which it supplied be free—not any more free than the US Patent Office services. Whatever information was demanded by any industry or individual would cost a statutory fee, determined by various schedules.

The Center would be equipped with possibly the largest array of electronic computers in existence. Every important scientific, electronic and industrial fact would be coded and carded, cross-indexed for various industries. All these billions of facts would be fed to the computers in such a manner that, upon inquiry, the proper information could be given, often within seconds.

These facts and information would not come solely from American sources. That would defeat the whole purpose. Facts would be culled from every country of the world, because only in this manner could the Center be all-comprehensive.

The Center would have to be closely allied with the Patent Office for intimate reciprocal information of every kind—indeed each would be dependent upon the other.

But industry, researchers, inventors and others would not have to waste their time any longer in useless research, when the key to their problem would be forthcoming within minutes at the Center. To be sure, the key itself would solve no problems—it would state, however, where your vital information could be had. It would be an immense shortcut to all research.

How long does electronic computer information—on magnetic tape and memory magnetic cores—last? Remember the Center would entrust to the computers thousands of billions of vital facts.

The experts in the field assure us that magnetic Mylar tape—the tape itself and the magnetic iron oxide—will last, at the present state of the art, at least 100 years. It may, with improvements to come, last much longer.

Magnetic cores and the magnetron impressed on them, we are informed, will probably last hundreds of years.

All this need not worry anyone, because the thousands of scientists and technicians of the future National Facts Center would continuously replace old magnetic tapes and memory cores with new ones as a routine procedure. —H.G.

A Merry Christmas and A Happy New Year From The Editors
Traveling-wave tubes which can reach beyond 25,000 mc efficiently spell increased power and range for shf communications. Here's how these unusual devices operate.

**LOWDOWN ON TRAVELING-WAVE TUBES**

By TOM JASKI

One of the most difficult tasks in electronics is amplifying rf voltages above 1,000 mc. Yet here we find the most important and versatile applications of communications, long-distance remote control and military defense measures.

Special tubes with very closely spaced electrodes, such as the lighthouse and pencil triodes, solve some of the problems up to 3,000 mc. Above this, on the transmitting end we just oscillate up a storm with bigger and better klystrons and magnetrons, and on the receiving end we heterodyne the feeble signals with a local oscillator and use a lot of if amplification.

The disadvantages of such a system are obvious. We depend on the brute force of a signal which can easily be interrupted by interfering conditions and distorted by noise, or we have to make the transmitting range so small that we can hardly miss.

Traveling-wave tubes offer a new approach to the problem. How they do this is what this story is about. But to understand the tubes, we must first understand the problem we are dealing with.

**Transit-time problem**

The core of the trouble is transit time. It takes electrons a finite time to travel from the cathode to the plate. In the tubes in your radio or television receiver the transit time is about .001 µsec. One millimicrosecond (1 µsec) doesn't seem like a lot of time and at broadcast frequencies it isn't. At 1 mc the transit time is just 1/1,000 cycle. But at 1,000 mc, this would be as long...
as a whole cycle. The ordinary tube would long ago have ceased amplifying. Let’s see why.

Fig. 1 helps explain the situation. Here we have a triode with a negative grid bias. As we apply an input signal, the grid becomes less and less negative on the positive swing of the signal. Because of this the number of electrons in the stream from the cathode becomes greater, and we find a much denser electron population between grid and cathode than between grid and plate, because a number of the electrons haven’t had time to get through the grid to the plate side yet. Because more charge carriers are leaving the grid than are leaving, the approaching mass of electrons, slowed down by the grid (still negative with respect to the cathode), imparts energy to it—actually does work in repelling electrons from the grid. This is the frequency of the external grid circuit. When the input signal reaches its positive peak and starts to decrease, more electrons will be between the grid and plate—leaving the grid—and electrons flow back into the grid from the external circuit. When the signal reaches a negative maximum the capacitive grid current reverses itself, reaching zero well before the voltage.

In other words, we have a phase shift. The grid current leads the signal voltage, and we have a capacitive reactance in the grid circuit. Now, you know that the higher the frequency the lower the capacitive reactance becomes, so the tube draws current from the input circuit, loads it and lowers the input signal because of lowered grid-circuit impedance. The phase shift is proportional to the frequency and the transit time.

Second, we can regard the tube’s dynamic plate resistance as a complex quantity, made up of the resistive characteristics of the electron stream and the interelectrode capacitance in series. The plate resistance increases at higher frequencies. The lowered grid impedance lowers the transconductance. The amplification of the tube is the product of the transconductance and the plate resistance. Thus the amplification of the tube is very drastically reduced at these higher frequencies.

This then is the transit-time problem—how to increase amplification which has been reduced because the electrons are slow. All the foregoing is pertinent to our discussion of traveling-wave tubes, or they are a good practical example of the proverb “If you can’t lick them, join them.” Instead of fighting transit time in traveling-wave tubes, we turn it to our advantage.

First, let us look at the construction of a traveling-wave tube. Fig. 2 shows a schematic section of one (and in Fig. 3 you can see what it looks like). At the left is an electron gun, similar to the type used in cathode-ray tubes, which is capable of producing a collimated beam of electrons in the order of 0.001 inch in diameter. The anode serves the usual purpose of accelerating the electrons. Then comes a long thin glass tube with a wire helix inside. The helix may have as many as 50 turns per inch. At the far right is the connection to the helix, and at two points on the tube we see a spiral wound outside the glass. Then, finally, at the far right there is a positive collecting electrode. Typically the whole assembly is about 12 to 15 inches long (although much shorter tubes are being made experimentally) and the helix is about 9 inches long. The diameter of the helix should be about 11/64 inch and the glass tube around it somewhat under 1/8 inch.

The electron gun is not very special, except for the shape of the beam, which is of uniform thickness. Fig. 4 shows the connections to the tube’s elements. There is a heater supply, an anode supply and a variable high-voltage supply for the helix. There then are the input and output connections which, as we see, are made by the spiral around the glass and not by direct connection to anything.

How it works

We talked about transit time, and we know that the electrons take a certain finite time to travel from the cathode to the collector electrode. To make use of this ability of this electron beam to impart energy to a wave, we must try to make a wave travel at about the same speed as the electrons. This is the purpose of the helix. The next logical question is, “How does the helix work?”

Let’s assume for the moment that we manage to introduce a wave on the waveguide from the input signal. (How this is done is explained later.) A wave normally travels through space or along a path in a waveguide or, in the simplest terms, along a wire, with about the speed of light. But if we wind the wire into a helix, we create capacitance between the turns, and the turns themselves are in effect inductances. Now if you know what a conventional delay line consisting of series inductances and parallel capacitors looks like (see Fig. 5), you can see the analogy between the helix and the delay line. In fact, the helix is enough of a delay line to slow the wave down by a factor of maybe as much as 30.

As the slowed-down wave travels the length of the tube, we shoot the electron stream down through the center of it. Now what happens? The wave has both an electrostatic and a magnetic component. The magnetic component isn’t useful to us. In fact all it does is try to scatter the electrons and break up our nice tight stream. However, we counteract this effect.

The electrostatic component is what we use. We represent the instantaneous pattern of the field due to the wave in the tube as in Fig. 6, where the arrows indicate (by convention) the acceleration in a positive direction (the field will try to accelerate positive charges in the direction of the arrows, and electrons—which are negative charges—are in the opposite direction). Thus some electrons will be speeded up and some slowed down, under the influence of the wave, and the beam of electrons will alternately be made denser and less dense (Fig. 7), depending on which part of the wave they are nearest to (whether they are moving toward a more positive or more negative area).

We have produced bunches of electrons all along the beam. By changing the relative collector voltage we can change also the average speed of the electrons, and by choosing our velocities just right we can assure that the bunches of electrons we form with the wave field are either always in a retarding or an accelerating field. (Arrows pointing to the left accelerate, and to the right retard, electrons moving along the tube from left to right.)

If we retard an electron (or anything else), we make it give up some of its kinetic energy. This energy must go somewhere, for it cannot be lost. In our case the energy is imparted to the wave, which then becomes a little stronger each time a bunch of electrons gives it some energy. To do this we make sure that our bunches are always in the retarding part of the field (in
In early traveling-wave tubes, input and output were handled by a short section of waveguide (see Fig. 9) which had to surround the helix for a short section. The helix was then functioning as the abbreviated center conductor. However, as the development of waveguides progressed (delivering such new concepts as the G-string and the flat printed-circuit guides), the builders of TWT's understood that an actual conventional waveguide section was not required and that a simple wire wrapped around the glass would be just as good. Essentially, this is the idea of how we get the wave in and out of the helix with the simple outside spiral.

The electrons' velocity in their long journey through the helix has to be very high if they are to reach the collector electrode. By putting a high voltage on the helix, we have some control over this velocity. So by controlling the helix (and collector) voltage we can make the tube suitable for waves which travel at different speeds. Since a delay line acts differently upon voltages of different frequencies, in effect we have a tube which we can use for various frequencies.

Actually the traveling-wave tube is a wide-band device, but it need not always be. If we make the tube too efficient, we may end up with a very-narrow-band tube. Here's why. If we take out the wave from the helix, say in a waveguide fashion, the waveguide in turn can reflect energy into the helix. With the reflected wave traveling backward in the tube, the efficiency will be lowered a bit. However if the reflected wave reaches the other end at all, it will again be reflected, now forward, and will then be in the right phase for amplification. The amplified, twice-reflected wave will be added to the original, and so we have positive feedback and oscillation. Tubes designed for amplification only are so designed that the reflected portion never reaches the front end again. This is done by building losses into the helix or placing an attenuator consisting of a split graphite cylinder around it. Tubes made for oscillators use the reflection. But with the helix voltage constant, this tube will oscillate only in a narrow band of frequencies, no matter what we do to the rest of the circuit. Thus we have the apparent contradiction that we have a narrow-band device, which can be swept (by changing the helix voltage) over its possible range (of narrow bands).

Some readers might have difficulties visualizing a "traveling" wave when there isn't anything really moving, like particles or such. I found it useful to think of a childhood game played with a rope. If you lay the rope on the ground and vigorously wag one end up and down, the whole rope will soon be in motion, although not running away from you. Progressively the "bulges" in the rope will seem to travel forward. These traveling "bulges" illustrate the idea of a traveling wave. It isn't going any place, it's just an amplitude which appears in different places. If a rope (or, better, a violin string) is wagged hard enough, particularly when it is stretched, you get the opposite or "standing" wave, which shows the same amplitude in the same place and seems to have a "bulge" which stands still.

And before we forget, the backward "traveling" energy in the oscillator tube does of course cancel, in its first reflection down the tube, some of the effect of the first "forward" wave, but it is only a small percentage and more than made up for by the amplified second reflected "forward" wave. We
MYSTERY LIGHT

By GEORGE P. PEARCE

EVERY member of the family will have fun with this lamp. You'll all get a kick out of seeing it light when you point at it. You can set it to remain on and use the lamp for a night light. Set it to flash about 100 times a minute and you will have a twirling star which is better than a night light for putting the kids to sleep.

Slow the flashes down to about 60 a minute and hang it on the porch any time you're expecting guests who may not know exactly where your house is. Just tell them, "It's the one with the flasher."

If you don't like light in the bedroom at night but want to be able to see what time it is if you wake up while it's still pitch black out, set the lamp for the mystery-light effect and position the box where it will illuminate your watch. Whenever you want to know the time, you poke your hand in the general direction of the light and it will promptly flicker to show you where it is. Place your finger on the bulb and you will get enough light to see your watch or clock without disturbing anyone else. When you pull your hand away, the light goes out.

The mystery lamp uses about one-fifth the current drawn by an electric clock and that only when it is actually lit. It is easily built and you probably have most of the necessary components in your parts box.

For a case I used a strong cardboard box 5 x 3 x 2 1/4 inches. A piece of 1/4-inch plywood (3 x 5 inches) just small enough to let the box cover slide over it serves as a chassis. Do not use a metal case or chassis unless an isolation transformer is added to the circuit. This will avoid hot-chassis dangers. The diagram shows the circuit.

Potentiometer R2 is fastened to a sheet-steel plate so it can be mounted flat on the plywood base, in the center of which a 1/4-inch hole is drilled so the slotted stub-shaft setting can be adjusted with a small screwdriver without opening the case. Use an insulated screwdriver as the potentiometer's shaft may be hot. R2 varies the circuit's resistance between 27,000 and 527,000 ohms.

The lamp socket is mounted on a support made from a strip of 18-gauge steel and holds the lamp's bulb so it sticks up about 1/4 inch through a 9/16-inch hole in the top of the case. For further details see the photos.

The box is painted a glossy black (mystery boxes should always be black). Four rubber feet are tacked to its base to prevent bolt ends and nuts from scratching the table the box sits on.

When you are ready to use the lamp, plug it into any wall outlet and set it for the desired use. When R2 is set for minimum resistance, the lamp will glow steadily. As more resistance is added, the lamp will begin to flicker. For the mystery-lamp function, increase the resistance until the lamp just goes out. Now just point your finger at it and it will start to flicker. Touch the bulb with a couple of fingers and it will go much faster. Should the flashing fail to occur, reverse the plug at the wall outlet.

Lowdown on Traveling-Wave Tubes (Continued)

take a portion of the output, manage to get some of it back down the tube, and amplify this to add to the original output, and we take a portion of the now bigger output and send it back down the tube, etc., etc. To put it in simple terms, that's how it oscillates.

What can they do?

Traveling-wave tubes can have a gain of as much as 70 db. By helix voltage control, TWT oscillators can be made to oscillate over a range of 2 to 1. Thus some tubes are available which will cover the band from 1,000 to 2,000 me and so on all the way up to tubes which reach over 25,000 megacycles. This is not necessarily the limit of TWT's; we just haven't much practical application for higher frequencies, yet.

At present, the practical applications for TWT's are enough to keep the manufacturers quite busy. They are used first as broad-band, low-noise radio-frequency amplifiers. They are used as tunable oscillators. Fig. 10 shows a signal generator using a TWT as oscillator. Because of a feature which we haven't discussed (the "grid") shown in Fig. 2, which can turn the electron beam on and off or modulate the electron stream, thus controlling its density and its ability to impart energy to the wave) we can amplitude-modulate the output. This "grid," which is really more like a "gate," operates like the grid of a cathode-ray tube for beam modulation. Therefore, TWT's can also be used as modulators at microwave frequencies.

Telemetering, missile guidance, microwave voice communication, television program relays are present applications for the tubes. Scatter propagation, cable amplifiers for coaxial lines and radar systems are possible future applications. You can be sure that they will be playing an important part, for right now they are the only high-gain voltage amplifiers available for the microwave regions.
SOLAR POWER

Part II—The solar battery in industry; both low- and high-power applications

By JORDAN McQUAY

LAST month we looked into the history and theory of solar batteries. Now we will see how they are used.

One of the simplest devices employing solar power is a flashlight (Fig. 1). During 5 hours' exposure to sunshine, enough energy is stored in its nickel-cadmium battery to provide a minimum of 1 hour of continuous electrical power. The converter consists of 9 silicon solar cells, connected in series. A diode keeps the batteries from discharging during periods of no exposure to sunlight.

A slightly larger converter, composed of 16 rectangular type cells, can operate a small electric fan (Fig. 2) for almost indefinite periods of time.

Clocks, perpetually powered by the sun, give continuous and unlimited operation. Because of the low power drain of dc clocks, a 20-cell solar-power converter is sufficient for continuous operation.

A highway flasher unit (Fig. 3) uses an array of 32 solar cells and a nickel-cadmium battery. Two isolated silicon cells operate a relay that diverts charging current to the battery during daylight, and turns on a periodic flasher during darkness. This device is useful for marking highway construction work as well as airstrip emergency runways.

Simple but effective broadcast type radio receivers have been designed to operate with small solar power converters. Commercial broadcast receivers are also available. Using a solar-power converter with four penlight-size rechargeable batteries, the radio consists essentially of six transistors and a diode, printed circuit wiring, and a push-pull output feeding either a 2½-inch speaker or earphones. The set operates either directly from the solar cells or indirectly from the nickel-cadmium batteries.

Portable low-power uhf and vhf transmitters can also operate with solar-power converters. With a larger power converter and appropriate antenna system, efficient communication well beyond line-of-sight distances can be expected.

Army engineers have developed a two-way voice-operated FM transmitter-receiver radio contained almost entirely within a combat helmet. It uses a solar-power converter and miniature nickel-cadmium batteries. Two banks of 38 silicon solar cells are imbedded in the top of the helmet. These connect with the nickel-cadmium batteries to provide a power supply. The batteries, subminiature transmitter and receiver are all in the combat helmet, and weigh about 1 pound. Only the microphone is external.

An eyeglass type hearing aid uses a four-cell solar power converter with a tiny nickel-cadmium battery. Converter, battery, microphone, amplifier and volume control are all in the sidebar or temple housing of the eyeglass frames. The subminiature amplifier uses four transistors, and feeds a plastic earpiece. Binaural sound is also possible. Just use two complete and independent units, one in each sidebar.

High-power applications

This category of solar-power application includes all devices drawing more than about 5 watts.

A rural telephone (type F) carrier system has been powered successfully by the Bell System with a solar-power converter using 432 silicon cells. It provides nearly 10 watts of electrical power and is used in conjunction with 22-volt nickel-cadmium batteries. Amplifiers and repeaters of the system are all-transistor units to minimize power consumption. With this type of converter, electrical energy derived from the sun during daylight hours operates the carrier system and charges the storage batteries which take over during inclement weather and at night.

A radio repeater station of the US Forest Service, atop Santiago Peak in Southern California, is powered by batteries kept charged by a 504-cell solar power converter. This is an unattended, automatic repeater station using a transistor radio transmitter and receiver. Energy from the converter is transferred to the storage batteries at the rate of about 125 watts per day. The installation needs virtually no maintenance or repair.

*See "Build a Solar-Powered Radio" by Edwin Bohr, RADIO-ELECTRONICS, March, 1956."
Another use for solar power is at the Los Angeles Harbor lighthouse of the US Coast Guard. Here, a 360-cell converter and storage batteries provide continuous power for harbor navigational aids and channel markers. Installations have also been made at other critical locations throughout the world.

Probably the most inaccessible locations where solar power converters are proving their worth are in outer space, where they function as either the primary or the only source of power in satellites.

The first US satellite to be launched successfully was a 6.4-inch metallic sphere, which is still orbiting in space after nearly a year. Distributed over its shell are 6 converters, each containing 18 silicon solar cells imbedded in ceramic cement and cushioned in a special, glassed housing (Fig. 4). At such high altitudes, the satellite is exposed to direct sunlight more than half the time of travel around the world. Producing all necessary power for one of the radio transmitters aboard the satellite, the 108 silicon solar cells will function indefinitely.

Russian satellites have also been equipped with some type of solar power converters, but no specific technical data concerning construction and operation are available.

As new and improved satellites are launched into outer space, each will probably contain a solar power converter to assure continuous electrical operation of its data transmitters.

As the physical size of satellites increases, their internal workings become more and more sophisticated, requiring additional power for operation of the various telemetering devices and radio transmitters. This requirement led to the development of ring-type converters, composed of several hundred silicon cells.

An even more advanced outer-space US project uses an entire missile as a satellite. To provide for the extensive power requirements of such a device, mammoth ring-type converters have been developed. These utilize nearly 3,000 silicon cells (Fig. 5) arranged in two rings, one at each end of the missile. Although larger and more powerful than the tiny solar clusters used on early US satellites, these advanced converters are electrically similar.

Without solar power, satellites would soon become ineffective as they orbit around the earth. With it, they can continue to broadcast scientific and other data concerning either outer space or the surface of the earth. Solar power is especially important for global surveillance and reconnaissance, using television equipment to view all parts of the world while in flight, and to transmit such information to receiving sites on the earth below.

Although exposed to a variety of astral elements—meteorite bombardment, cosmic dust, intense heat and cold, X-rays, and gamma rays—unless they are physically damaged, the silicon cells of solar-power converters aboard US satellites will probably outlast the radio transmitters they power as well as the satellites themselves.

Future applications

Current experiments by leading laboratories and manufacturers with large-area solar cells suggest many extensive, future applications of solar power. In many of the under-developed regions of the earth, the introduction of inexpensive solar power would have a tremendous sociological and political impact.

In areas where commercial electricity is not available, houses and buildings could be literally covered with solar-power converters to provide all necessary household operating electricity.

Airway beacons in almost-inaccessible regions can be powered for continuous operation, as can highway markers and other aids to navigation on land, on sea or in the air.

Remote weather stations, in some isolated spot or in space, could make meteorological measurements and transmit the data back to civilization by means of solar-powered and unattended radio transmitters.

Manned space stations could get enough electric power from vast clusters of solar power converters. These are but a few of the many possible, future applications of solar power.

As greater amounts of electrical power can be converted from sunlight, even wider, more extensive and more exciting applications can be expected in the challenging years ahead.

Future applications of solar power are almost unlimited, because of the average stability and regularity of sunlight in the temperate regions of the world.
HERE is a phototimer that gives constant performance and maintains accurate calibration for long periods of time. The three ranges which fill most timing requirements are 0 to 15 seconds, 5 to 65 seconds and 0.75 to 10 minutes. Tests have shown that preset timing periods are unchanged for line-voltage variations over a range of 90 to 140 volts.

Most timing circuits are dependent upon a capacitor discharging slowly through a large resistor. As the voltage across the capacitor reaches a critical value, a relay circuit is actuated to give the desired timing. The three factors which may affect the stability of timing are the time constant of the R-C timing circuit, the starting voltage of the capacitor at the beginning of the timing period and the critical voltage to which the capacitor discharges.

The first cause of instability is precluded by using paper capacitors instead of electrolytics whose capacitance varies with changes of temperature, age and applied voltage. Metallized capacitors can be used even though their change of capacitance with age is larger than that of the paper type. The other two factors affecting stability are more or less controlled by line voltage. Line-voltage variation troubles can be lessened by using voltage-regulator tubes to supply the plate and capacitor charging voltages. The added expense of voltage-regulator tubes can be eliminated without affecting timing stability if the line-voltage variation effects in the timing circuit can be made to cancel each other. The circuit shown here uses this principle (see diagram).

The timing circuit is controlled by S1. The length of the timing period is controlled by R2 and S2. When S1 is in the reset (open) position and ac line A is negative with respect to line B, grid current flows through R6, R3 and the bottom part of R2. C1 will then charge to a voltage determined by the setting of R2. With S1 switched to the time position, a sinusoidal voltage from the movable arm of R2 is fed to the grid of the thyratron which is in phase with the plate voltage. This would normally cause the tube to conduct on half-cycles of the line voltage when line A is positive with respect to line B. However, the large voltage to which C1 is charged keeps the thyratron from firing. As C1 discharges through R3 (or R4 or R5, depending on the range), the negative grid bias lowers to the point where the instantaneous grid–cathode voltage allows the tube to fire. The tube current energizes the relay and turns off the apparatus being timed. Capacitor C2 is connected across the relay to keep it from chattering and R7 is used to prevent excessive current surges when the tube first fires.

As the plate voltage of the thyratron increases, a larger negative grid bias is required to keep it from conducting and allow the circuit to give the same timing period as before the increase. This increase of negative bias voltage is automatic since the voltage furnishing the charge for C1 is the same line voltage that is applied to the thyratron grid and plate. The same cancellation effect in a reverse sense occurs with a reduction of line voltage.

The timer is constructed along conventional lines. C1 is made by connecting four 1-of-200 volt paper capacitors in parallel, and the 76-megohm resistor is made up using four 18-megohm resistors in series. All the other components are readily available. Should timing periods longer than 10 minutes be required, either C1 or R5 can be increased in value to include the desired range. S1 must be left in the reset position long enough to charge C1 completely—2 seconds should be adequate.

The dial indicating the position of R2 is calibrated with a watch having a sweep second hand. The longest timing range is calibrated by connecting an electric clock into the timed output of the timer. The dial calibration should be rechecked at several points whenever the tube is replaced.
MUCH is being said these days about three-channel stereo—pro and con. Some people say that when a two-channel system is properly adjusted and the audience is seated ideally with respect to the speakers, there is no conscious feeling of sound separation and the listener is magically enveloped in the curtain of stereo realism.

Unfortunately, because of recording defects, inadequacies of speakers or difficulties in their placement, or perhaps even the psychological effect of being able to see two speaker systems, this ideal is not always achieved. The result is frequently referred to as the “hole in the middle.” This region between the speakers is seldom a completely blank area. More often it is a sort of no man’s land, in which center-stage performers seem to be moving about from side to side.

Various schemes have been devised to correct the hole which stands in the way of ideal two-channel listening pleasure. These methods make use of a third channel which is recovered from the two-channel source. For example, if two microphones are correctly located with respect to each other and with respect to the plane of the sound source, their combined output will be the same as that of a single microphone placed exactly midway between them. The hole in the middle can be perfectly plugged by recovering this third channel through combination of the two stereo signals. Recovery and reproduction of the third channel focuses center-stage soloists and provides the final tonality of the original sound.

Adding the third channel

Third-channel systems are generally of either the L-R difference of L + R sum signal types. Fig 1 shows a popular approach to the difference signal method. Because of the nondirectional quality of bass frequencies, they tend to reach the two recording microphones with substantially equal magnitude. This results in equal signals in both amplifiers, and the center-channel output is zero. Treble frequencies, however, result in different signals through both amplifiers and produce a difference signal in the center-channel speaker system. Aside from inability to phase the center speakers and the loss of bass frequencies, this method could be used to fill the hole in the middle.

Obviously, this system cannot be used to reproduce a monophonic signal, since the center speaker remains mute when left and right amplifiers are balanced. Furthermore, dissimilar power amplifiers connected in this fashion could develop serious instability problems. Also, the center channel cannot be used as a remote monophonic reproducer of a stereophonic input because of the drastic reduction of bass frequency response in the mixing process.

Fig. 2 shows another way to get a third channel—this

*Assistant chief engineer, Allied Radio Corp., Chicago, Ill.
audio—high fidelity

Fig. 1—Center speaker reproduces a difference signal.

time by a summation process. Here the mixing takes place in the preamp outputs by a resistance mixing or by mixing in a tube. Though this method has the obvious advantage of full frequency response in the center channel and can be used remotely as a monophonic reproducer, it requires a separate preamp and a dual basic amplifier plus a third-channel amplifier or three basic amplifiers. This could be prohibitive from a standpoint of space and cost.

The Knight-Kit 40-watt stereo amplifier eliminates the need for the separate preamp and the third power amplifier by using the output transformers in a somewhat different configuration. Fig. 3 shows this setup—with the 4-ohm taps grounded instead of the transformer common leads. Since the 4-ohm tap, electrically, is the secondary center tap, the output transformers are connected in an additive arrangement which resembles push-pull. Correct phasing of the center speaker is no problem. A T-jad is shown on the center speaker because the acoustic output of the center speaker is virtually the same as the other two in a balanced condition and need only be set as high as necessary to augment the center.

When using the output transformers in this unusual manner, stability must be insured under all conditions. As a matter of fact, the entire amplifier was designed around the output circuit to insure good frequency response and an extremely high stability margin. A true test of the stability of this amplifier is that when the center channel is loaded...
with a 4-, 8- or 16-ohm speaker and both other channels are unloaded, there is no tendency toward instability at either the high or the low end.

Amplifier specs

The output stages use 6973 tubes with fixed bias and can deliver 20 watts per channel to the load with less than 0.5% total harmonic distortion (see Fig. 4). This low distortion is due in part to 38 dB of negative feedback in each channel.

The phase inverter uses a 12AX7 in the "long-tailed pair" circuit because of the desirable effect on frequency response and phase shift, in addition to its ability to provide gain.

The preamp consists of another 12AX7 with passive equalization located between the two triode sections. There are five pairs of stereo inputs.

There are five pairs of stereo inputs, each comprised of stereo inputs, each comprised of stereo inputs.

**Fig. 3**—A sum signal produced by mixing in the output transformers, including tape head, magnetic phono, ceramic phono, tuner, and auxiliary.

Frequency response at a 10-watt output level is within 1 dB from 15 to 40,000 cycles into the tuner input for all three channels. Hum and noise figures, based on 10-mv and 1-volt input reference levels, are 60 dB below 20 watts into the tape and phono inputs and 75 dB below 20 watts into the tuner and auxiliary inputs. There are hum balance controls in the heater circuits of both channels with 50 volts of filtered dc to raise the heaters above ground. The tone controls are dual-concentric pots with clutch drive, and are capable of a full 15 dB of boost or cut on both bass and treble at 20 and 20,000 cycles. Harmonic distortion at 20 watts per channel is less than 0.5% and intermodulation distortion at 60 and 7,000 cycles, mixed 4 to 1, is less than 1% at rated power.

Isolation between channels is better than 40 dB in all stereo positions, and 84 dB with the third speaker connected.

The amplifier is being marketed in kit form by Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., for approximately $50. It comes complete in a stylish case with full instructions for assembling the unit.

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**Audio—High Fidelity**

**Fig. 4**—Circuit of the Knight 40-watt stereo amplifier kit omitting portions of right channel.
AUDIO—HIGH FIDELITY

STKRO records on open-reel tapes are re-

ingning popularity as the ultra-narrow-gap

playback head comes into wider use. Originally
developed for playback of 3.75 tapes, the 90-mic-

cron head more closely approximates the fre-

cquency response on quarter-track stereo at 7.5

ips. The present signal-to-noise ratio on quarter-

track is only factors other than the playback

head. Tape fans with two-track recorded tapes in

their collection will find that the new head
delivers improved sound. I hadn't supposed this

so. Listening to a variety of two-track tapes, I noticed a condi-
tion we all encounter after upgrading the rec-

ording to a sound system. Recorded material that

used to sound reasonably flat to 10,000 cycles
returns flatness above that figure following in-
stallation of the new component. But recordings,
tape or disc, that once exhibited peaks in the upper

middle sound artificial when playback re-

sponse includes frequencies above 10,000 cycles.

No matter what the future of two-track, good

tapes in this form have not been made obsolete.

TCHAIKOVSKY: Francesca Da Rimini

Hamlet

Leopold Stokowski conducting New York Stadium

Symphony Orchestra.

Everest Stereo 4-Track Tape STBR-3011

(7-Inch, Playing time, 42 min. $7.95)

Technical Rating: EXCELLENT

Considering the sonic demands of these power-

ful scores, this is an encouraging entry in quar-
ter-track stereo. Evidence has been lacking so

far that the average master tape could be re-
duced to quarter-track and still retain the

waltz of half-track stereo. Everest, however,
is the first outfit to release a sizable group of

classical four-track 7.5-tapes that deliver the solid

sound we look for in quarter-track stereo.

Lows are very impressive. Hichs are cleaner and

more extended than those heard in the four-track

Bolero tape reviewed last month. On a flat sys-
tem, tape hiss is no problem. Stereo separation

is no wider than that of a good disc but the depth
illusion is better. The fantastic thing is the price—

only a little more than a symphonic tape car-

tridge of this duration.

Hal Holbrook in Mark Twain Tonight

Columbia Stereo Record OS-2019

Technical Rating: GOOD

In transferring to records Hal Holbrook's

masterly characterization of Mark Twain re-

cently seen on broadway, Columbia uses stereo
to emphasize the rambling informality of the

great American humorist's platform manner.

The performance-uniformly before an alert

audience, Mr. Holbrook is free to move about

as he chooses. Twain's wit is much funnier when
delivered at the spur of the moment.

Lavalle in Hi-Fi

Paul Lavalle—His Woodwinds and Band

RCA Victor Stereo Tape Cartridge KPS-3006

(Playing Time, 31 min. $5.95)

Now that dealers are beginning to stock 3.75

RCA tape cartridges, owners of conventional

four-track machines may be curious about the

results obtained when the tape is transferred

to open rews. The easiest way to do this is

to cut the tape at the point where the exposed

strip re-enters the magazine on its way to the

takeup wheel. In the majority of cases, it may

be advisable to splice leader tape immediately.

Turn over the cartridge to put the business side

of the tape on the inside. Then release the

brakes that grip the edge of the wheels. If

the inside of the cartridge has been disturbed,

the safest winding speed is 7.5 ips. The fast for-

ward speed of some tape machines may em-

phasize the play in the loosely seated unwind-

ning wheel of the cartridge. I stretched my first

tape that way when the wheel shuddered to a

virtual halt before I could stop the takeup reel.

After transfer, the major problem is equaliza-

tion. These bright novelties by Paul Lavalle's

group sounded lost on an open reel. Lows were

there but little else could be heard with the

playback equalization I had used for open-reel

7.5 four-track. Top end closed shop at a point

about 4,000 cycles below the high end of the

open-reel Francesca Da Rimini Everest tape

reviewed this month, which was of blank

tape with response improvement of 4 db above

12,000 cycles is schedule for use in tape car-

tridge. I signal-to-noise ratio is far from the

 *) A rough estimate of open reel due to the uniformly

high level of the music.

Symphony of the Air

Concerts Four-Track Stereo 4T-4002

(7-Inch, Playing time, 39 min. $7.95)

Technical Rating: FAIR

Two recent Concertes releases are reviewed

today, side by side this month to underline how in-

consistent can be the present audio quality of

quarter-track tapes. Originally recorded in 1954

Carnegie Hall with the later version, the former

members of the NBC Sympho-

ny are heard in a tape that is below par in

performance and price. A much better

water mark for open reel due to the uniformly

high level of the music.

LOEWE: Gigi and My Fair Lady

Cesar Giovanni Orchestra

Concerto 4-Track Stereo 4T-4001

(7-Inch, Playing time, 33 min. $7.95)

Technical Rating: EXCELLENT

The selections from Gigi and My Fair Lady

are an entirely different story. Although the tape

is shown to deliver more engaging and pungent
demos available today, but anyone upgrading his stereo rig is

advise to include a record of this type when

auditioning components. A particularly devilish
test is found in some of the delicate transients

of the harp. Very delicious.

Note: Records below are 12-inch mono LP and

play back with RIAA curve unless otherwise

indicated.

Eveline Garme on Stage

ABC-Paramount ABC-307

Technical Rating: FAIR

The arena of the vast Convention Center at Los

Angeles was the setting for a Salute to

Benny Carter, who was the guest of honor.

Careful listening uncovers a hint of the acous-

tical freedom possible under such conditions.

Songstress Eveline Garme and the band were

mixed at very close range, and the master tape

was equalized for maximum effectiveness on

small phones. Despite these factors, enough of

the free-sounding acoustics come through to

that the appetite for further experiments of

this type under a flatter recording curve.

Swaying the '20's

Benny Carter Quartet

Contemporary M-3561

Technical Rating: EXCELLENT

In this outstanding release, some of the best

tunes of the 1920's are brought to life by two

jazz "greats" who knew them when. Benny

Carter, playing sax and trumpet, is joined by

veteran pianist Earl Wintner, bass, and drummer Shelly Manne take care of their

innovations with customary ease. Carter and

Hines, inventive as ever, dispense more ideas

in one tune than some jazz men display on a

whole side of an LP. The sound is on the top

side of excellent.

Name and address of any manufacturer of rec-

order mentioned in this column may be obtained by

writing Records, Radio-Electronics, 151 West

1 St., New York 11, N.Y.
**TRANISTORS IN AUDIO**

**Part I—The first in a series of articles intended to guide you down the road toward designing your own transistor equipment. This month, the methods used to select optimum circuit values for a transistor amplifier stage are presented.**

By HERBERT RAVENSWOOD

BUILDING transistor equipment can lead to problems in a variety of ways. Either you can find full details of all kinds of equipment, except the one type you happen to want; or you find one that looks exactly like it was published only a few months back, but one of the transistors it calls for is already obsolete; or the circuit published used one battery voltage and the one convenient for your use is different.

Before you vent your spleen on the publisher for any of these shortcomings, realize what a rapidly growing industry transistors represent. If you happen to be on the mailing list of several transistor manufacturers, you know that a type current this month may no longer exist next month. Usually there is a substitute—an improved type—but can you use it without making circuit changes? Even if it can be used without changes, would variations in circuit values make it perform better?

**Work up your own circuit**

The solution is easy—just work out your own circuit from the information you have. But if you intend one of the more ambitious projects, using several transistors, don't be too hopeful at first—get one stage working at a time. You can guard against burning out one transistor until you get the right values for it and then you can tackle the next. If you make up the complete circuit, you may have one or more transistors burn out on you.

Always be sure the collector supply voltage is lower than the maximum rating for the transistor you are using. If your voltage supply is higher than the transistor's maximum rating, use a voltage divider that will keep you from exceeding the maximum voltage even when the transistor draws no current (as it does at cutoff). Make sure the voltage is right before you put the transistor in circuit.

Next, adjust the transistor's operating point to an optimum for the purpose in hand. Early stages in a multipurpose amplifier—whether for a hearing aid, an audio stage for a radio receiver or a stage in an audio preamp or power amp—are operated for maximum gain and in some instances for minimum noise (but this we shall come to later). Later stages trade a little of the maximum gain for current or voltage swing.

If you're like me—used to working with tubes for several years—the need for thinking about current swing as well as voltage swing may be a little difficult at first. But, believe me, it comes easy as soon as you start working with one of the little beasts in front of you. The important thing to remember is that a transistor acts as a current amplifier.

This is complicated a little because it is more convenient to measure voltages. But if we measure voltage across a resistance, it is easily converted into current. Let's give a transistor a workover to illustrate. The 2N109 is a good choice. It is readily available, is a good general-purpose type and probably it will not be obsolete tomorrow!

We set it up in the simple circuit of Fig. 1. Two resistors can be adjusted in this setup, the collector load and bias resistors. For convenience the input resistor is kept a constant value, making current gain easier to figure. At any chosen value of collector load resistor, the bias can be adjusted in one of two ways. The first is to watch the output on the scope and adjust the bias so that the output and the input are in phase at the same time as input level. This is a little involved, because you have to juggle the bias resistor value and the audio oscillator's output control together until the right point is found.

The most direct way is to adjust the bias with a voltmeter set to read dc collector volts, so the voltage on the collector is half the supply voltage. For the test figures tabulated, I used a supply set to 15 volts. Maximum swing, with both ends bending over at the same point, invariably occurs when the collector voltage is set to about 7.5. Incidentally, the available voltage swing under this condition invariably measured nearly the full 15 volts peak to peak, or a little more than 5 volts rms, which shows the transistor is a more efficient voltage amplifier—for giving swing—than any tube amplifier. Do you know a tube that will give 250 volts peak-to-peak swing with only 260 volts on its plate, R-C-coupled?

This adjustment to mid-supply volt-

---

**TABLE 1—TEST RESULTS OF SIX 2N109'S**

<table>
<thead>
<tr>
<th>Transistor No.</th>
<th>Collector volts (10K)</th>
<th>Collector current, ma</th>
<th>Volts out (1 volt in)</th>
<th>Current gain 1K</th>
<th>Current gain 10K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Collector</td>
<td>7</td>
<td>7.5</td>
<td>7.3</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>2</td>
<td>0.8</td>
<td>0.75</td>
<td>0.77</td>
<td>1.15</td>
<td>1.05</td>
</tr>
<tr>
<td>3</td>
<td>4.8</td>
<td>4.4</td>
<td>4.7</td>
<td>5.3</td>
<td>5.2</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>44</td>
<td>47</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>7.6</td>
<td>7.5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>7.4</td>
<td>7.5</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>3.4</td>
<td>3.2</td>
<td>3.4</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>8</td>
<td>68</td>
<td>64</td>
<td>68</td>
<td>72</td>
<td>72</td>
</tr>
</tbody>
</table>

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**Fig. 1—Setup for making tests described in this article.**
Let's figure the current gain

Now let's see how we figure the current gain, and what it means in regard to what can be done with the transistor. First it's a good idea, unless you plan to use just one transistor and set your circuit to suit that one, to run through half a dozen and see how they compare. For this purpose I went through a bunch of six 2N109's with two values of collector and bias resistors. The results are tabulated in Table I. With a 10,000-ohm collector resistor the bias resistor is 1 megohm. With a 1,000-ohm collector resistor the bias resistance is 160,000 ohms.

With a 1-megohm bias resistor, bias current is 15 µA, and the collector voltage varies between 3.5 and 7.5. This corresponds with a drop across the 10,000-ohm collector load resistor from 11.5 volts or 1.15 ma, to 7.5 volts or 0.75 ma. With a 160,000-ohm bias resistor, the collector voltage varies between 5 and 7.6. This, across a 1,000-ohm collector load represents a drop of 10 volts with 10 ma to 7.4 volts with 7.4 ma.

Current gain is measured by checking the voltage gain and converting to current. For example, with the 10,000-ohm collector load, 1 volt rms is fed into the input end of the 100,000-ohm input resistor. This means the input current is 10 µA rms. If we then measure an output of 4.8 volts rms, in the collector load of 10,000 ohms, the output current is 0.48 ma, or 480 µA, representing a current gain of 48.

At high current operating conditions, the input voltage will have to come up (or an appropriately lower input resistance could be used). With a 160,000-ohm bias resistor and a 15-volt supply, the bias current must be 94 µA. So we can use 50 µA rms, which, with a 100,000-ohm resistor, requires an input voltage of 5. If this yields an output of 3.4 volts rms across the 1,000-ohm coupling resistor, it represents an output current of 3.4 ma, or a current gain of 68.

Now which transistor would you pick to make further tests on? If you are planning to make a reliable piece of equipment, I would suggest you take one of the samples with current gain near the lowest. You may not be able to rely on high values repeating. For the rest of these tests I used the 2N109 identified as No. 3 in Table I. And the spread on these transistors is small compared to some I have tried! Of course, the fact that different transistors produce different collector voltages with the same bias resistor, or need a different resistor value to get the right collector voltage, means we shall need to do something to make the bias produce the right collector voltage automatically. But more about that later.

Picking one of the transistors, the next step was to check its current gain over a whole range of collector load resistances which are tabulated in Table II. The procedure for each reading is as follows (see Fig. 2 for the hookup used in this test):

1. Set collector resistor to the value required for the reading. Start with 10,000 ohms.
2. Adjust the bias resistor so collector voltage is 7.5.
3. Adjust the input voltage so the output voltage across the collector can be a convenient multiplier of current gain. For 10,000 ohms the input voltage was 1 volt rms. Then the 0-6-volt rms range reads current gain of 0-60—4.7 volts means a current gain of 47. (This can be verified this way: 1 volt into 100,000 ohms delivers 10 µA; a current amplification of, say 50, will produce 500 µA, which, in a 10,000-ohm load, will develop 5 volts.) For 8,000 ohms, the input voltage can be raised to 1.25 when the same conversion can be used. Since 1.25 volts into 100,000 ohms delivers 12.5 µA, a current amplification of 50 will yield 625 µA, which,
Across an 8,000-ohm load, will develop 5 volts again. For a 6,000-ohm collector load, the input can come up to 1.66 volts and still use the same conversion. This series of inverse input voltages can be used on up to a 2,000-ohm collector resistor, in this case, requiring 5 volts input. But at 1,000 ohms, current gain takes a jump, so a 10-volt input would overload the output. A 5-volt input can be used again, using the scale to represent a current-gain range of 0-120, where a 3.4-volt reading means the current gain is 68. Higher current readings can be taken in the same proportion.

4. Disconnect the battery, unplug the transistor and measure the bias resistor, from which you can calculate the base current.

An important thing to watch at higher currents (collector resistor lower than about 2,000 ohms) is the transistor’s temperature. It should never get more than slightly warm. Of course, tests are made quickly under conditions that would not be permissible for continuous operation.

Effect of varying the bias

Another thing we can investigate when we use this setup is the possibility of getting lower gain at different bias values. Turning the input down until the output is only about 1 volt rms and adjusting the bias without changing the input, we can find how the output varies, indicating differences in current gain, at different bias points. Using a 10,000-ohm collector load, the gain stays very nearly constant—as near as can be told from the readings.

But with a 1,000-ohm collector load we find quite a deviation at various bias points. This can be understood by looking at the published characteristics (Fig. 3). The 10,000-ohm load line lies across only the lower area of the diagram, while the 1,000-ohm load line cuts up across a section a little higher up the curves. Table III gives the results at various bias points for a 1,000-ohm collector resistor and Table IV for 250 ohms. At low collector-voltage (high-current) operation, current gain is lowest. It rises to a maximum around 12 volts, 2 ma on the collector (for the 1,000-ohm load), and drops off a little again at lower currents.

The figures given apply only to the particular 2N109 used and probably only at the temperature of the day I took the readings. While it is indicative of the kind of curvature you will find with all of them, they vary considerably from sample to sample in this respect and some types are worse than others.

But what have we learned about using the transistor in a practical hook-up? The high 100,000-ohm input resistor is not directly applicable to any amplifier circuit. We used it here as a convenience, for three reasons:

1. By using a high input resistance we can use a paper capacitor without phase troubles to provide dc isolation, avoiding the small leakage that occurs with electrolytics which alters the bias slightly. A practical circuit using electrolytics must allow for this leakage, but for test measurements it is easier to avoid it.

2. The high input resistance lets us use an ac input voltage that can readily be measured.

3. We insure that the input current has the same waveform as the applied voltage. This makes the transistor reasonably linear as an amplifier. Even though we may have a sensitive voltmeter to measure input voltage at the base, its waveform will be poor, because of the transistor’s nonlinear input resistance. This way everything behaves as linearly as possible, so the transistor’s basic properties can be measured in a straightforward manner.

In practice, of course, the input resistance will be much lower than 100,000 ohms. If we come down to 10,000 ohms for a collector load, we need only 0.1-volt rms input to give the full 4.7-volt rms output, representing the same current gain. We could possibly drop to lower value input resistors and realize a voltage gain much larger than the current gain.

But in a practical R-C-coupled stage, we are limited to the current gain of the transistor per stage. If the collector is coupled directly through a capacitor to the following base (Fig. 4), best efficiency is obtained if all the current swing is fed to the following base. This means the collector voltage will cease to swing, because of the low impedance coupled in parallel with its collector resistance. Any current swing that still goes through the collector load resistor can be regarded as a coupling loss.

The collector resistance (ac) of a transistor is high. (The collector voltage/current curves for a transistor are very similar to the plate voltage/current curves for a pentode.) Consequently it is a constant-current generator. Our objective is to get the current swing from the collector transferred to the base of the following stage.

Suppose the first stage yields a current gain of 50 (Fig. 5). An input swing of 10 ma rms yields an output swing of 500 ma rms. But now, if the collector load resistance is 10,000 ohms and the following stage’s base input resistance is 500 ohms, the available current swing divides, 1/20 into the 10,000 ohms and 19/20 into the 500 ohms. So the effective current gain from the base of the first transistor to the base of the second is 19/20 of the ideal, or 47.5.

We could measure this as a voltage gain. If both transistors have an input base resistance of 500 ohms, the voltage gain measures the same as the current gain, 47.5, but the waveform will be very poor due to the nonlinearity of the base input resistance. Therefore, now is it that R-C coupling, without any additional resistance, does not similarly produce considerable distortion?
 AUDIO—HIGH FIDELITY

The answer is simple: because the collector, with its load resistance, supplies current, rather than voltage. A total 500-\mu A swing is supplied by the collector, whether 475\mu A goes through the load resistor, or all 500\mu A goes through the load resistor. When it supplies 475\mu A to the base of the following stage, the voltage waveform goes away because the current waveform is driven linearly. But when the whole 500\mu A goes into the load resistor, which can be done by pulling the following transistor out of its socket, the voltage rises and has good waveform (provided it does not swing too far).

Improving the gain figure

Across the 475-ohm collector load (10,000 ohms in parallel with 500 ohms) when feeding the following transistor, a 500-\mu A swing produces about 238 mv of poor waveform. But when the following transistor is pulled, the voltage jumps to 5 volts of good waveform, because the 500\mu A is now fed through the linear 10,000-ohm resistor.

But this seems rather wasteful. We are only getting an active gain of about 47.5 when the transistor seems to be capable of amplifying the current swing by about 50 while, at the same time, working from an input impedance of about 500 ohms with an input swing of 10\mu A or 5 mv, into a 10,000-ohm collector load it yields a 5-volt output, representing a gain of about 1,000.

Effective Z = 22K (due to 5000 load on sec)

Fig. 6—How transformer coupling can increase current gain by avoiding excessive current drop when the following stage is coupled, without losing the current coupling (as would occur if a resistor were inserted in series with the coupling to the following base).

(disregarding possible nonlinearity for the moment). Then when it is R-C-coupled to a following stage, only the gain of 46-50 can be realized.

Using a high value collector load resistor, say 1,000 ohms, yields a higher current gain. By suitable choice of bias it can be pushed up to about 80. But then the current gain is divided between 1,000 ohms collector resistance and 600 ohms base input resistance, leaving only about two-thirds of the 80 value, or about 63. As the effective source resistance for the following base has dropped from about 10,000 to 1,000 ohms, this will be accompanied by some loss of linearity. Steps which we detail later could overcome this, but they also lose their slight advantage in gain.

A more successful method of improving gain is to use an interstage transformer (Fig. 6). We have seen that going from a low collector load resistor up to 10,000 ohms reduces wide-swing current gain from about 68 to about 47.

A calculation based on these figures shows the effective (internal) collector resistance to be about 22,000 ohms in this region. So using an effective collector resistance of about 22,000 ohms should leave us with a current gain of about 34 (half the maximum value of 68). This can be provided by a transformer, working stepdown, so the input resistance of the following stage is stepped up to about 22,000 ohms from its actual value to 500 ohms. This is an impedance ratio of almost 50 to 1, or a turns ratio of about 7 to 1. As the voltage is stepped down, the current is stepped up. So the overall current gain will be about 34 x 7 = 238, which is a considerable improvement.

Now we have some good basic figures from which to start in figuring out the best values to use for any particular job. We have found that transistors vary somewhat, but there are non-linearities that can prove troublesome. In following articles we shall show how to tackle these problems at different stages and for different purposes, and end up with the circuit that best suits the job. TO BE CONTINUED

Simple Attenuation Network

By A. G. SYNDOR

T-PADS usually take care of the majority of attenuation problems the electronic technician has to handle. In such an attenuator, three resistors are connected to give the proper matching load to the impedances it is connected between, and the desired loss. A conventional T-pad is shown in Fig. 1. The formulas for determining the values of the resistors in the pad are:

Asymmetrical or unbalanced T (different input and output impedances): For example, 3,000 ohms input to 500 ohms output with 15-db attenuation:

\[ R_3 = \frac{2\sqrt{N \times Z_2 \times Z_{in}}}{N - 1} \]

\[ R_3 = \frac{2\sqrt{31,62 \times 3,000 \times 500}}{31,62 - 1} = 450\Omega \]

\[ R_1 = Z_{in} \times \left( \frac{N - 1}{N} \right) \times R_3 \]

\[ R_1 = 3,000 \times \left( \frac{32.62}{30.62} \right) = 450 \times 3.9 \]

\[ R_2 = Z_{in} \times \left( \frac{N + 1}{N} \right) \times R_3 \]

\[ R_2 = 500 \times \left( \frac{32.62}{30.62} \right) = 450 \times 2.9 \]

Symmetrical or balanced T (input and output impedances are the same): For example, for 500 ohms input to 500 ohms output with 18-db attenuation:

\[ Z = Z_{in} = Z_{out} = 500\Omega \]

\[ R_3 = \frac{2\sqrt{N}}{K} \]

\[ R = \frac{2\sqrt{500 \times 500}}{31.62} = 128\Omega \]

This covers the standard T pad. But in non-critical spots there is a simpler method. If we rearrange the legs of the network we come up with the arrangement of Fig. 2. Here we have taken one of the T-pad’s legs and moved it to the opposite end of the parallel leg. We call this arrangement a Z pad, as its appearance resembles the letter Z.

In effect, all resistors in Fig. 2 are in series, though not with the input or load, and it is obvious that a single tapped resistor can be used. Fig. 3 is a sketch of such a resistor and shows the terminals for both input and output connections. The sections of the

resistor are marked for comparison with other types of pads.

For attenuation pads with identical input and output impedances, one 1,500-ohm resistor covers all attenuations between 4-48 db and provides 50-600 ohms input and output impedance.

Say we need 18-db attenuation in a 500-ohm line. From the equations, we found a T pad uses 388 ohms for R1, 388 ohms for R2, 128 ohms for R3. With an ohmmeter we measure section AB of our resistor (see Fig. 3) and set the first slider for 388 ohms (R1). Then we measure from B to C for 128 ohms (R3) and from C to D for 388 ohms (R2). Total resistance needed is 804 ohms.

For different input and output impedances use the standard T pad formulas and let section AB of the resistor (Fig. 3) equal R1, section BC equal R3, and section CD equal R2.

Fig. 1

Fig. 2

Fig. 3

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Complex electronic equipment isn't needed to check your hi-fi system—use a test record or tape and your own two ears

By CHARLES B. GRAHAM
ASSOCIATE EDITOR

ONE of the best aids for technicians and audiophiles in checking out hi-fi systems, especially stereo versions, is the specially prepared test recording. Test records are better than music (demonstration records) because they furnish for reproduction precise definable bits of sound whose pitch and loudness are carefully controlled.

All test recordings have accompanying descriptive notes so the listener will know what to expect to hear if equipment is working properly. If it is not, the test record will be imperfectly reproduced, giving one an idea where the equipment fails short.

In addition to testing the response of a system to changes in pitch and loudness, it is desirable to check the dynamic range, signal-to-noise ratio, transient response, distortion and equalization.

Using a test record

We measure the ability of a system to respond to changes in pitch by taking a frequency run from, say, 30 to 15,000 cycles. Dynamic range and signal-to-noise ratio are functions of the loudest undistorted volume the system can handle taken together with the system noise, tube and component hiss, hum, recording-medium noise (stylus on vinylite, or tape hiss). Turntable noise (largely rumble) is also a factor here.

Distortion can be checked roughly by listening or, better still, by observing waveshapes on an oscilloscope screen. Good transient response can be indicated (though not measured) because smooth high-frequency response and gradual roll-off can often be correlated with good transient response.

In addition to the preceding characteristics, there is one which we do not have in monophonic reproduction, but do run into with stereo—crosstalk, or its reciprocal, channel separation.

Since stereo discs always involve mechanically coupled elements, both when cut and when played back, there is always some mechanical leakover, some crosstalk between channels. When this is at least 20 db down from the level of the desired material, it is pretty well masked. But channel separation of any, 20 db on the recording may be demolished by the playback cartridge, since many pickups have less than 15 db of separation over most of their ranges. The separation in pickups decreases as the frequency goes up.

Stereo disc cutters also have finite limitations on their separation and tend to have less separation as frequency increases. The Westrex 3-C cutter, most widely used today, has channel separation of perhaps 25 db or so up to about 10 kc, and between 10 and 15 db up to beyond 15 kc. William Miltenburg, chief engineer for RCA-Victor Records in New York, says that RCA is at present recording most discs to the limits of audibility. According to recording engineers, the earlier Westrex 1-A cutter was flat only to about 10 kc. Many improvements remain to be made.

Stereo test discs are sold by seven companies in this country, and two or three more expect to release one about the time this appears. They can be divided into two groups—those best suited to shop or home use because they have a variety of tests and those intended for checking frequency response and channel separation. The first group consists of the Audiotester 30-200, Audio Fidelity FCS 50,000, Components H-58 (7-inch) and Ziff-Davis Stereo-Mono Test Record. They may be joined before long by test records from Vanguard and Westminster, and probably Fairchild Recording. The second group includes the London PS-131, RCA-Victor 12-5-71 and 73, Teldec TP 217/T and Westrex 1-C. (Mono test discs are also available. They are made by Components, Cook, Clarkstan, Electra, Gotham, Lafayette, Radio, Popular Science Magazine and Urania.)

With few exceptions test tapes and discs are not widely available at local record stores or hi-fi showrooms. Sometimes they can be purchased only direct
from the manufacturer. Others are listed in mail-order catalogs. At the end of this article are listed the addresses of the makers of these items.

Test discs and tapes may be used without any equipment except the gear under check, using one's ears to compare the actual sound output with the sound described in the notes accompanying the test material. An ac meter is helpful, and an oscilloscope is even better. If the meter is not an audio vtvm, it should have a low scale—preferably 1.5 volts—since it must be connected across the voice coil of the output transformer where the impedance is so low that the signal voltages may be small. A vtvm can go at any convenient point in the circuit, for example, across the tape recorder output or across the input to the power amplifier.

A scope is especially useful in observing the waveforms produced when playing high-level test tones. Distortion can often be easily observed visually when it cannot be identified with certainty by ear. A scope is also very helpful in rumble tests since the reference tone, usually 1,000 cycles, will show up on the scope as a small but steady shape, whereas the random noise along with possible unsteady rumble will shift and change continually. The scope can be connected right across the voice coil output. It should be calibrated, if it does not have a graticule, by sticking two pieces of paper or tape on the screen just far enough apart to mask the part of the screen not traced by the 1,000-cycle reference tone.

On the discs

Certain discs and tapes have previously been described in these pages. Westrex 1-C (issued in limited quantities and no longer available), London PS-131 and RCA 12-5-71 (1 kc-20 kc) stereo test discs are detailed in RADIO-ELECTRONICS, March, 1959, page 90. Ampex, Audio Devices and Livingston test tapes are discussed on page 46 of May, 1958, and Westminster's earlier SWB-AL 101 and Stereophony's tape on page 43, June, 1958.

Typical of the most useful stereo test discs is Components' stereo Hi-Fi Test Record (this company is responsible for the actual engineering of several test discs released by other companies). This 12-inch LP has 13 cuts or bands. Side A for stereo testing only, has band 1 recorded at medium level; a single tone, announced for the right channel first, then the left one, for channel identification. Band 2 has a metronome recorded equally in both channels, to allow balancing the sound coming from the two speakers.

Band 3 feeds tone in phase to both speakers for 15 seconds, then out of phase for 15 seconds. If the speakers (and the cartridge and amplifiers) are correctly phased, the second tone will be noticeably lower than the first. If the speakers (or other units) are not phased properly, the second will sound louder than the first. This is because they aid each other when they come out of speakers phased together (as they do gives going in and out at the same time). They tend to cancel sound partly in the second cut if the speakers are properly phased, fairly closely balanced, and if there isn't too much reverberation and reflection in the room. If the speakers are not properly phased, then the in-phase signals of the first band would come from the speakers out of phase, and the out-of-phase signals of the second band would come from the non-phased speakers in phase. However, in each case the signals must be balanced beforehand and the room must be pretty dead. We had a lot of trouble with this test, finally solving it by turning the gain down low on both channels and putting the two speakers close together and listening very close in front of them. Vanguard Records has apparently worked this out, for the instructions accompanying their forthcoming test record suggest placing the two speakers side by side.

Band 4 is a gliding tone in one channel, starting at 10 kc and coming all the way down to 60 cycles. This is repeated in band 5 for the other channel. It will show how smooth (or bumpy) the response is, and is excellent for testing channel separation. Band 6 has numerous unusual stereo sound effects, including a wall-shaking reproduction of the whistle of the Queen Mary.

The second side of the disc is useful for both stereo and mono testing. It has the familiar stylus wear test in bands 1 and 7. If the test tone sounds smooth in both of these bands, the stylus is in good shape. If inside band 7 sounds distorted when compared to band 1, the stylus is bad. Band 2 is a glide tone from 35 kc down to 1 kc, with tiny audible (and visible, if scope is in use) beep markers every 3-4 kc. This will show up pickup (and arm) resonances. Band 3 checks RIAA equalization by playing 15 kc to 30 cycles in graduated steps, with announcements.

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Other test discs have similar groups of tests, many of which are very well thought out and executed. One especially good one on the Audio Fidelity disc is that for channel separation and intermodulation. It provides a 3,000-cycle tone on one channel at the same time that it has 800 cycles on the other. Then it reverses the tones. By turning the gain down on first one channel, then the other, one can easily note any crosstalk.

Other tests on the Audio Fidelity disc are: band 1, metronome, for balancing speakers; band 2, 1,000 cycles at 5 cm/sec (reasonably high "zero" level) in both channels; band 3, silent grooves, for rumble test; band 4, high-frequency
test tones; band 5, low-frequency test tones; band 6, glide tone, 70–15 cycles; band 7, 140 cycles—musical note A; bands 8 and 9, 3,000 and 500 cycles for crosstalk test. Reverse side of disc, excerpts from five symphonic marches (with label and first two reverses.

Audio Fidelity FSC 5890 is a superior demonstration disc, which includes some incredibly live sound effects. Giant steam and Diesel locomotives thunder and grind across the living room; racing cars rear past, skid and screech, and various cannon and gunfire sounds ricochet and echo into the distance.

Audio test 30-200 test disc has these stereo tests on side B: bands 1 and 3, pickup alignment and channel separation, 1,000 cycles at 5 cm/sec on each channel, then 1,000 cycles at 2.5 cm/sec; bands 2 and 4, frequency runs from 10 kc down to 50 cycles, equalized for RIAA curve; band 5, stereo balance—metronome recorded equally on both channels; band 6, 1,000 cycles 40 db down, to calibrate rumble. On side A there are mono and stereo tests: bands 1 and 6, 8,000 cycles at 3.5 cm/sec for stylus wear checking; band 2, frequency run for RIAA curve; band 3, IM distortion (100 and 7,000 cycles); band 4, rumble test; band 5, sweep from 50 to 10 cycles at 7 cm/sec (very high level) to find pickup and tone arm resonances.

The RCA-Victor 12-5-71 and 73 (both are needed for full frequency coverage) have only frequency runs. 12-5-71 is at 78 rpm to record the highest frequencies better. It goes from 20 to 1 kc in 1-ke steps at 3.8 cm/sec. One side has only channel 1 recorded, the other side has channel 2 recorded. The second disc (12-5-73) has low frequencies recorded at 38.85 rpm. It goes from 1 kc down to 30 cycles, one channel a side. Recording levels are indicated as at 0.42 cm/sec, but adequate. The surfaces of these discs are quiet.

The Teldec record made in Europe by English Decca and Telefunken has frequency bands from 1 to 1 kc in 10 steps, alternating channels. Then it runs 500 to 60 cycles in octaves, four bands. Teldec also has a 45-rpm disc—940 cycles at high velocity, 11 cm/sec for factory calibration of pickups.

Ziff-Davis Publishing Co. has issued a 7-inch LP test disc on which side A has these tests for stereo: band 1, channel identification and separation, 1,000 cycles, medium level, first one channel, then the other; band 2, metronome for channel balancing; band 3, speaker phasing, 100 cycles recorded in-phase (lateral) then out of phase (vertical cut); band 4, rumble test, 100 cycles recorded 20 db down, then 20, 40, and 50 db down from standard level for calibrating player and system noise. Side B has mono and stereo tests on bands 1 and 9, 100 cycles for estimating stylus wear; band 15, 1 ke to 40 cycles equalized RIAA, lateral cut.

Test tapes

Presently nine test tapes are available, sold by six companies, with RCA producing tapes for standard two-track stereo machines as well as the new four-track slow-speed cartridge machines. NCB-Tecnico has two tapes also, one for 7 1/2 and one for 15 ips. Audio Devices' tape was originally intended for 15 ips, but can be used at the 7 1/2-inch speed since at 15 inches it goes out to 15 kc. Thus at 7 1/2 ips it will check the playback heads up to 7,500 cycles. In addition to these two tapes there are the Livingston LX-1E, Ampex 5503 and AudioTest 30-208. The material on these is much less varied than on the discs described earlier.

Test tapes can measure the performance of only the playback function of a tape machine and assist the technician in correcting playback problems. They cannot measure the performance of the machine in recording.

Some time ago a particularly effective test tape (D-110) was produced by the Dubbings Co., who duplicates stereo tapes commercially on a large scale for many record companies. The tape is no longer made, but is still available for $12.50 from some mail-order houses and distributors. This tape, which runs for 14 minutes, includes precisely calibrated signals and voice announcements in a number of places to measure recorder wow and flutter, head alignment, frequency response, signal-to-noise ratio, maximum signal level and tape speed. The 66-page instruction book accompanying it is an education in itself. The Dubbings tape has much more complete tests than any of the presently more widely available tapes.

Audio test tape 30-208 includes seven sections recorded at 7 1/2 ips on a 5-inch reel. It checks head alignment at 7,500 cycles, frequency response and equalization in 10 spots from 30 to 10,000 cycles; has a section for checking IM distortion (which is most effective only with an IM analyzer, but which can be useful if a scope is used), a flutter test (5,000 cycles), a stereo balance test (metronome sound) and a number of piano chords.

RCA-Victor 12-5-64T test tape for the four-track 3.75 ips cartridge includes head azimuth alignment, 1,000 cycles at standard recording level, and a frequency run 15,000 to 50 cycles, and a phasing tone—2,000 cycles—and voice.

One final caution—these test discs, although usually produced under conditions of quality control at least as rigid as those used in regular production of musical recordings, cannot possibly be absolutely uniform from one disc to the next. The best pressing is a mass-production proposition, and small production variations are inevitable. Therefore results using test discs, much more than using test tapes, should be regarded as indications, not necessarily as measurements, or qualitative results.

Even such a small random and generally uncontrollable factor as the twist of the connecting wires at the rear of the tape will alter the amount of cross-talk of the system, changing from one day to the next.

Too, different pickups may alter the response of the system to test-disc material due to high-frequency resonances set up between the disc vinyl and the effective mass of the stylus. This point is often 12 to 17 kc. Three stereo test discs were received from Cook Laboratories too late for inclusion in this article. These, along with discs announced by Vanguard and Westminster, will be reviewed in a forthcoming issue.

STEREOPHONIC TEST DISCS*

AUDIO-FIDELITY: FCS 10,000, Audio Fidelity, 720 11 Ave., New York 17, N. Y. $4.95.

AUDIOTEST (General Cemint): 30-200, Audiotex Div. of G.C. Treaton, Rockford, Ill. $5.


RCA: 12-5-71, 78 rpm; RCA-Victor Custom Record Dept., 155 E. 24 St., New York 10, N. Y. $5.50, 12-5-73, 56.50.

TELEDISCO: TP 2157, Gotham Audio Sales Corp., 2 W. 44 St., New York 36, N. Y. $1.50.


Tape Tests


AUDIOTESTER (General Cemint): 30-208, Audiotex Div. of G.C. Treaton, Rockford, Ill. $5.

DUBBINGS: D-110, Discontinued: Available from some distributors. 3/4 ips. $10-$12.50.

NCB-TECNICON: Technic Laboratories Inc., Box 491, Lafayette, N. Y. 7/10 ips. $9.95.

LIVINGSTON: LK1E, Livingston Audio Products, Caldwell, N. J. $2.75.

RCA: 12-5-64, RCA-Victor Custom Record Dept., 155 E. 24 St., New York 10, N. Y. 4-track; 7/4 ips. 37.98.

*All discs 12-inch, 33 rpm unless noted. All tapes 7-inch, 7/10-7-12.5 ips unless noted.

"We're lucky this last one has cassettes!"

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Motor speed regulators are another field open to the enterprising electronic service technician

By W. G. CULPEPPER

In paper manufacturing it is essential to keep the speed of several dc motors constant during the process. Several electronic equipment manufacturers have developed successful electronic speed regulators. This article is primarily concerned with a specific one developed by Westinghouse for the St. Regis Paper Co. and now in operation at its Pensacola plant.

The regulator that supplies field current to a shunt-wound dc motor, which has a preselected regulated armature voltage, consists of three sections or panels: the input, amplifier and power panels. Motor speed is controlled by its field-current regulator. As the operation of the regulator is better understood by getting an overall picture of the machine components, let's take a look at Fig. 1.

The chief operator selects the desired speed of the paper machine with a motor-operated rheostat in the field circuit of the running generator. The machine drive this controls consists of 11 dc motors, ranging in horsepower from 50 to 400. These motors are individually brought up to the desired speed by a starting generator and transferred to the running generator bus. Each section motor drives a small ac tachometer or cue tach generator whose output is fed to the input stage of its speed regulator. There is also a master motor (which is also started with the starting generator and transferred to the run generator). It drives a reference ac tachometer whose output is fed to the input stage of all speed regulators. At each dc motor control station there is a rheostat in

Power, input, and amplifier panels that make up the electronics part of the regulator system.
series with the reference voltage which enables an operator to vary speed to get the desired tension (draw) of the paper sheet between sections. This rheostat (draw control) must be cleaned frequently because of the gases, vapors and dust to which it is exposed.

One problem we encountered—poor contact between the movable arm and its terminal—was corrected by soldering a piece of voice-coil wire between the arm and terminal. A later model of this regulator system uses an enclosed rheostat.

Input stage
The input stage rectifies and filters the cue and reference voltage and is connected as shown in Fig. 2. A difference between master speed and section speed results in a voltage output at A and B. The output of cue and reference tachometers ranges from 20 to 90 volts, depending upon the speed selected by the machine operator. For good operation at all speeds, the rectifiers must track together. Experiments were carried out by Westinghouse engineers and plant personnel using crystal diodes, 6X5's, selenium rectifiers, 6SN7's and 5692's to determine which was best for this application. In addition to tracking, the rectifiers are exposed to temperature changes, contaminated air and a certain amount of vibration. The 5692's with grid tied to plate, have proved very successful, provided they are pretested for tracking ability. In pretesting input tubes, a circuit similar to the input stage is used and equal voltage is applied to both sections of the tube. This voltage is varied throughout the normally encountered range (20 to 90 volts). If the unbalance is 0.5 volt or less and does not vary more than 0.2 volt, the tube will be satisfactory.

Amplifier panel
The voltage at points A and B is the error voltage which results when drive motor speed and master speed are unequal. This error voltage is amplified in two stages to provide the grid power needed to control the thyratrons in the power panel. This amplifier panel (Fig. 3) also includes the damping circuit which takes a portion of the change in output from the thyratrons, amplifies it and opposes the action which caused the change in thyratron operation. Potentiometer R2 controls the amount of anti-hunt or damping signal and is adjusted under normal load conditions. R1 controls the amplifier's sensitivity and is operated in a maximum position. The tubes used in the amplifier panel originally were 6SN7's but have been replaced with 5692's. These tubes are pretested for unbalance and microphonics, and it is not unusual for them to give 8,000 to 9,000 continuous hours of service. The amplifier's B-plus is supplied by a 6X5 used as a full-wave rectifier.

Power supply
The power panel (Fig. 4) has three grid-controlled thyratrons (672-A) supplying the field current of the dc drive motor. Their output is determined by preset phase-shifted grid voltage, and superimposed dc voltage from the voltage amplifier panel. Grid voltage of the thyratrons lags the anode voltage by approximately 120°, and the dc voltage is determined by error voltage. During starting and accelerating the motor, the regulator supplies rated field current, and only after transferring to the running generator does the regulating action begin. The starting, acceleration and transfer of the motor from starting generator to running generator is handled by a relay panel.

In the thyratrons' output circuit and in series with the motor field is a field-failure relay to drop the motor off the run generator bus should there be a
fault in thyratron operation or a loss of field current.

Primary power to the power panel is 440-volt 3-phase 60-cycle, and three single-phase transformers with dual primary and secondary windings are used. The primary windings of each transformer are connected in series and delta-connected with the other transformers. The secondaries are zigzag-connected so the regulator will still function if one of the thyrratrons should fail. The operational life of the thyrratrons averages between 12 and 18 months of continuous use.

The whole system

Briefly, here's how the regulator works:

Assume normal operation with the section motor cue-tach output matched to master reference-tach output. A friction load or work load increase would cause the section motor speed to drop. Therefore, the cue-tach generator output would drop and result in a voltage output at A and B, with A positive. Positive voltage applied to V1-a's grid (Fig. 3) causes a drop in its plate voltage (E). V1-a's lowerd E< sub> decreases V2-a's plate current, V2-a's plate voltage rises, and point C becomes positive or less negative with respect to point D. Point C is connected to the thyratron's cathode circuit and point D to their grid circuit. A positive cathode (negative grid) drops the amplitude of ac grid voltage (see Fig. 5), the tube conducts less, the motor's field current decreases and its speed increases until it matches the master speed.

When tube current decreases, this change in current through field and damping resistors causes an output from the damping transformer. This damping signal is applied to the grid circuit of V1-b, the first stage of the damping amplifier section. This signal, under the above conditions makes V1-b's grid positive, and its plate voltage drops. V2-b's plate voltage or point D goes positive, which opposes the original change between C and D.

Properly adjusting the anti-hunt potentiometer keeps hunting at a minimum. R4 (Fig. 4) determines, in part, the time constant of the damping circuit, and its setting varies in each regulator due to the type of load of each section motor. R5 and R6 vary the phase of the grid voltage of two of the thyrratrons, and these adjustments are for equalizing the load on the thyrratrons.

Other adjustments also have to be made in initial installation or when major components are changed. Two of these are setting the motor field resistors for maximum and minimum field current, and setting the cue-tach generator output voltage for proper calibration of the paper-machine speed.

Regulator troubles

Run-of-the-mill regulator troubles are common to electronics: open resistors, shorted capacitors, tube and transformer failure. The important requirement in troubleshooting the regulators is speed. Since production stops when the regulators are out of order, the company loses money. The faster they are put back to work the smaller the loss.

Bad bearings on cue-tach generators also will feed false signals to the regulator and cause motor speed to change or swing, resulting in a break in production. Poor commutation on the master dc motor will cause the entire machine to swing. Improper adjustment of draw controls by operators will cause production losses. Any variation in motor speed, whatever the cause, must be checked by the electronic technician to determine whether the variation was caused by faulty regulator action or by abnormal operating conditions. Generally speaking, however, close cooperation between production and maintenance personnel results in a minimum of lost production due to regulator failure.

There are two electronic speed-regulated paper machine drives at this plant, and one additional machine which employs a very effective magnetic amplifier circuit.

Problems, when initially encountered in these installations, generally were typical of those expected of any new design. From the electronic technician's viewpoint, they served to point out, once again, the value of careful circuit analysis in troubleshooting.

Fig. 4 — The power panel which converts three-phase 440-volt input to regulated dc. This supplies field voltage to the paper-mill's drive motors.
Dust, dirt, and smog have no effect on this compact unit as it performs its job of counting metal objects passing its sensing coil.

Electronic Counter has many uses...

By JOHN POTTER SHIELDS

The electronic metal indicator and counter described in this article was designed to count accurately metallic objects passing by on a conveyor belt. It was intended to count metal can bodies in can manufacturing plants. It is also useful for counting filled metal cans prior to packaging in food processing plants, breweries, etc. Besides its use as a can counter, it has other functions which will be explained later.

One of the main advantages of this type of electronic counter is that it will work in locations where a photoelectric counter would be totally unsatisfactory. For example, it will work well where atmospheric conditions would quickly cloud the optical system of a photocell setup.

Another advantage is that buildup of dirt or other foreign materials on the pickup or sensing coil does not interfere with its operation. This is particularly important in installations where considerable dirt and grime are present and maintenance personnel may not always take the time to clean the sensing coil continually. The reason why the sensing coil can tolerate an accumulation of grime, even metal filings, is that the relative motion of the metal to be counted actuates the device.

How it works

V1 and V2 form a two-stage high-gain amplifier. The sensing coil is connected to the cathode circuit of the first stage. There are two reasons for this. First, due to the rather low impedance of the sensing coil, a better match can be obtained by placing it in the cathode rather than the grid circuit of this stage. Second, since the sensing coil is connected to the cathode circuit, the de plate and screen currents of the tube will flow through it, causing its core to become slightly magnetized, a necessity for proper operation. The output from the second amplifier stage, V2, is coupled to the control grid of thyratron V3. Note that the signal is not rectified before it appears on the grid of V3.

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Sensitivity is controlled by potentiometer R7 in V3’s cathode circuit. In operation, the potentiometer is adjusted so that V3’s cathode is slightly more positive than its control grid. This, of course, is the same as making the grid negative with respect to the cathode. In this condition, the tube is cut off and the relay remains open. When a metallic object passes within about 1 in. of the sensing coil, a minute voltage pulse is generated in the coil. This pulse is caused by the passing metallic object disturbing the magnetic field produced by the sensing coil. This pulse is fed to the two-stage amplifier and applied to the control grid of V3. When the amplified pulse reaches the grid of V3 the tube conducts, closing the plate circuit relay.

A standard half-wave power supply operates the device. An R-C pi-section filter provides adequate filtering, and an OA3 gas regulator tube provides a regulated voltage for the screen of V2 and a reference static bias voltage for V3.

An electrolytic capacitor (C3) across the relay coil prevents relay chatter. If the device is used as an electronic counter, the value of this capacitor should be such that it will discharge through the relay coil rapidly enough so that the relay can respond to the next counting pulse. In this application, the smallest value of capacitance that will keep the relay from chattering should be used.

While a 6SJ7 pentode, triode-connected, was used for V1, a triode (6J5) is just as good.

Parts layout of the unit is not critical and the builder can use his judgment in layout. We used a shock-mounted tube socket for V1 to minimize microphonics. This is not necessary if the unit is located where there is little vibration.

If it is used to count metallic objects, a suitable electromagnetic counter can be obtained from a number of manufacturers. These counters are made with a variety of operating coil voltages including 6.3 and 117, making it four-tube unit.

Circuit of the

possible to operate one from either the line voltage or the power transformer heater winding. I found it necessary to put a 0.1-µf capacitor across the relay contacts to insure reliable counter operation at high speeds.

The sensing or pickup coil consists of a choke coil with the I laminations removed. This coil is connected to the unit by a length of shielded cable. Since the impedance of the input circuit is low, the cable can be quite long without signal loss. The unit is very stable, operating for extended periods of time with no trace of instability or drift.

Other than the uses already mentioned, the electronic metal indicator and counter has a place in the experimenter’s lab. For example, it can be used to check the speed of a phono turntable. Simply tape a small piece of iron or steel to the turntable so that, as the turntable revolves, the piece of metal contacts within an inch or less of the sensing coil. (The metal used must be a magnetic material such as iron or steel.) With an electromagnetic counter attached to the relay contacts, let the turntable run for exactly 1 minute. At the end of the minute, the counter will tell you the exact number of revolutions the turntable made. In brief, the uses for this device are limited only by your imagination.

Transistors

by

Alloy Diffusion

A LLOYD DIFFUSION, a new process for making transistors, puts vhf germanium transistors in the low-price field. The Amperex OC170 made by this process has a cutoff frequency of 70 mc and an average beta of 180. It can be used as a mixer-oscillator in mobile radio equipment, car radios and short-wave receivers, and as rf and if amplifiers for FM receivers.

In the Amperex process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of p-type germanium. Two small metal pellets are placed on it. Pellet B, for the base, contains only an n-type impurity. The other pellet (E), for the emitter, contains both p-type and n-type impurity.

When the assembly is heated, the germanium dissolves into the metal pellets until saturation and the pellet impurities diffuse into the solid germanium. However, the p-type impurity in the emitter pellet has such a low diffusion constant, that for practical purposes it does not penetrate into the germanium. The n-type impurity in the emitter and base pellets has a much greater diffusion factor and readily penetrates into the solid germanium to form a diffused n-type layer underneath the pellets.

When the assembly is cooled, a layer of germanium recrystallizes from the pellets. The layer that recrystallizes from the emitter pellet contains many atoms of the p-type impurity and is therefore a p-type germanium layer. The germanium layer that recrystallizes from the base pellet is n-type as there are no other impurities in this pellet.

Connections are made to the germanium and the metal pellets and a p-n transistor is obtained. The original p-type germanium is the collector, the pellet B is the base and pellet E the emitter.

The OC171 and OC169 are additional p-n-p types made by the alloy-diffusion process. The OC171 is designed as a

local oscillator and preamplifier in FM sets. The OC169 is used at lower frequencies and has slightly lower gain.

The alloy-diffusion process makes it possible to mass produce transistors with a base layer only a few microns for very short transient time and high cutoff frequencies. The rejection rate is also very low which makes the low price (less than $2) possible.
BILL HADLEY, chief development engineer for the Tin Plate Division of Mullaney Steel Corp., slammed his palm against the super's desk with an air of finality. "No, sir," he said irri tardly, "I won't touch the blame thing!"

"Look, Bill," Morgan the super pleaded, "be reasonable. I know it looks like a bum idea. But I can't help it. Goddard still runs this department. And he wants this thing worked out."

"Stall him off," Hadley growled. "He's retiring next month. Still the project until he starts drawing his pension and then we'll throw it out."

"I can't," Morgan wailed. "I thought of that. But Goddard insists we build up this sheet-assorting machine of his right now. He wants his name on one more set of patents before he walks out. He's already scheduled a demonstration of the blame thing for 3 weeks from Friday. If we don't have it ready, we're in the soup."

Hadley shrugged his shoulders. "That's your problem. Look at it from my point of view. The idea isn't sound. Goddard must be slipping because his gadget won't work. Not in 3 weeks or 3 years. If I assign a couple of my boys to the project, they'll have to admit failure when the time is up. Then Goddard'll get teed off and fire them. I can't afford that. Engineers are too hard to find."

Morgan threw up his hands. "All right, wise guy. So what do we do?"

"I don't know," Hadley said. "I told you it was your problem."

"Wait a minute," Morgan said after a short silence, "I've got an idea—What we need is a fall guy."

Hadley said, "I don't get it."

"Listen. Your boys are all too busy to put on this job. Right? They're working night and day on something else and we can't take them off it. Right?"

"If you say so," Hadley said. "Only I don't see..."

"You will," Morgan interrupted. "So we give the project to this other character, and it's his baby."

"Yeah," Hadley said, "I see. When the time's up, he hasn't done a job so my boys inherit the assignment, and meanwhile Goddard retires. Then we forget the whole thing."

"Check. And our fall guy gets the ax instead of you or me or any of your boys."

"Brother," Hadley said admiringly, "what a dirty trick!"

"Yeah," Morgan grinned, "ain't it?"

"There's a rub. Where you going to find a fall guy? He has to act like an engineer or Goddard'll smell a rat."

"I've got one in mind," Morgan said. "That character in electronic maintenance who's always after us to transfer him to development."

"Edgar Johansen?" Hadley asked. He shook his head. "He's a good kid, and he does a pretty fair job in maintenance. Let's find somebody else."

"There isn't anybody else," Morgan said. "Him we can palm off as an engineer. He can anyway get Goddard's gadget thrown together, even if it doesn't work. After that nature takes its course."

Bill Hadley bit his lip. He'd been around this place for a good many years and seen some nasty tricks pulled in his day. But up to now he'd never been actually involved in a deal like this. Still, Edgar was young and it wouldn't be too hard for him to find another job somewhere. Maybe the experience of trying to develop Goddard's gadget would even be good for him. And of course he'd never know the assignment was a fakeroo, an impossibility that the best engineer in the place couldn't handle. Still, it was a dirty trick.

"I don't like it, Morgan," he said. "The poor kid hasn't got a chance."

"You rather I give it to one of your boys?" Morgan asked sweetly. "You like that better?"

Bill Hadley made up his mind. He shrugged resignedly. "Okay," he said. "Edgar it is."

"Check," Morgan said with a satisfied smile. "We leave it to Edgar."

"Yeah," Hadley said. He felt like a louse. "We leave it to Edgar. You going to tell him or do I have to?"

"Both of us. I'll give him the assignment and you brief him on the technical end. Okay?"

The fall guy arrives

Back in the lab, Bill Hadley heard the footsteps approaching his desk and looked up apprehensively. It was Edgar Johansen. The kid was grinning from ear to ear, and he carried the manila folder rolled into a tube as though it were a wand of royalty.
"Morning, Mr. Hadley, sir," Edgar said. He brushed a wad of tousled hair out of his eyes.

"Morning, Edgar," Hadley said. "I see you've got the prospectus on your new assignment." He jerked a thumb at the manila folder.

"Yes, sir, Mr. Hadley, sir," Edgar said. "I want to thank you for speaking to Mr. Morgan about me. He told me you recommended me for the project."

Hadley ground his teeth. What a sense of humor the super had. "Forget it, Edgar," he said. "How about if we go over the prospectus together?"

"Swell," Edgar said gratefully. "It's awfully nice of you to give me some of your time. I know you're real busy."

"Yeah," Hadley said gruffly. He cleared his throat, embarrassed. "Pull up a chair and we'll look over the prospectus.

Edgar slid a chair over to the desk self-consciously and sat down. Hadley unrolled the manila folder and spread it out in front of them. There were half a dozen sketches and a pencil-drawn schematic diagram. Hadley stared at the schematic representation of Goddard's idea unseeing for a moment, feeling like a Judas. Then he forced his eyes into focus.

"Okay," he said. "Now the whole idea of the device is to sort tin plate for holes after it's been cut into sheets. We made a piler up there that takes those sheets with holes in them, opens them up into a reject piler, and convey the prime plate into another piler. Savvy? Just like we do on the lines before the strip is cut into sheets.

"Yes, sir," Edgar said, his brow puckered. "But Mr. Hadley, sir, if we're going to sort sheets, how do we prevent the hole detector from detecting the spaces between sheets? I mean the spaces will look just like big holes to the detector.

That's the idea of this gadget," Hadley said seriously. "Trace out the circuits now. Visualize a conveyor belt carrying 3-foot-square sheets of tin plate toward a tray containing a bank of photocells wired in parallel, with a common load resistor. Just before the leading edge of the first sheet reaches the hole detector tray, it slides across a single photo cell and cuts off the light from the source mounted above it. The signal developed by the single cell going dark feeds an amplifier, here, which triggers this relay tube into action. Through a time-delay circuit, the relay tube applies plate voltage to this amplifier fed by the paralleled banks of cells in the tray.

"I see," Edgar said excitedly. "The relay amplifier goes dead between sheets.

"Yeah," Hadley said. "Let's go on." He continued tracing out the circuit, wondering if Edgar would find the flaws in the idea. "By the time the relay amplifier gets its plate voltage, the leading edge of the sheet has arrived at the detector tray, and slid across it to cut off the light arriving from the bank of light sources above it. Now the photocells in the tray are ready to detect any hole that might be in the sheet. When a hole flits past, one of the cells receives light for an instant and the signal developed across the load resistor feeds the amplifier which excites another time-delay circuit that, moments later, triggers this pair of thyristrons in a phase-shift circuit, energizing the solenoid in their plate circuit just as the bad sheet comes along. There is a deflection gate mechanically coupled to the solenoid core, so that when it trips at the proper instant to deflect the sheet containing the detected hole into a rejected-sheet bin. Other sheets, those without holes in them, will slide over the top of the gate and be conveyed into another piler to be sold as prime plate.

"Yes, sir," Edgar said musingly, looking up from the schematic with a troubled frown. "But...

"Now back to the detector tray," Hadley said hurriedly. "As the trailing edge of a sheet approaches the tray, it encounters an unseeingly, admitting light from the source above it. The current flow through the single cell now disables the relay tube, cutting off the plate voltage to the tray amplifier. During the time the tray is uncovered, one sheet having passed over it and the next one may have arrived, the tray amplifier is deprived of plate voltage and so the signal developed across the photocells' common load resistor is not passed on to the thyristrons to trip the deflection gate. When the next sheet arrives, the device is cocked again, so to speak, and the cycle repeats itself, tripping the gate when a hole is detected in a sheet or passing the sheet on if it's okay.

But it won't work

"Boy," Edgar said admiringly, shaking his head, "Mr. Goddard must have spent some time on that problem. It's clever enough, if it won't work.

"Won't work?" Bill Hadley echoed, startled. Maybe this kid was sharper than they'd thought. "Why not?"

"Well, gosh, Mr. Hadley, sir," Edgar said self-consciously, "first, every time the conveyor speed changes a little, the time-delay circuit will have to be altered in the disabling device. Second, whenever the disabling circuit cuts on or off, a nice big transient voltage goes whooping through the tray amplifier to trip the deflection gate. Third, whenever a hole passes over, the disabling circuit will cycle and fail to reject a piece of defective plate. Fourth...

"Hold it," Hadley interrupted. "I said I'd go through the circuit with you, not solve the problems encountered. That's your job." He pushed the folder toward Hadley. "Edgar, it's Mr. Goddard's see- the flaws made it awkward.

"Well, sure, Mr. Hadley, sir," Edgar said, picking up the folder. His face was turning red. "I didn't mean for you to work out the bugs. I was just...

"Yeah, yeah," Bill Hadley said. "I know. You've got 3 weeks to get this thing built up and working. You better start.

"Right away, Mr. Hadley, sir," Edgar said, standing up and moving his chair back to where he had found it. His face had become an impassive mask. His feelings were obviously hurt.

"I'll get the mechanical shop to build up the conveyor and feeder," Hadley said kindly. He wished there were some other way to handle the situation, realized there wasn't. It was too bad the kid had to be the one. But there was no cure for it. "You'd better go to work on the electronic end."

"Yes, sir," Edgar said. He headed for the door to the lab.

"Oh, and, Edgar, Goddard is a funny guy," Hadley called after him. "You'd better not make too many changes in his gadget. He'll recognize them if you do and he'll raise hell around here.

"Yes, sir," Edgar said. "No changes." He left the room as Edgar sighed deeply, hating himself.

The final test

"Today's the day," Morgan said, rubbing his chin apprehensively. "Edgar ready for the demonstration?"

"It's all set up," Bill Hadley said, "if that's what you mean. I've been staying away from there myself. I don't want to know too much about it.

"Check," the super said. "We'll catch hell, of course. But Goddard can't do any more than chew us out. After all, we assigned the project and it's been built up. When the demonstration fails, we'll appear distressed but not too apologetic. If the engineer couldn't handle the job, it's his fault, not ours."

"Trouble is," Hadley said, shaking his head, "I've got a conscience. The kid's been in to see me a dozen times and I've had to be too busy to see him. I feel like a heel.

"You'll get over it. Goddard won't hang him."
"Yeah, but the kid's sensitive. Goddard'll have plenty to say before he fires him, and it'll break the kid's heart."

"Better him than you or me," Morgan said. "Agree?"

"I don't know. I suppose so. But I keep thinking that, if I'd taken the project myself, maybe I could have found another way of doing the same thing Goddard's gadget is supposed to do but won't."

"That's no good," Morgan snapped. "You know Goddard. Change his designs a little and he raises hell."

"Ah, yeah," Hadley said testily. "I'm just thinking out loud, is all. What time is it?"

The super looked at his watch, got up and walked around his desk. "Time to go. Goddard's meeting us in the assorting room. Remember now, dismissed but not too apologetically."

Bill always sat on the floor, with the incessant grind and roar of heavy machinery providing a constant background. There was already a little knot of people gathered around the new assorting machine. Hadley recognized Goddard's broad back and balding head. The man was best over the machine, peering into the metal cabinet attached to one of the rails forming the framework for the conveyors and feeding mechanism. Goddard stood beside him, shouting something into his ear. Goddard waved up as they approached, shook hands jovially first with Morgan, then with Hadley.

"Plane was early," Goddard yelled. "See you got her built up OK."

"Sure enough," Morgan shouted back. "We've been too busy to follow through on it the last couple weeks, Hadley and I. But we went through the prospectus before we assigned it to the engineer. Pretty ingenious idea."


"Pretty good, Mr. Hadley, sir," Edgar said. "I haven't had much chance to run tests though."

"Understandable. Three weeks isn't all the time in the world." Hadley peered down into the cabinet. Tube filaments shone cherry red in the dark interior. The blue glow of a pair of tiny motors was evident. "Goddard was looking it over?"

"Yes, sir," Edgar said. "First thing he did was check around to see if I'd made any changes in his design."

"Did you?"

"It's all here," Edgar said, not meeting his employer's eye, but the way he drew it. He jerked a thumb at the cabinet, lowered its cover. "I guess I'm ready whenever Mr. Goddard is."

Hadley felt an empty sensation in the pit of his stomach. He considered leaving the scene for the solitude of his lab. He didn't much want to be around in the next few minutes when Edgar's failure became evident. But he couldn't afford to lose sight of the problem. He had a job of his own to protect, and he'd better stick around to testify that he'd had nothing to do with the machine other than to assign the project. Mentally, he rehearsed his speech. "It seemed such a clean-cut idea," he'd say, "that it never occurred to me there'd be any trouble with it. I've been awfully busy but if I'd known the lad was going to have trouble I'd have worked nights with him. I'd..." he derailed his train of thought abruptly, forced himself to work back to Edgar's side.

"I'm sorry, Edgar," he said, yelling to be heard above the roar of machinery. "It was a dirty trick. I'll accept the full responsibility. I'll tell Goddard the whole deal, and..."

"Forget it, Mr. Hadley, sir," Edgar shouted. "It's nothing at him. 'Don't worry about a thing."

"Are we ready?" Goddard was shouting. "Come on, let's get going here. I've got a speech to write." He chuckled, rubbed his balding head. "They're giving me a gold watch day after tomorrow. I'll have to say a few words."

After that it all seemed like a dream to Bill Hadley. He withdrew from the little crowd a few steps and watched the proceedings in a semi-daze. He saw the machine operator start the feeder and control motors at Goddard's signal, saw the sheets of tin plate slide off the top of the pile one by one to drop onto the conveyor belts and start their short journey to the detector head. He saw half a dozen sheets pass the deflection gate and continue on their way to the prime piler. Then there was a buzz and a snap audible above the background noise as the deflection gate jumped upward and a single sheet slid under it to be deposited in the reject piler. Edgar picked the sheet out of the piler and held it up for inspection, grinning broadly. There was a tiny hole visible near one end of the sheet. The demonstration continued, but Bill Hadley left. He wandered back to his lab and sat down at his desk, his mind whirling...
COMMUNICATIONS SATELLITES like this one may orbit the earth as relay stations linking all major cities for TV and microwave networks. Slow rotation of the doughnut would maintain stability and create artificial gravity for personnel. RCA conception is similar to that suggested by Hugo Gernsback in Radio-Electronics, March, 1958 (pages 33 and 125).

600-FOOT RADIO TELESCOPE to be completed in 1962 will probe space up to 38,000,000,000 light years away for Naval Research Labs at Sugar Grove, W. Va. The more than 7-acre surface (600 feet in diameter) of this world’s largest movable dish will dwarf the 250-footer at Jodrell Bank, England, presently the biggest known.

The huge reflector will also aid communications with space vehicles and may be used in detecting ballistic missile launchings across the ocean. It is being designed by Grad, Urban & Steeley, New York architects-engineers.

AUTOMOBILE PHONO CHANGER takes standard 45-rpm records, plays stack of 14 discs with ceramic pickup through the car’s regular radio. The 12-volt motor is governor-controlled. Engineered and manufactured by RCA for 1960 Plymouths and DeSotos.

SOLDERLESS BREADBOARD has over 100 gold-plated eyelets with elastic rubber cores permitting instant connection or removal of two to six wires or component leads. Circuit Board is made by Plastic Associates, Laguna Beach, Calif.

DO-IT-YOURSELF TRANSFORMER for laboratory bench has primary, core and binding posts arranged for rapid winding of secondary. This readily-adjustable source of ac voltage, made by the Superior Electric Co., Bristol, Conn., supplies up to 150 volt-amperes and can also be used as a current transformer.
WAY RADIOS FOR CITIZENS BAND

By ROBERT F. SCOTT

In the September issue, we described RCA's Radio-Phone and International Crystal's Citizen Bander class-D transceivers. Now, we will cover the Multi-Elnac Citi-fone and the salient features of several other makes and models. The Citi-fone is a nine-tube transmitter-receiver combination operating on any five preselected channels. It is available in two models. The CD-5/6 operates from 117 volts ac and 6 volts dc. The CD-5/12 operates from ac and a 12-volt dc source. Two line cords are supplied. One plug is in an automobile's cigarette-lighter socket and the other into a standard 117-volt ac wall receptacle. There are three controls on the front panel—the on-off switch and volume control on the lower left, the channel selector in the center and the squelch control on the right.

The circuit

The Citi-fone's diagram is in Fig. 1. The receiver circuit is a single-conversion superhet with a broad-band 6BJ6 rf amplifier, 6BE6 mixer, half of a 12AU7 as a Pierce crystal oscillator, a pair of 6BQ6's in a two-stage 455-ke if amplifier, 6AL5 detector, avc and noise limiter, 6AN8 af amplifier and squelch control tube, and a 6AQ5 af power amplifier.

The transmitter is an oscillator—power amplifier combination using half of a 12AU7 as the crystal oscillator and a 6AQ5 rf power amplifier. The modulator consists of the pentode half of the 6AN8 and the 6AQ5 audio power amplifier. High-level Heising modulation is used, with the output transformer primary serving as the modulation choke.

The power supply uses a full-wave bridge type rectifier. The power transformer has dual primaries, one for 117 volts ac and the other a tapped low-voltage winding driven by a vibrator when operating from a dc source.

V6-b is a self-adjusting series noise limiter whose threshold is determined by the strength of the incoming signal. Resistors R1 and R2 form the detector load and C1 is the rf bypass. The detected audio signal and a negative voltage proportional to carrier strength are developed across the detector load. V6-b's plate is connected to a point on the detector load while its cathode is tied to the most negative point through R3 and R4.

The cathode is held at a level proportional to average carrier strength by the time constant of R3-C2, which is long compared to changes in the modulation envelope. Thus, with its cathode more negative than its plate, V6-b conducts and passes the signal to the audio amplifier. Noise peaks that exceed the maximum carrier modulation level instantaneously drive the plate negative with respect to the cathode and cut off the tube for the duration of the pulse.

The squelch circuit silences the receiver and eliminates annoying atmospheric and other noises when no signal is being received. V6-a's cathode is held at a comparitively constant positive voltage by returning cathode resistor R6 to a tap on a B-plus voltage divider consisting of R8, R9 and R10. Conduction in V6-a is controlled by the voltage difference between grid and cathode. Grid resistor R5 is returned to the plate of squelch control tube V6-b and the grid-to-cathode voltage is determined by the voltage drop across R7. Thus, conduction in the af amplifier is controlled by V6-b's plate voltage. When V6-b is conducting, V6-a's grid is sufficiently negative with respect to the cathode to cut off the tube, so there is no output. When cut off, V6-b restores normal operating bias, and the amplifier conducts.

V6-b gets its plate voltage through load resistor R7 connected to V6-a's cathode biasing network. The grid of V6-a is connected to the avc line, which is negative when a signal comes in. One end of the SQUELCH control (R14) goes to B- plus at the junction of R8 and R9; the other to a minus voltage at the junction of R11 and R12. Its setting determines bias of V6-b's cathode.

The SQUELCH control is adjusted just to the point at which

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Fig. 1 — Circuit of the Multi-Ember Citfone.
V6-b conducts. Thus the amplifier is cut off when no signal is coming in. When a signal is received, the negative ave voltage cuts off V6-b so there is no current flow through R7. V6-a is then biased solely by the voltage drop across R6. When the station leaves the air, the ave voltage disappears. V6-b conducts and the voltage drop across R7 makes V6-a's grid more negative than the junction of R6 and R7. V6-a cuts off and again silences the receiver.

Vocaline ED-27

Called the Cominaire, this transceiver is a 10-tube unit with several interesting design features that are uncommon in this type of equipment. Its receiver is a crystal-controlled double-conversion superhet. It is unusual in that it is not necessary to change receiver crystals when switching from one channel to another. In other words, it performs like a single-conversion superhet preceded by a crystal-controlled broad-band converter or a double superhet with a variable second if. The circuit of the rf amplifier and first and second conversion stages is shown in Fig. 2.

V1 is a broad-band rf amplifier with tuned grid and plate circuits. V2 is a crystal-controlled triode oscillator and pentode mixer. A 31-mc oscillator frequency is injected into the mixer grid circuit through inductive coupling between the oscillator and rf amplifier plate coils.

The oscillator signal beats with the incoming carrier to produce a first if ranging from 4.035 mc on channel 1 (29.960 mc) to 3.775 mc on channel 22 (27.225 mc). This if signal is developed across the first if transformer and fed to the signal grid of the 6BE6 second mixer. The second oscillator is inductively-tuned by L4. The FINE TUNING control—one on the chassis—covers a range of from 3.580 to 3.320 mc to provide a 455-ke second if at the desired channel frequency. Thus, for channel 1, the first if is 4.035 mc (31.000-29.960 mc) and the second oscillator is tuned to the difference between the first and second if's, or 3.580 mc. Similarly, channel 11 (27.085 mc) develops a 3.915-mc first if and the second oscillator must be tuned to 3.460 mc. The 6BE6 output is amplified by a 455-ke if amplifier.

Pentode rf power amplifiers are used in all the transceivers that we've seen. The screen grid reduces the grid-plate capacitance to such a small value that pentodes are generally considered sufficiently stable in rf amplifiers to make neutralization unnecessary, and few transceiver manufacturers use it. However, the power sensitivity of the modern pentode is so great that the slightest amount of feedback may cause oscillation. We've seen cases where one brand of tube had to be neutralized in a given circuit while others didn't. Thus an unneutralized final amplifier might possibly lead to trouble—particularly in cases where the amplifier tube has to be replaced. Stability under all possible operating conditions is particularly important in Citizens Radio Service where the average operator is not trained to detect and correct spurious oscillations. Vocaline guards against this in the Cominaire by connecting a neutralizing capacitor between the cold end of the oscillator plate coil and the final plate as in Fig. 3.

Pi-type plate tank circuits are widely used in transceiver rf output stages to facilitate matching and loading the various types of antennas that may be used. Shunt-fed plate circuits are more common in most applications but Vocaline has selected a series-fed arrangement as in Fig. 3. In this case, plate supply voltage flows through the coil, and dc appears across the capacitors. The circuit is tuned to resonance with the capacitor nearest the plate and the antenna loading is adjusted with the capacitor on the output side.

The incandescent lamp in series with the antenna indicates relative antenna current. The lamp consumes some power that would normally appear in the antenna so it should be shunted by the switch when not being used.

Globe squelch circuit

The Globe CB-100 is a nine-tube three-channel transceiver operating from 117 volts ac or 12 volts dc. Its squelch circuit (Fig. 4) uses a diode instead of the triode or pentode as in the circuits described previously. Its detector circuit is conventional and its automatic noise limiter is similar to the one in the Citi-fone in Fig. 1.

The cathode of squelch diode V4-c is biased positive by a variable voltage picked up from the arm of the squelch control and its plate receives a positive voltage from the screen grid of the first if amplifier.

With the squelch control set correctly and no signal is coming in, the if amplifier operates at full gain and its screen voltage is low. This makes V4-c's plate less positive than the cathode so the tube cuts off and appears as an open circuit in the audio circuit between the output of the noise limiter and the input to the af amplifier. An incoming signal develops avc voltage that reduces the if amplifier gain and causes its screen voltage to rise. V4-c's plate is now more positive than the cathode so the tube conducts and passes the audio signal.

Other features of the Vocaline and Globe transceivers will be covered in a later issue.

Fig. 2—Rf amplifier, first and second conversion stages in Vocaline ED-27.

Fig. 3—Neutralization in the Vocaline's power amplifier.

Fig. 4—Globe CB-100's squelch circuit.
HINTS on installing MOBILE RADIO EQUIPMENT

By ROBERT J. HENDRICK

A good installation is a useful installation, and a useful installation takes proper planning and work.

The same basic procedures and precautions must be observed in any mobile installation, whether a 10-ton line truck or a standard automobile. Many installations fall flat on their faces and are a source of customer complaint right from the start, mostly because of minor mistakes in the original installation.

Since most vehicle operators have little or no technical knowledge of the radio equipment, take every precaution to prevent any degradation in its performance.

The old adage "an ounce of prevention is worth a pound of cure" is well applied to two-way radio installations. Start the customer off happy and he'll be easier to keep happy. Now, let's get down to business and see what has to be done.

Commercial two-way radio equipment is housed in rugged metal cabinets that can be secured to the vehicle with bolts or self-tapping metal screws. Later models of commercial mobile radio equipment are housed in a single rather compact cabinet, but some of the older units still in service may be in two or, in rare cases, three separate packages. These units are more bulky and present greater mounting difficulties than recent models. Happily, they are rapidly becoming obsolete and are disappearing from commercial use because of the new FCC regulations requiring narrow-band operation and better frequency stability.

In standard automobile installations where rear-mount type units are used, fasten the set to the raised portion of the trunk floor. Cables should face the rear since some models have metering receptacles and jacks that are on this end of the unit. Mounting in this position also leaves the customer more trunk space.

For permanent installations, bolt the cabinet down rather than use self-tapping screws. Sometimes, short metal brackets may be needed to support the two rear corners of the housing—they may overhang the raised portion of the trunk floor by 3 or 4 inches. These brackets can be formed out of strap iron or aluminum (Fig. 1). If self-tapping metal screws are used and the unit is placed on the lower portion of the trunk floor above the gas tank, which in most late model cars is mounted very, very close to the floor, be careful not to puncture the gas tank.

Truck installations of necessity have greater variations in mounting because there are so many sizes and models of vehicles. Generally two types of mountings are used. Where space permits, the unit can be placed under or behind the seat in the cab. Otherwise it must be mounted externally on the vehicle, in the most out-of-the-way location that is reasonably accessible for servicing. Whenever the unit is mounted externally, some type of weatherproof housing must be provided. Most manufacturers can supply weatherproof cabinets for their equipment, or the housing can be fabricated locally to meet the user's needs. Some operators like a housing made of marine plywood that provides room for tool storage as well as the radio equipment. Others prefer a weatherproof housing as compact as possible and fabricate it out of heavy-gauge sheet metal (Fig. 2).

When installing front-mount units, each installation has to be taken on a case-by-case basis since there is not much choice of location. Most late-model automobiles have very little space under the dash or against the firewall. Trucks are somewhat more adaptable to front-mount units since space is not so scarce. About all that can be done if the customer insists on front-mount units is to secure the cabinets with straps or brackets in the most out-of-the-way yet accessible location possible.

Whether installing the unit on automobile or truck, rear-mount, front-mount or externally, always place the unit in the most out-of-the-way location and at the same time make it as accessible for servicing as possible.

Cables and wiring

Cable placement, routing and connections are important phases of any mobile installation. The cable run should al-
always begin at the radio and run toward the front of the vehicle. The initial placement of cables is temporary and approximate, since final placement under mats and seats and also length adjustment are determined after the power cable has been run through the firewall and connected to the power source and the control cable's length has been adjusted. The power cable and relay control wiring should be routed through the firewall by using existing holes and heavy rubber grommets. Try the holes where the automobile cabling is routet if space permits; otherwise a spare knockout can be used or a new hole drilled through the firewall. Always use a hole large enough to permit inserting a heavy rubber grommet or adequate taping of cables to prevent nicking and subsequent shorting to the metal of the firewall.

Since connecting up the power cable, fuse block and relay is much the same for all types of vehicles, we shall consider this phase of the installation as a whole. Properly connecting the power cable to the power source can make the difference between very satisfactory or poor performance. By observing a few basic rules the power cable installation will cause no difficulty. First securely fasten the hot lead of the power cable to the hot side of the vehicle battery to get a very-low-resistance connection—preferably at the hot side of the starter solenoid rather than direct to the battery terminal. This avoids corrosion which often develops at the battery terminal, causing a high-resistance termination and excessive voltage drop. If a connection at the battery terminal is necessary, coat the terminals with an anti-corrosion compound.

The power supply's ground cable should be fastened securely to the vehicle frame, engine block or, if convenient, directly to the battery ground terminal. As with the hot side of the power cable, a good low-resistance connection is important. Clean and scrape the point where the connection will be made until a bright, smooth surface is obtained. After securing this connection, made to frame or engine block, spray with a clear plastic coating of some type to minimize oxidation and the possibility of a high-resistance joint in the future.

The remainder of the power-supply installation is a matter of placement, routing and securing. The fuse block and relay should be mounted with self-tapping metal screws to the firewall, if possible. The next best spot is on the inside skirt of one of the front fenders, in each instance getting the fuse block and relay as high as possible to minimize splashings from the road and engine oil and grime from collecting on them. Most relays should be mounted with their terminals pointing downward (Fig. 3) to keep water from collecting in the cover and causing defective operation or failure.

Connections to the relay and fuse block terminals should always be secure electrically and mechanically. If I seem a little overzealous in stressing the importance of the power-cable installation, it is from bitter experience. Many and varied symptoms and deceptive troubles have been traced to faulty power-supply installations. If we keep our power supply to the radio equipment working at top efficiency, we have made a sizable contribution toward an efficient trouble-free installation.

Running cables in automobile installations from firewall to the radio unit in the trunk is much the same for all cars, although there may be some slight variations. Leave enough of the control cable to reach the control head under the dash conveniently and adjust the length of the power cable so no excessive amount of loose cable remains on the engine side of the firewall. Then route the power and control cables under the front floor mat, both cables running side by side. Install a cable clamp at the firewall to prevent slipping. The cable run continues under the floor mats to the rear.

The routing of the cables at this point is a matter of choice. They may be run down the middle or on the right or left side, depending to a great extent upon the make and model of automobile and choice of the installer. Always route the cables under the floor mats and seats in a manner that will avoid binding or unnecessary strain, and by all means try to place them so the rear seat does not rest directly upon them, since a constant rubbing over a long period of time at this point will bare the cables and cause trouble. This type of trouble often develops as an intermittent condition and may be difficult to locate from the operator's description of it.

At this point, all excess cable is pulled to the trunk, adjusted for proper length to plug into the radio unit, coiled and neatly taped to prevent tangling and an unsightly appearance. Fig. 4 shows a typical wiring layout for an automobile installation.

Truck installations where the radio unit is installed under or behind the seat in the cab are much the same as for automobiles. The cables are placed under the floor mat, coiled neatly under the seat and taped so that no undue amount of binding or strain is placed upon them.

For truck installations in which the radio unit is mounted externally, a great deal more planning is necessary. The cables must be routed out of the weatherproof housing of the radio unit and into the vehicle cab. Usually a hole is cut in the rear of the cab or the cables may come into the cab through a hole in the floorboard. However, the hole in the cab is preferred, since this keeps the cables away from the considerable amount of mud and water they would receive if run under the floorboard. Always protect the portion of the cables between the weatherproof housing and the cab by running them through a piece of 1⅛-inch flexible tubing or water hose. Secure and waterproof by doping the ends of this tubing where it enters the weatherproof housing and the vehicle cab.

Installing accessories

Mounting the control head, microphone hook or support plate, and speaker is similar for all types of vehicles. They

(Continued on page 68)
EVERYTHING A CLOCK-RADIO CAN OFFER

- Completely portable, all-transistor circuit
- Runs up to 500 hours on standard batteries
- Deluxe features at half the cost
- Easy to assemble

"YOUR CUE" TRANSISTOR CLOCK RADIO KIT (TCR-1)

Take all the deluxe features found in the most expensive clock-radios, add the convenience of complete portability, plus a modern 6-transistor battery operated circuit... then slash the price at least in half, and you have the new Heathkit "Your Cue" Transistor Portable Clock Radio.

Packing every modern clock-radio feature into a compact, beautifully styled turquoise and ivory plastic cabinet, "Your Cue" lulls you to sleep, wakes you up, gives you the correct time and provides top quality radio entertainment in and out-of-doors. It can also be used with the Heathkit Transistor Intercom system, opposite page, to provide music or a "selective alarm" system for one or more rooms covered by the intercom system.

An "Alarm-set" hand, hour hand, minute hand and sweep second hand grace the easy-to-read clock dial. All controls are conveniently located and simple to operate. The "lull-to-sleep" control sets the radio for up to an hour's playing time, automatically shutting off the receiver when you are deep in slumber. Other controls set "Your Cue" to wake you to soft music, or conventional "buzzer" alarm. A special earphone jack is provided for private listening or connection to your intercom or music system. At all times crystal-clear portable radio entertainment is yours at the flick of a switch.

The modern 6-transistor circuit features prealigned IF's for ease of assembly. A tuned RF stage and double tuned input to the IF stage assure top performance. The built-in rod-type antenna pulls in far-off stations with outstanding clarity while a large 4" x 6" speaker provides tonal reproduction of unusual quality.

Six easily obtainable penlight-size mercury batteries power the radio receiver up to 500 hours, while the clock operates up to 5 months from a single battery of the same type. Ordinary penlight cells may also be used with reduced battery life.

The handsome two-tone cabinet, measuring only 3½" H. x 8" W. x 7½" D. fits neatly into the optional carrying case for beach use, boating, sporting events, hunting, hiking, or camping.

Wherever you are, you'll find "Your Cue" your constant companion. Shpg. Wt. 5 lbs.

LEATHER CARRYING CASE

HEATHKIT TCR-1

$45.95

HEATH COMPANY/Benton Harbor, Mich.
New Transistor Intercom Kit

TALK WITH ANY OR ALL FIVE STATIONS WITH YOUR OWN INTERCOM SYSTEM

- Battery Power Permits Placement Anywhere
- Versatile Unit Has Many Important Uses
- Complete Privacy of Conversations Assured

TRANSISTOR INTERCOM KIT (XI-1 and XIR-1)
A flexible, versatile transistor intercom, has been developed by Heath engineers to enable you to set up your own unique communications system at an unbelievably low price!

Consisting of a master unit (XI-1) and up to five remote stations (XIR-1), the system is designed for any remote unit to call the master, for any remote station to call any other remote station, or for the master unit to call any single remote unit or any combination of remote units. Complete privacy is assured, since a call to a remote station cannot be interrupted or listened to while the remote unit is in operation unless switched in by the master unit. Used with either an AC power source, it can serve as a music or "selective alarm" system.

Transistor circuitry means long life, instant operation and minimum battery drain. Eight ordinary, inexpensive "C" flashlight batteries will run a unit for up to 300 hours of normal "on" time. Circuitry is especially designed for crisp, clear intelligible communication and the instant operation feature allows tuning of the system without disturbing the listener. Use of battery power allows easy switching of power sources, allowing each unit to be placed where most convenient. Only two wires are required between the master unit and each remote station. Beautifully styled, the Heathkit Intercom presents a new approach in design. Both master and remote stations have two-piece cases in ivory and turquoise for a rich, quality appearance. Batteries not included. Shpg. Wt. 6 lbs.

AC POWER SUPPLY (XP-1)
A permanent power supply for 24-hour operation of the XI-1 Intercom on household current. Converts 110V AC to well filtered 12-volt DC output, eliminating the need for batteries. Power supply is small, compact and fits in space normally occupied by batteries.

HEATHKIT XP-1. $39.95

NEW IMPROVED DESIGN
STEREO-MONO PREAMP KIT (SP-2A, SP-1A)
Get the SP-2A Stereo Preamp kit now, or the SP-1A monophonic version which you can easily convert to stereo whenever you choose by assembling the second channel (C-SP-1A) and plugging it into your SP-1A.

The SP-2A permits stereo, two channel mixing, or either channel monophonic use, and includes a remote balance control.

Six inputs (12 in the stereo version) accommodate tape, magnetic phono and microphone, plus three separate high level inputs. Level controls provided on "mag. phono" and high level inputs. Switch selects YARTB equalization for tape head input and RIAA, LP or 78 RPM compensation for mag. phono input. HEATHKIT SP-1A (monophonic) Shpg. Wt. 13 lbs. $37.95
HEATHKIT C-SP-1A (not shown) (converts SP-1A to SP-2A) Shpg. Wt. 4 lbs. $21.95

THE WORLD'S BIGGEST BARGAIN IN A HI-FI AMPLIFIER
55 WATT HI-FI AMPLIFIER KIT (W-7A)
Utilizing advanced design in components and tubes to achieve unprecedented performance with fewer parts, Heathkit has produced the world's first and only "dollar-a-watt" genuine high fidelity amplifier. Meeting full 55-watt hi-fi rating and 55-watt professional standards, the new improved W-7A provides a comfortable margin of distortion-free power for any high fidelity application.

The sleek, modern styling of this unit allows unobtrusive installation anywhere in the home. The clean, open layout of chassis and precut, cabled wiring harness makes the W-7A extremely easy to assemble. Shpg. Wt. 28 lbs.

SPECIFICATIONS—Power output: Hi-Fidelity, 55 watts; Professional, 50 watts; Power response: 110 dB from 30 Hz to 3000 Hz at 45 watts output. Total harmonic distortion: Less than 4% from 300 Hz to 15 kHz at 50 watts output. Intermodulation distortion: Less than 7Hz at 50-watts output. Intermodulation distortion: Less than 3% at 30 watts output. Damping factor: Switched input permits selective input to amplifier. W-7A output: 4 watts at 4 ohms. 16 watts at 8 ohms. Power requirements: 117 volts, 50/60 cycles. 50/100 watts. Dimensions: 8 3/4 x 8 x 15 1/2 W.

DEC. 1959 61
Stereo Amplifiers

YOUR BEST DOLLAR VALUE IN STEREO...

14/14 WATT STEREO AMPLIFIER KIT (SA-2)

Complete control is at your fingertips with this versatile Stereo Amplifier-Preamplifier. Providing 14 watts per stereo channel, or 28 watts total monophonic, the SA-2 offers every modern feature in a大师级主控解决方案 at a price to please the budget minded. The unit offers selection of dual channel stereo operation, monophonic operation using both channels simultaneously, or using either channel for monophonic program material independent of the other channel. A 4-position input selector switch provides choice of mag. phono, crystal phono, tuner, and high level auxiliary input for tape recorder, TV, etc. Other features include RIAA equalization on mag. phono, channel reversing function, clutched volume control, ganged dual tone controls, speaker phase reversal switch and two AC outlets. Handsomely styled black and gold vinyl-clad steel cabinet. Shpg. Wt. 23 lbs.

SPECIFICATIONS—Power output: 14 watts per channel, "Hi-Fi"; 12 watts per channel, "professional"; 16 watts per channel, "utility". Power response: 0-100 db from 50 cps to 20 kc at 14 watts output. Total harmonic distortion: less than 0.5%; 30 cps to 15 kc at 14 watts output. Intermodulation distortion: less than 1.5% at 15 watts output using 60 cps and 6 kc signal mixed 3:1. Hum and noise: mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. Controls: dual clutched volume; ganged bass, ganged treble; 4-position selector; speaker phase switch; AC receptacle switch. Dimensions: 25 1/4" H x 14" W x 8 1/4" D. Power requirements: 115 volts, 50/60 cycle. AC. 150 watts (tuned).

ECONOMY STEREO AMPLIFIER KIT (SA-3)

This amazing performer delivers more than enough power for pure, undis- tended room-filling stereophonic sound at the lowest possible cost. Featuring 3 watts per stereo channel and 6 watts as a monophonic amplifier, the SA-3 has been proven by exhaustive tests to be more than adequate in volume for every listening taste.

You will find its case of assembly another plus feature. Heathkit construction manuals, world famous for their clarity and thoroughness, lead you a simple step at a time to successful completion of the kit. Larger than life-size diagrams show you exactly what each part looks like, where it goes, and how it is installed.

The amplifier is tastefully styled in black with gold trimmed control knobs and gold screened front and rear panel. A tremendous buy at this low Heathkit price! Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: 3 watts per channel. Power response: 1 db from 50 cps, 20 kc at 3 watts; 70 db output. Total harmonic distortion: less than 0.5%; 60 cps, 4 kc. Intermodulation distortion: less than 0.5%. 3 watts output using 60 cycle & 6 kc signal mixed 4:1. Hum and noise: 63 db below full output. Controls: dual clutched volume; ganged treble. Finish: black with gold trim. Dimensions: 12 3/4" H x 6 1/4" W x 6 3/4" D. Weight: 10 lbs.

6-TRANSISTOR PORTABLE RADIOS (XR-2P and XR-2L)

New, improved styling, new stereo tuning, up to 1,000 hours on flashlight batteries ... are just a few of the plus features you get with these new transistor portables. Carry them with you wherever you go, to the beach, on trips, boating, etc. These new, improved models bring you the outstanding performance of the preceding models plus brand new styling and the additional convenience of stereo tuning for smooth, effortless station selection. The XR-2P features a mitchie and heavy high-impact plastic case. The XR-2L has a transistor only plastic case with an identically shaped plastic front. Six Texas Instruments transistors are used for high sensitivity and selectivity. A large 4" x 6" PM speaker with heavy magnet provides excellent tone quality. The roomy chassis makes it unnecessary to crowd components, adding greatly to ease of construction. The six standard size "D" flashlight batteries used for power provide extremely long battery life and can be purchased anywhere. Fun to build, and fun to use ... order one today!

TRANSISTOR DEPTH SOUNDER (DS-1)

Weekend boater or professional . . . fisherman or skindiver . . . here's the depth sounder for you. Depth is indicated by a flashing red lamp moving smoothly behind a transparent circle in the molded plastic face dia. A large knob around the face allows the viewer to easily read the indicator on bright light or sunlight. The transis- toer uses a barium titanate element mounted in a fused, molded epoxy resin housing with solid brass through-hole riveting and mounting hardware. While designed for permanent mounting on the bottom of the boat, temporary outboard mounting of the transducer is also possible. The completely transistorized circuit operates from 6 flashlight cells and one alkaline battery. Comes complete with splash-proof cabinet, hardware and gimballed mounting bracket. Shpg. Wt. 10 lbs.
A NEW AMPLIFIER AND PREAMP UNIT PRICED WELL WITHIN ANY BUDGET

14-WATT HI-FI AMPLIFIER KIT (EA-3)

This thrilling successor to the famous Heathkit EA-2 is one of the finest investments anyone can make in top quality high fidelity equipment. It delivers a full 14 watts of hi-fi rated power and easily meets professional standards as a 12-watt amplifier.

Rich, full range sound reproduction and low noise and distortion are achieved through careful design using the latest developments in the audio science. Miniature tubes are used throughout, including EL-84 output tubes in a push-pull output circuit with a special-design output transformer. The built-in preamplifier has three separate switch-selected inputs for magnetic phono, crystal phono or tape, and AM-FM tuner. RIAA equalization is featured on the magnetic phono input.


NEVER BEFORE HAS ANY HI-FI AMPLIFIER OFFERED SO MUCH AT SO LOW A PRICE

"UNIVERSAL" 14-WATT HI-FI AMPLIFIER KIT (UA-2)

Meeting 14-watt "hi-fi" and 12-watt "professional" standards, the UA-2 lives up to its title "universal" performing with equal brilliance in the most demanding monophonic or stereophonic high fidelity systems. Its high quality, remarkable economy and ease of assembly make it one of the finest values in high fidelity equipment. Buy two for stereo. Shg. Wt. 13 lbs.

SPECIFICATIONS—Power output: Hi-Fi rating: 14 watts. Professional rating: 12 watts. Power response: ±1 db from 20 cps to 15 kc at 14 watts output. Total harmonic distortion: Less than 1% from 20 cps to 15 kc at 14 watts output. Intermodulation distortion: Less than 1/2% at 14 watts output using 60 cps and 6 kc signal mixed at 1%. Hum and noise: mag: phone input, 47 db below 14 watts; tuner and crystal phono, 65 db below 14 watts. Output impedances: 4, 8, and 16 ohms.

MORE STATIONS AND TRUE FM QUALITY ARE YOURS WITH THIS FINE TUNER KIT

HIGH FIDELITY FM TUNER KIT (FM-4)

This handsonely styled FM tuner features better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with on-off switch, flywheel tuning and prewired, prealigned and prestaged tuning unit. Clean chassis layout, prealigned intermediate stage transformers and assembled tuning unit makes construction simple—guaranteed top performance. Flywheel turning for new, soft, evenly-lighted dial scale provide smooth, effortless operation. Vinyl-covered case has black, simulated-leather texture with gold design and trim. Multiplex adapter: output also provided. Shpg. Wt. 8 lbs.


HEATH COMPANY/Benton Harbor, Mich.
PROFESSIONAL QUALITY TAPE RECORDER KITS (TR-1 Series)

Enjoy the incomparable performance of these professional quality tape recorders at less than half the usual cost. These outstanding kits offer a combination of features found only in much higher priced professional equipment, generally selling for $350 to $400. Not all of these special features are the handsome styling which characterizes the kit . . . a semi-gloss black panel is set off by a plastic escutcheon in soft gold, which is matched by black control knobs with gold inserts. The mechanical assembly, with fast forward and rewind functions, comes to you completely assembled and adjusted, you build only the tape amplifier. And, you'll find this very easy to accomplish, since the two circuit boards eliminate much of the wiring. Separate record and playback heads and amplifiers allow monitoring from tape while recording and a "pause" control permits instant stopping and starting of tape for accurate cutting and tape editing. A slight counter is provided for convenient selection of any particular recording. Push-pull knobs provide instant selection of 3/4" or 71/2" IPS tape speed. Safety interlock on record switch reduces possibility of accidental erasure of recorded tape.

SPECIFICATIONS—Tape speed: 3.75" and 7.5" (or recorded. Maximum reel size: 71/4", Frequency response (record-playback): ±2.5 db, 50 to 12,000 cps at 7.5 IPS; ±2.5 db, 50 to 6,000 cps at 3.75 IPS. Harmonic distortion: 1/2% or less at normal recording level; 2.5% or less at peak recording level. Signal-to-noise ratio: 50 db or better, referred to normal recording level. Flutter and wow: 0.3% RMS at 7.5 IPS; 0.35% RMS at 3.75 IPS. Heads (3): brake, record, and in-line stereo playback (TR-1C, monophonic playback). Playback equalization: NARTB curve, within ±2.5 db. Inputs (2): microphone and line. Input impedances: 1 Mohm. Model TR-1D & TR-1E outputs (1): A and B stereo channels. Model TR-1C output (1): monophonic. Output levels: approximating 2 volts maximum. Output impedance: approximately 600 ohms, (balanced outputs). Recording level indicator: professional type db meter. Bias erase frequency: 60 Hz. Timing accuracy: ±1%. Power requirements: 115-230 volts AC; 50-60 cycles, 20 watts. Dimensions: 10" H. x 121/4" W. x 7/8" D. Total height: 101/4". Mounting: requires minimum of 83/4" below and 13/4" above mounting surface. May be cabled in either horizontal or vertical position.

MODEL TR-1C Monophonic Tape Deck: $159.95 $16.00 DWN. Monophonic Record and Playback.
MODEL TR-1D Two Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 2-track Pre-recorded Stereo Tapes (stacked). $169.95 $17.00 DWN. $15.00 MO.
MODEL TR-1E Four Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 4-track Pre-recorded Stereo Tapes (stacked). $169.95 $17.00 DWN. $15.00 MO.
MODEL C-TR-1C Conversion Kit: Converts TR-1C to TR-1D (see TR-1D description above). Shpg. Wt. 2 lbs. . . . . . . $19.95
MODEL C-TR-1D Conversion Kit: Converts TR-1D to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. . . . . . . $19.95
NOTE: To convert TR-1C to TR-1E, purchase both C-TR-1C and C-TR-1D conversion kits.

HEATH COMPANY/Benton Harbor, Mich.

STEREO-MONO TAPE RECORDER KITS (TR-1A Series)

Here are the tape recorders the avid hi-fi fan will find most appealing! Their complete flexibility in installation and many functions make them our most versatile tape recorder kits. This outstanding tape recorder now can be purchased in any one of three versions. You can buy the new two-track (TR-1A1) or four-track (TR-1AQ) versions which record and play back both stereo and monophonic programming, or the two-track monophonic record-playback version (TR-1A) and later convert to either two-track or four-track stereo record-playback models by purchasing the MK-4 or MK-5 convolution kits. The tape deck mechanism is extremely simple to assemble. Long, faithful service is assured by precision bearings and close machining tolerances that hold flutter and wow to less than 0.35%. Power is provided by a four-pole, fan-cooled induction motor. One lever controls all tape handling functions of forward, fast-forward or rewind modes of operation. The deck handles up to 7" tape reels at 5.7 or 3.75 IPS as determined by belt position. The TR-1A series decks may be mounted in either a vertical or horizontal position (mounting brackets included). The TE-1 Tape Electronics kit supplied feature NARTB equalization, separate record and playback gain controls and a safety interlock. Provision is made for mike or line inputs and recording level is indicated on a 6-1/2 "magic eye" tube. Two circuit boards simplify assembly.

MODEL TR-1A: Monophonic two-track record/playback with fast forward and rewind functions. Includes one $99.95 $10.00 DWN. TE-1 Tape Electronics kit. Shpg. Wt. 24 lbs. $9.00 MO.

MODEL TR-1A1: Two-track monophonic and stereo record/playback with fast forward and rewind functions. Two $149.95 $15.00 DWN. TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. $13.00 MO.

MODEL TR-1AQ: Four-track monophonic and stereo record/playback with fast forward and rewind functions. Two $149.95 $15.00 DWN. TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. $13.00 MO.

TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. $13.00 MO.

TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. $13.00 MO.

TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. $13.00 MO.

TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. $13.00 MO.
New "Acoustic Suspension" Hi-Fi Speaker System Kit

NOW—FOR THE FIRST TIME—EXCLUSIVELY FROM HEATH

ACOUSTIC SUSPENSION HI-FI SPEAKER SYSTEM KIT (AS-2)
A revolutionary principle in speaker design, the Acoustic Research speaker has been universally accepted as one of the most praiseworthy speaker systems in the world of high fidelity sound reproduction. Heathkit is proud to be the sole kit licensee of this Acoustic Suspension principle from AR, Inc., and now offers for the first time this remarkable speaker system in money-saving, easy-to-build kit form.

The 10" Acoustic Suspension woofer delivers clean, clear extended-range bass response and outstanding high frequency distribution is provided by the specially designed "cross-fired" two-speaker tweeter assembly.

Another first in the Heathkit line is the availability of preassembled and prefinished cabinets. Cabinets are available in prefinished birch (blond) or mahogany, or in unfinished birch suitable for the finish of your choice. Kit assembly consists merely of mounting the speakers, wiring the simple crossover network and filling the cabinet with the fiberglass included. Shpg. Wt. 32 lbs.

SPECIFICATIONS—Frequency response (at 10 watts input): ±5 db, 42 to 14,000 cps; 10 db down at 30 and 16,000 cps. Harmonic distortion: below 2% at 20, 50, and 100 cps. Suggested amplifier power: 20 watts minimum. Suggested damping factor: high (5:1 or greater). Efficiency: about 2%. Distribution angle: 90° in horizontal plane. Dimensions: 34 1/4" W. x 13 5/8" H. x 13 1/4" D.

AN INSTRUMENT LONG-AWAITED BY SERVICE TECHNICIANS EVERYWHERE!

HEATHKIT FM TEST OSCILLATOR KIT (FMO-1)
Here in one compact, easy-to-use instrument are provided all the test signals and sweep frequencies required for fast, easy alignment and troubleshooting of RF, IF and detector sections of FM tuners and receivers. An instrument unique in the test equipment field . . . being the only one of its type designed especially for FM service work.

SPECIFICATIONS—Output frequencies: for RF alignment, 90 mc (FM band low end), 100 mc (FM band middle range), 10 mc (IF band high end). Modulation: 400-cycle incidental FM, IF and detector alignment. 10.7 mc sweep. Sweep width markers: 200 kc to 1 mc, variable, 10.7 mc (crystal), 100 kc sub-markers. Modulation: 400-cycle AM. For other applications: 10.5 mc (crystal) and harmonics, 100 kc, 400-cycle audio. Controls: main frequency selector, modulation switch (concentric level control), marker oscillator switch (concentric level control), sweep width—power switch, output control, RF-IF (source impedance) switch. Power supply: transformer, selenium rectifier. Power requirements: 110-125 V, 50/60 cycles, 12 watts. Cabinet sizes: 15" H. x 4 1/2" W. x 4 1/2" D.

PREASSEMBLED AND AlIGNED BANDSWITCH/COIL ASSEMBLY

RF SIGNAL GENERATOR KIT (RF-1)
Moderately priced, and capable of precision performance the RF-1 provides highly accurate and stable RF signals for troubleshooting and aligning RF and IF circuits of all kinds. Modulated or unmodulated RF output of at least 100,000 microvolts is available, controlled by both fixed-step and continuously variable controls. A built-in 400 cycle audio generator with 10-volt output provides internal modulation of RF signal and is available separately for audio tests. A preassembled bandswitch and coil assembly, aligned to factory precision standards, eliminates the need for special alignment equipment. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Frequency range: Band A, 100 kc to 200 kc; Band B, 310 kc to 1,1 mc; Band C, 1 mc to 3.3 mc; Band D, 3.4 mc to 11 mc; Band E, 10 mc to 32 mc. Band F, 32 mc to 110 mc. Calibrated harmonics: 110 mc to 200 mc. Accuracy: ±5%. Output: impedance, 50 ohms. Voltage, in excess of 100,000 voltage on all bands. Modulation: internal, 400 cycles across 32%, depth, external, approx. 3 V across 50 k ohms for 300%. 400 cycles audio output: approx. 10 V open circuit. Tube complement: 11 12AT7 RF oscillator; 21 6A6 modulator and output. Power requirements: 110-125 V, 50/60 cycles, 15 watts. Aluminum cabinet dimensions: 6 1/2" W. x 9 1/2" H. x 3 1/2" D.
Ham Radio Gear

TOP POWER WITH ECONOMY AND SAFETY

KILOWATT POWER SUPPLY KIT (KS-1)
The KS-1 is designed as a companion to the "Chippewa" Linear Amplifier and is also suitable for supplying plate power to most other RF amplifiers in the medium to high power class. The KS-1 features an oil-filled, hermetically sealed plate transformer to minimize corona, a swinging choke in the filter circuit for good regulation, and a 60-second time delay relay to permit adequate heating of the mercury vapor rectifiers before application of plate voltage. All components are conservatively rated and well insulated for long life and dependable service. Shpg. Wt. 105 lbs.

SPECIFICATIONS—Maximum DC power output: 1500 watts. Nominal DC voltage output: 1300 or 1500 volts. Maximum DC current output: 1500 ma. Regulation: Better than 0.5%. Input power requirements: 1500 ma, 12.6 volts for 6.3 volts AC (DC). Number of tubes: 3. Weight: 30 lbs.

MOVE TO THE TOP IN TRANSMITTING POWER

"CHIEF" KILOWATT LINEAR AMPLIFIER KIT (KL-1)
The KL-1 operates at maximum legal amateur power inputs in SSB, CW or AM service using any of the popular CW, SSB and AM exciters as a driver. Premium tubes (4-400's) push the "Chippewa" to top performance levels while a centrifugal blower provides more than adequate cooling. Shpg. Wt. 70 lbs.

SPECIFICATIONS—RF section: Driving power required (1 meter): Class A (tuned grid) 6 watts only; Class B (tuned grid) 40 watts; Class AB (tuned grid) 60 watts or more. Power input: Class AB (SSB) 750 watts. Plate transformer: 5000 ma. Power output (2 meters): Class A (tuned grid) 750 watts; Class B (SSB) 4000 watts; Class AB (SSB) 4000 watts. Power output (4 meters): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (6 meters): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (80 meters): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts. Power output (all bands): Class A (tuned grid) 750 watts; Class B (SSB) 3000 watts; Class AB (SSB) 3000 watts.

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**DECEMBER, 1959**

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must board the able space in The secured between in a position knee control head out also the side possible be. Sometimes communications. There you will come almost that the ground plane supplied the same time considering the same type antenna you use, make sure that the lead-in is well secured and clamped to prevent breaks at the antenna because of vibration and strain over a long period of time. Also see that the whip is adjusted properly in a vertical plane and in respect to the lines of the vehicle to give the best appearance possible.

Mobile antennas for the 150-174- and 450-470-mc bands are almost universally the rooftop type, with the ground being on one side and a directional effect may be noticed. Consequently, this type antenna is not recommended except for temporary installations and in services where the equipment is always used over relatively short distances that can be covered with a less efficient antenna.

The coaxial type antenna is usually fender- or bumper-mounted and again is not recommended for standard in-

The speaker bracket may be secured under the instrument panel alongside the control head. This is usually the alternate method of mounting in automobiles. On most truck installations the speaker is mounted on the top, flat portion of the instrument panel, or overhead by securing the speaker bracket to the metal section of the headliner, taking care not to pierce the roof with the self-tapping screws. This type of mounting is usually acceptable for trucks, since marring the vehicle's interior, and unsightly spots are less objectionable than poor sound level from the speaker.

Of course, mounting the speaker on the steering column with a special bracket is always a possibility. However, on most late model cars and trucks this has become impractical.

Antennas

Three general types of mobile antennas are in use: the low-band and high-band vhf antenna and the uhf type. Let us consider the low-band vhf antenna covering the 25-50-mc range. The most common kind in this service is the universal spring-base swivel-mounted antenna with a quarter-wave whip. Permanent automobile installations usually locate it on one of the rear fenders or preferably on the flat portion of the car body above the upper corner of the trunk lid (Fig. 6). Bumper mounting can be used but is not recommended due to the fact that a poor ground plane and reflected power is usually high. Consequently the antenna's efficiency is materially reduced. Disguise type antennas are also available for cowl or front fender mounting but again are not recommended except for special purposes such as plainclothes detective cars, etc., because the efficiency of such antennas is also poor.

Truck installations usually find the antenna placed on one of the rear corners of the cab in a position that keeps the whip from striking the cab when the vehicle is moving. Whether the antenna is mounted on an automobile or a truck, avoid marring the body finish when drilling the mounting holes and make sure that the mounting is completely watertight to prevent leaks in the trunk or cab. On some late-model automobiles, an inner reinforcing panel is placed inside the trunk adjacent to the upper quarter-panel of the rear fenders, sometimes making it necessary to cut through this reinforcing metal to mount the antenna and bring the antenna lead-in to the radio unit. In such installations, always seal the inner panel after the antenna has been mounted and the lead-in properly placed, since an opening at this point lets dust enter the trunk and is a cause for customer complaint.

Another type antenna is also used, less frequently, in the 25-50-mc band. It is designed for rooftop mounting on automobiles and trucks. Its built-in loading coil makes it possible to shorten the whip length considerably, making the rooftop mounting more practical.

Finally, regardless of the type antenna you use, make sure that the lead-in is well secured and clamped to prevent breaks at the antenna because of vibration and strain over a long period of time. Also see that the whip is adjusted properly in a vertical plane and in respect to the lines of the vehicle to give the best appearance possible.

Mobile antennas for the 150-174- and 450-470-mc bands are almost universally the rooftop type, with the ground being on one side and a directional effect may be noticed. Consequently, this type antenna is not recommended except for temporary installations and in services where the equipment is always used over relatively short distances that can be covered with a less efficient antenna.

The coaxial type antenna is usually fender- or bumper-mounted and again is not recommended for standard in-
stallations. It is expensive and generally does not perform as well as the conventional rooftop variety.

Rooftop antennas for the 150-174- and 450-470-mc bands are mounted in essentially the same manner, and installation procedures for all practical purposes are identical. Mounting the antenna requires one hole in the roof near the center, exact placement depending upon the location of dome light and roof support bows. Since the hole is usually ½ to ¾ inch in diameter, a good drill bit or preferably a hole saw is necessary to get a clean, smoothly cut hole. Be careful not to puncture the headliner.

Automobile installations require that the antenna lead-in be fished through the hole in the roof, tunnel across the trunk, and pass to the headliner. The hole in the top of the header is then filled to the point first and then to the roof, thus facilitating the fishing process. Once the lead-in has been fished from the trunk through the hole in the roof, the antenna installation can be completed quickly. See that the lead-in is perfectly free at all points so no strain will be placed upon it. Then carefully replace the unfastened portion of the headliner so it looks as well as it did originally, secure the antenna to the roof and align the rod if necessary.

Finally, never forget that performance requirements are rigid for any commercial mobile installation. Determine the customer's requirements and expectations. Install the equipment to meet the most severe conditions anticipated and hope that the operator will give it somewhat better treatment.
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across the coil's original winding (see diagram) to tune the receiver to the higher frequencies of the broadcast band. (Our local stations are at 1400, 1040 and 1000 kc.) The whole broadcast band may be covered by placing a 220-µuf capacitor (C1) across this winding.

A 25-µf electrolytic couples the signal from the detector to the first transistor amplifier. The transistor stages are conventional R-C-coupled amplifiers with base and collector resistors connected to ground. Their emitters are connected to the positive end of the B-supply. The last stage drives a hearing-aid earpiece.

A miniature 15-volt battery is used for the B-supply and a 1.5-volt penlight cell for the detector's filament. Filament leads must be connected as shown. The on-off switch is home-made. Two small brads are nailed through the bottom of the set's wooden case, and a soldering lug is bolted to the case. Turning this lug connects the brads, completing the battery circuit.

The case is made from two pieces of ¼-inch and one piece of ½-inch plywood. First, cut the three pieces to size, place a small brad through each corner and sand all sides evenly. Next, the center of the ½-inch board is removed, leaving a ½-inch border. At the top of the case a ¼-inch hole is drilled for the antenna coil's core. Another ½-inch hole is drilled for the antenna jack. The earpiece leads run through a hole in the opposite end of the case.

There is no special way of mounting the parts, although they must be kept as close together as possible. Be very careful to prevent parts from touching and leads from shorting. Generous use of spaghetti will help.

Operation is simple. Just turn on the power, plug an outdoor antenna into the antenna jack and you are ready to listen. The antenna coil's core is a combination tuning and volume control. Tuning is critical for distant stations, but for local stations some detuning may be necessary to reduce volume.

Outside, I use a flexible antenna wire run up my coat sleeve to receive local stations.

If the set's gain and sensitivity seem poor, reverse the tickler winding (L1) connections. Varying the value of the detector's plate-load resistor (R3) may give sharper tuning.

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RADIO
Dial-Cord Dilemma
If you do the job right, you won’t end up with your fingers tied to the chassis

By ROY E. PAFENBERG

The prospect of replacing the dial cord in certain modern receivers is not to be taken lightly. Apparently the best engineering brains are assigned to design these monstrosities and they, out of frustration, attempt to outdo each other in the complexity of their creations. The simple mechanism capable of rotating a single shaft a maximum of 180° has grown until it seems that every component that can be shifted has been coupled to the fragile dial cord.

Be that as it may, a defective dial cord must be replaced after the owner of the set has tried and in the process bent the tuning capacitor plates, broken the dial glass, cracked the cabinet and lost the dial pointer or spring.

It is difficult to make a reasonable profit on a dial-cord job because the customer, even if he has attempted the repair himself, generally regards it as a simple mechanical operation, unworthy of a technician’s time and pay.

The answer to this problem lies in salesmanship. By the simple arithmetic of time multiplied by an hourly rate, you can usually convince the customer that a service charge of $3 to $5 is not excessive. Also point out that while the set is being serviced, a general overhaul is in order. This selling of insurance by correcting minor defects, replacing weak tubes, leaky or under-rated coupling capacitors, etc. can turn these nuisance jobs into real money makers.

Now let us see how we can do these

Simple tools and bottle of dial-cord dressing aid restringing dial cords.

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jobs as painlessly and profitably as possible.

Do not consider published data beneath your skill. Manufacturers' service data and the specialized dial-stringing guides do much to speed up the job. On many sets, when the dial cord is restrung in what appears to be the obvious manner, not one degree of rotation will result. When the manufacturer's admittedly complex instructions are followed, they work like a charm, despite the finished job appearing to be such a maze of opposing forces that it couldn't be turned with a pipe wrench. Use all service data, and be grateful.

Use the proper cord and springs for each job. An adequate stock of cord, springs and wire of various sizes and money. Use only good-quality materials and stay away from fish-line expedients. On the really tough jobs, prestress the cord by hanging a heavy weight on it for several hours.

Take advantage of the proper tools. Long-nose pliers and clamping tweezers have their uses. Fine piano-wire snakes are simple and effective tools. Bend eyes and hooks in the ends of a variety of sizes and lengths and you will find them invaluable. A length of soda bottle formed around the drive pulley will hold its shape without springing off and may be used to pull the cord through when space is at a premium. Scotch tape will often hold the cord in place until the spring can be secured.

Remember that most dial-cord stringing problems arise from too much tension rather than not enough.

When the job is completed, be sure that knots are secure and seam them with service cement.

Don't let the set go if it is not absolutely perfect. A comeback on an apparently simple, purely mechanical repair can do you nothing but harm in the customer's eye. Use one of the available dial-cord dressings as insurance.

That's all there is to it. Let these pointers help build your business and increase your profits.

END

1 FAMILY; 3 HAMS, 3 STATIONS

Father, son and grandson in the Gallo family of New Orleans, La., are all licensed amateurs, each with his own complete rig. Louis Jacob, W5AU, right in the photograph, started things off. His son, Louis Jr., now W5GR, is in the middle. And to the left is his son KN5TNR, now 14 years old, now in high school. The older Gallos make loudspeaker housings at their plant, located at 2107 Montegut St., New Orleans.—E. T. Jones

DECEMBER, 1959

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DEC. 1959
By checking dc gain the technician can learn a great deal about ac operation

By CARL DAVID TODD*

If you are a service technician, you have been repairing transistor radios, intercoms and hi-fi preamps. (Or soon will be!) This means that you must have the equipment to test transistors properly.

There are some 65 transistor parameters which can be measured for a complete evaluation study. Fortunately, only a few need be measured to determine if a transistor's characteristics have changed markedly from those it should have.

One of these parameters is dc gain. Frequently current gain decreases as the transistor ages. This results in less amplification in the circuit in which it is used, and can create distortion and circuit mismatching due to changes in impedance.

The technician usually finds the transistor in an ac amplifier circuit. Equipment for measuring this small-signal ac gain has been described in various articles. A more meaningful parameter in many circuit applications is the dc gain in the common-emitter configuration, hFE. What is hFE and how does it compare? There is fairly good correlation of hFE (alternating-current gain) and hRE (dc gain) at low levels and some knowledge of hRE is a must for power output work. Dc gain is also a very important parameter in switching, control or logic circuits. This factor also enters into bias circuit design for rf amplifiers.

By definition: hFE is the ratio of the collector current (dc) to the base current (dc) or,

$$h_{FE} = \frac{I_c}{I_b}$$

A possible measuring circuit is shown in Fig. 1. A collector-to-emitter voltage is applied; a base current caused to flow and the value of hFE is calculated by dividing collector current by base current.

This method has several disadvantages. First, it requires two good milliammeters. And if any reasonable accuracy is required, the meters must be better than those usually in the shop.

The calculation required is a nuisance and increases the possibility for error. It would be convenient in many respects if one or more meters and the calculation could be omitted.

The test set to be described needs only one milliammeter and does the calculating internally. The resulting hFE value is displayed by a reading on a multiturn dial.

Circuit theory

As previously stated, hFE is the ratio of the collector current, Ic, to the base current, Ib. We are interested only in this ratio. By inserting two resistors, as shown, in the simplified circuit of Fig. 2, two voltages V1 and V2 will be produced which are directly proportional to Ib and Ic, respectively.

Note that the polarities of voltages V1 and V2 are such that the voltage V1 is the difference of the two. If a dc null detector is used to measure V1 and either R1 or R2 adjusted until V1 is zero, then the two voltages must be equal. This leads to a simpler expression,

$$h_{FE} = \frac{R_2}{R_1}$$

Now hFE is expressed only as a function of two resistances. Since only the ratio of R1 to R2 is important, either may be varied to produce the null in V1. If R2 were varied, the hFE reading would be a nonlinear function as in Fig. 3.
However, if R1 were the variable and R2 were held constant, a linear relation as in Fig. 4 would be obtained between hFE and R1.

It is impractical to vary R1 in the circuit since this requires a base-resistor current generator with a very high impedance with respect to R1. R1 must have a value in the order of several thousand ohms to obtain sufficient voltages for VBE and VCE when small currents are involved. This would require an unreasonable base-current generator, so the base current—and indirectly the collector current—could remain constant when the null is being obtained.

This problem may be avoided by using a circuit like that in Fig. 5. Here, the equivalent R is, in effect, only a portion of R1'. A potentiometer could be used instead of R1', but it is hard to get an accurate potentiometer that has the required wattage rating.

The maximum value of hFE that may be measured is determined by the ratio of the parallel equivalent of R1' and R1 to the value of R2.

Circuit description

Fig. 6 is a block diagram of a test set using the resistance-null technique. Fig. 7 is the unit's schematic.

The internal base-current supply consists of a voltage-doubler power supply and a network of resistances. T1 is a 25-volt filament transformer. Switch S2 is for coarse adjustment of IB, while potentiometer R3 is for fine adjustment.

Base current can be varied from zero to some maximum value determined by the setting of S2 for all ranges up to 10 ma. The highest current range is adjusted with an additional potentiometer section ganged with R3. This is necessary because of power dissipation requirements. Protective resistor R12 helps limit the maximum current that can be drawn when the hFE RANGE switch is in the 0-100 high-current position.

Base current can come from an external supply if desired.

The collector supply uses a full-wave bridge rectifier and a transistor voltage control. Transistor V does two jobs. It adjusts the collector supply voltage and is a filter. The basic circuit is in Fig. 8. This is merely a d-e emitter-follower stage and for reasonable values of Rb (the effective loading resistance of the transistor under test) the output voltage, VCE, will be very nearly equal to the base voltage. (That is, VCE will be quite small.) VCE will actually be somewhat less than VAB because of the forward emitter-base drop. Nevertheless, varying the base voltage varies the output. So, if the base is held constant, the output will be constant for practical purposes even though the collector supply voltage may vary.

With the simple shunt-capacitor filter alone, ac ripple would be very high. Passive filtering is always a problem for high-current supplies. However, by using the transistor as an active filter, ripple content is greatly diminished.

The base voltage is held constant by the R-C filter network consisting of C4 and a portion of R4 as shown in Fig. 7. With the filter described, ripple is in the order of 1 mv rms or less. Should the 1 ampere or so available from the internal supply be insufficient, a set of terminals for external VCC supply is provided.

The actual measuring portion of the test set shown in Fig. 6 has three ranges hFE. One 0-100 range is for low-current operation and the other for high-current use. The 0-500 range is suitable for both high and low currents. All hFE range changing is done by switching in various base- and collector-current reading resistors with S4.

Two extra switch sections are used for S4. These are "potential" switches for the null detector circuitry used to eliminate errors caused by voltage drops across the switch contacts as high currents. As indicated in Fig. 9, this technique eliminates difficulty due to contact resistance and resistance in the leads.

Terminals are provided for monitoring VCM, VCE and IB, and for connecting the null detector into the circuit.

Switch S3 reverses both base and collector supplies to accommodate either n-p-n or p-n-p transistors.

Construction

Rack-mount construction techniques (Continued on page 78)
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...from using General Electric's PROFIT* Program. That's the dollar-saving, income-building record of Chicago partners Robert Knudsen and Harold Russell!

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TEL-RAD'S SERVICE WORK doesn't stop while tube stocks are being checked. Here Richard Schlueter (facing rack in picture at left), salesman for Melvin Electronics, General Electric tube distributor, inspects the PROFIT* tube inventory for types to re-order. Schlueter does this job weekly, handling all routine and paperwork—thus saving valuable time for Knudsen and Russell.
OUR SALES ON THE INCREASE!

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GENERAL ELECTRIC
were used in the author's original model of the test set since it was to be included with other test panels mounted in a standard relay rack. The general layout is straightforward, as shown in the photos, but is not critical since the primary concern is for dc conditions.

Wiring may be either from point to point or square-cornered as the builder wishes. The only critical points to watch when wiring the unit are switch S4 and the dress of the leads to and from potentiometer R15. When wiring S4, be sure that connections to the current reading resistors R13, R14, R16, R17, R18 are made as shown in Fig. 9. All wiring to and from R15 should be kept away from the 117-volt line to prevent ac pickup which may give a false null-detector reading.

To increase the power dissipation capabilities of regulator transistor V, it should be mounted on a heavy sheet of copper, brass or aluminum. A 5 x 6-inch sheet of 1/8-inch stock should be adequate.

What can it do

The test set shown in Fig. 7 measures has up to 100 for a maximum collector current of 400 ma in the low-current range and up to 5 amps in the high-current range, provided the maximum base current does not exceed 40 or 500 ma, respectively. In the 0-500 ma range, I may be a maximum of 1 amp with the I maximum being 40 ma.

Collector voltage available depends upon the collector current. The primary limitations are the power dissipation capabilities of the voltage control transistor, and the voltage drop across the I reading resistor. The difference between the desired VCE voltage and the total unfiltered supply voltage of approximately 7 volts appears partially across the collector-current reading resistor (R) and the remainder across transistor V. An equation which relates the variables involved is:

\[ V_{CE} = V_{EE} - I_{C} R + V_{BE} \]

(V_{EE} is the collector-to-emitter voltage of transistor V.)

To determine the maximum value of collector current permissible, several factors must be studied. First of all, since a transistor's current gain is a function of the collector current and voltage, there is a maximum value of collector current and a minimum value...
A look backstage. Layout is not critical and can be changed.

Fig. 8—Transistor voltage-control and filter circuit.

Fig. 9—How to connect potential lead to high current resistor without running into trouble with switch-contact or lead resistance.

of collector voltage at which the regulator transistor will have sufficient h FE to be effective. For the transistor used, the maximum value of Ic is roughly 3 amps and the minimum voltage is roughly 0.5.

Thus the maximum value of VCE available to be applied to the transistor under test will be:

$$V_{CE, max} = V_{CC} - Ic R_{e} - 0.5$$

For the test set described, VCC is approximately 7 or 3.5 volts, depending on the position of S3.

Oddly enough, for a given value of Ic there is also a minimum value of VCE which may be applied to the transistor under test, because all voltage not dropped either across the current reading resistor, R E, or across the transistor under test must appear across the regulator transistor. To avoid damag-

ing V, the applied VCC to the transistor under test must be greater than a value given by the following expression:

$$V_{CE, min} = V_{CC} - Ic R_{e} - PC_{P_{max}}$$

where $PC_{P_{max}}$ is the maximum collector power rating of transistor V. Thus, for small values of Ic, the minimum value of VCE is not important. At large currents, however, this factor must be considered. Switch S5 has been provided to give some aid to this problem.

Using the tester

To measure $h_{FE}$, a transistor is plugged into the socket, the VCC ADJUST control is set to give a voltage on the meter connected to the VCC terminals which is somewhat higher than for the operating point desired, and the base-current control adjusted to give the required value of Ic. Some readjustment of the VCC control may be necessary. Once the operating point has been set, turn the hFE dial until the meter connected to the NULL DETECTOR terminals reads zero.

The sensitivity required for the null detector depends on the operating Ic and the desired accuracy. The higher the value of Ic, the less sensitive the detector has to be. It may be shown that, for points near the null, the null-detector voltage is given by the expression:

$$V_{N} = h_{FE}^* - Ic R_{e}$$

where $h_{FE}^*$ is the percent change of hFE from the null value. Thus, if measurements are being made at a collector current of 20 ma on the 0–100 range, a null detector capable of detecting 12 mv is required if an $h_{FE}^*$ of 3% is desired. The hFE dial reads directly from 0 to 100 on the 0–100 range. On the 0–500 range the dial reading is multiplied by 5.

END
TEST INSTRUMENTS

Sine Waves via Phase Shift

Simple 1-transistor phase-shift oscillator puts out stable sine waves

By F. T. Merkler

FOR some reason, transistor phase-shift oscillators have not received the attention they deserve. It is true that the transistor version seems more difficult to design than the vacuum-tube circuit, but this is not due to a defect in the transistor but to an attempt to apply vacuum-tube thinking to an entirely new type of device. Perhaps you can physically replace a vacuum tube with an audio transistor (properly biased) in a standard three-tube network and have it operate, if you make the supply voltage high enough and pick a transistor with a high beta. This transistor circuit has definite advantages. When correctly designed, it produces a crisp sine wave, starts easily and continues oscillating until the battery drops down to about 4 volts. Not to be overlooked is the low cost of the few small parts needed.

The unit described here is the result of painstaking effort to produce a quality circuit that would be reliable, easily started, stable under temperature change, and would allow for unavoidable transistor variations. It oscillates at approximately 1,000 cycles with the components specified. Eleven 2N109 transistors were tested for beta to be sure of a proper spread in characteristics. Each variation in the circuit was tested with each of the 11 transistors at five supply voltages from 13 to 4 volts dc. The final circuit is a four-tube network with voltage feedback from collector to base of the grounded emitter amplifier. The feedback circuit protects the transistor from thermal runaway.

One of the tests given the completed unit was a heat run, with a test setup that monitored transistor case temperature, collector current and frequency. At the start of the run, case temperature was 28°C, collector current was 4.4 ma and frequency was 1,171 cycles per second. Supply voltage was held at 10 volts dc throughout the run. At a case temperature of 63°C, collector current was 2.8 ma and frequency of oscillation was 2,202 cycles per second. At a case temperature higher than 63°C (149°F), the circuit no longer oscillated, but the transistor was not damaged as its collector current leveled out at about 8.1 ma. The case temperature
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By I. Queen

EDITORIAL ASSOCIATE

TEST PANEL OF FINISHED UNIT WHICH MEASURES RESISTOR MISMATCH UP TO 5%.

A look at the comparator's inside shows just how simple a unit it is.

The percentage comparator, tested in our usual manner, works essentially as described. But using an audio detector a null could not be obtained better than about ±5%. Using a scope for the detector gave accuracy better than 1%.

Total accuracy (no pointer adjustment) is about ±2% with components used and a scope as detector. When pointer is repositioned as described in article, high accuracy (0.3%) is possible.

PROBABLY few technicians feel that they have much use for a bridge to measure resistance. An ohmmeter is so much more convenient and less expensive, and is generally adequate. However, there is an important bridge application that one encounters from time to time. That is the matching of resistors, say to within 1% or better. An ohmmeter is not accurate enough for this purpose. This comparator bridge can match resistors to within a fraction of 1 percent, reads up to a maximum of 5%, and can compare and match capacitors.

Matching is called for in phase splitters, balanced networks, push-pull amplifiers, and similar circuits. Sometimes precision resistors are specified but actually matched pairs are required. It is generally true that the actual value of resistance is not very critical. With access to a percentage comparator you can check the accuracy of precision resistors before you connect them into a balanced circuit. Even better, you can measure the resistors you already have on hand, perhaps avoiding the purchase of expensive units. Even 10% resistors may be used in delicately balanced networks if they are matched.

To test a matched pair, you need only compare one with the other. Thus a complete bridge is not needed. This circuit uses only two bridge arms; the other two are the resistors being matched. An ac signal source lets us use an earpiece as a sensitive detector. I use a 600-ohm audio generator capable of about 5 volts output, but even a low-power transistor oscillator may be used. A signal frequency of about 650 cycles provides sufficient sensitivity.

R1 and R2 should be nearly equal, preferably to within 0.5% tolerance.

Connect the comparator to a signal generator. Connect the pair to be matched to terminals J3-J4 and J5-J6. Plug in an earpiece and balance the bridge. Note the percentage difference. Now transpose the matched pair and balance again. The first reading should be on one side of zero, the second on the other. Both readings should be nearly equal. If they differ by a considerable amount, a resistor to match the one that is out of line is needed.

(Continued on page 88)
"I'm 32 and an electronics technician. I have a wife and two children to support. I completed a military tour of duty in electronics, followed by a year in electronic school.

"I've got a good job, but it's getting tougher every day because I'm supposed to know all the answers to the increasingly complex technical assignments that come my way.

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TEST INSTRUMENTS

(Continued from page 83)

Considerable amount, your standards R1 and R2 are probably not sufficiently matched. If the readings differ by a small amount (not greater than 1%), reposition your pointer knob.

For example, suppose the readings are 1% and 1.5%, respectively. Evidently the correct reading is 1.25%, the median value. Loosen the pointer knob, relocate to read 1.25% both times.

The comparator’s complete circuit.

The next step is to adjust C. This is done with a matched pair connected to the X terminals and the bridge balanced for minimum tone. Vary C slowly until the sound is nearly gone. It should be possible to bring the output very close to actual null. If the sound cannot be brought down to minimum with C across terminals J3-J4, disconnect it and try across J5 and J6. It balances out the capacitance of the wiring.

When the resistance at X2 is larger than at X1, potentiometer R3 will balance to the left of zero and vice versa. This can be definitely determined by an actual measurement. Balance the comparator with a matched pair. Then add a small resistor (in series with one of the pair being tested) and note which side of balance the pointer must move. Thereafter you will always know which resistor is the larger of the pair, by noting whether balance occurs to the right or left of zero.

Without circuitry changes, this comparator may be used for capacitance. Keep leads to capacitors very short to maintain high accuracy. With a variable capacitor across one set of terminals, this instrument becomes a capacitance meter. Connect an unknown fixed capacitor across the other terminals, then adjust the variable for balance (with the pointer knob left at zero). Known fixed capacitors may be used to calibrate the variable in terms of µµf.

The calibrated scale is found on page 84 and 85 for 0.01% and 0.1% accuracy, respectively. This table is symmetrical, the setting being the same for 0.01% and 0.1% accuracy.

The calibrated scale is given in terms of µµf, it is in series with the variable capacitor. To determine the value of the variable for balance, subtract the value fixed from the calibrated value of the variable capacitor.

When using the comparator, be sure to adjust C to balance the bridge initially. Then adjust all other variable resistors for balance, then read C. The variable R3 is the most critical.

END
Part I—Modern look in TV should mean fewer servicing problems and less technician exasperation

By WAYNE LEMONS

EVERY year the TV set designers rearrange, refine and change tube types in a never-ending search for perfection and advertising blurs—1960 is no exception. A great deal of emphasis is placed on ease of service, and accessibility is better than ever before on most models. This is not true of all manufacturers, unfortunately, but is more or less true of the industry as a whole. Several manufacturers claim that from 90% to 98% of servicing may be performed by simply removing the back cover.

Even allowing for some overenthusiasm on the part of the builders, there is no doubt that the technician has been considered by most designers. In fact, we find this year that almost every manufacturer has turned his big selling guns toward the technician, hoping, of course, for a favorable recommendation to the potential customer. So let's take a look at some of the new circuits and mechanical features we'll be seeing in the coming year.

Picture tubes

The most dramatic change this year is the recently introduced "sparser" 25-inch picture tube whose faceplate is part of the tube itself. Advantages claimed for this tube are more brightness and contrast, less reflected light and of course more area. The only cleaning necessary is the exposed faceplate. No grime can collect on the picture tube proper.

Other developments include a tube built by Motorola claimed to have 10 times more cathode area and thus should have 10 times more cathode life. An internal focus "shield" developed by Philco and said to give better focus over the entire screen and be less affected by outside influences is also new.

Not all manufacturers are using 110° tubes. Some have reverted to 90° types to be able to use more high voltage. The 110° types have a greater tendency to develop internal arcing. One manufacturer uses an external spark gap to provide for this contingency. The spark gap discharges harmlessly the excessive voltages which might otherwise be detrimental to the internal elements of the tube.

Of course, the 2EP4 electrostatically focused and electromagnetically deflected picture tube used in the Philco transistor portable is a new arrival on the service scene.

(Recommended cleaning material for picture tubes and faceplates is still water only or a very mild soap if absolutely necessary. As always, use of strong glass cleansers may damage the faceplate.)

Single-rod antennas

As we look over the '60 line, we find that more manufacturers are going to the single rod, called "Unipole," "Power Tower," etc., as a built-in antenna for local reception. Aside from its obvious mechanical advantage over the "rabbit ear" types, it can often produce as good or better pictures. The disadvantage is that the single rod represents an unbalanced load to a tuner that by design is a balanced-input device. Most manufacturers use balun coils and work the rod antenna against some large metal surface such as the chassis or picture-tube mount. A schematic of such an arrangement as used in an Admiral 15D1B 17-inch portable is shown in Fig. 1.

Printed boards

Although we service technicians have—in some quarters—been accused of apathy concerning the industry, we have certainly been far from indifferent to printed boards! The reaction has run from reluctant tolerance to downright disgust. When the National Alliance of Television Electronic Service Associations (NATESA) conducted a survey last year, a whopping 74% of the 2,500 technicians sent questionnaires responded. This compares with a response of roughly 10% to 25% on other matters.

Accessibility and difficulty of circuit tracing were considered the major problems by those polled. They also wanted more and better service information and single-sided (circuit on one side only) boards. This information and other recommendations of those polled were presented to the Institute of Printed Circuits by NATESA. That service people and their grips were considered by the manufacturer is evidenced by the 1960 printed-board designs. (See the article on this subject on page 98 of this issue.)
Road Maps

"Read map" is the term being used by most manufacturers who use printed boards, to describe the 1960 concept of printed circuitry. An exact replica of wiring on the back side is printed on the exposed side of the board to facilitate circuit tracing. This lets the technician follow the circuit from component to component without the aid of a strong lamp behind the board. Most boards are laid out with coordinates indicated so that a particular part can be localized to a certain section of the board. "Towns" or key test points are spotted, sometimes with voltage readings stamped on. One manufacturer uses color coding to distinguish the different circuits.

Board Breakage

Board breakage or conductor separation was a major drawback of the early printed board. This problem seems to be just about a thing of the past. Admiral, to prove they believe in the durability of the printed board, guarantees it for 5 years. Sylvania has a dramatic demonstrator that continuously flexes the printed board while the set operates normally. This proves beyond doubt that the new boards are more rugged.

Conductor Lifting

This problem has also been licked, according to the manufacturers. New processes seal the wiring to the board. This means though that we'll have to use needle-sharp probes to pierce through the "seal" to the conductor when testing.

Hand-wired sets

They are still around and could be for some time to come. Neither Zenith nor Hoffman have printed boards, and there may be others. Zenith, according to all sales figures, has an outstanding year with "hand-crafted" sets. This, possibly, is due in part to recommendations by service people, and may account for the big "sell" this year of printed boards to technicians through association and other meetings. It's hard to dispute the fact that service technicians' recommendations have great influence on the set buyer. This is especially true of negative recommendations, such as, "Don't buy a set with a 360° tube," etc.

Hoffman's circuit might be a trend in itself. In addition to being completely hand-wired, it uses conventional circuitry throughout and has no semiconductor diodes or rectifiers. This is extremely unusual departure from what we've been used to seeing recently. It certainly has the advantage of time-honored circuits that are generally reliable and easy to troubleshoot.

Modules

In addition to printed boards, Motorola is using modules in some of its models. A module consists of a number of components formed into decks much like the printed-circuit Couplates that have been used for several years. The decks are then stacked to form an even more compact circuit unit. Riser wires act as supports and terminals for the units. The Motorola modules are unusual in that every component in the module may be tested individually because, even though many internal connections are made, an external connection is provided for each end of every component. This does not mean that we will always be able to substitute a given part, because we can't remove the defective one from the circuit. The schematics of the horizontal and vertical sweep modules as used in the Motorola TS-556 (Fig. 2) will illustrate this more fully.

Sound

Last year emphasis was placed on more and better sound, and the trend continues. Many sets have phonio input plugs so the TV may be used as part of a stereo setup. Multiple speakers are almost a rule rather than a rarity. The rarity is a push-pull amplifier. Most sets, even those having four or five speakers, are using single-ended amplifiers and some sort of series-parallel connection to the speakers. The Admiral 20H6 TV and 381 amplifier has an extra single-ended stage for stereo, using EL84/6EQ5 as output tubes in an inverse feedback circuit.

Although a few companies including G-E are still using ratio detectors, most companies have replaced this type with some form of gatèd-beam detector, a more economical circuit. Zenith, who began the trend to gated-beam detection some years ago, is still using the 6N6 type tube. Most other companies are now using the 'DT6, which is said to give somewhat better detection under low-signal conditions. Philco is using a tube heretofore unused commercially to our knowledge in gatèd-beam detection,
Surge protectors, thermistors

Many companies are using some form of surge protection to prevent damaging tubes during the warmup period. This is true even on power-transformer type sets.

Admiral is using a manual-reset type of thermal cutout on their nontransformer sets. A button must be pushed in before the set will operate after an overload.

Most companies who do not provide surge protection on transformer sets are using a fused power supply that will prevent damage to the expensive power transformer should a B-plus short occur. A good practice when a major service job is performed on a transformer set not having such protection is to insert a 3.5- to 5-amp fuse in series with the transformer primary. This may save the customer a burned-out power transformer in the future. Slow-blow fuses are best for this application as they tolerate short overloads.

We find thermistors in just about every 110° chassis this year, especially in the vertical deflection circuit. The thermistor is needed because the resistance of 110° yokes tends to increase with heat, causing a reduction in height after the set has been on for some time. In most circuits, the thermistor is a 2.8-ohm (cold) unit in series with the vertical yoke coils. As the yoke heats, the thermistor also heats. The thermistor's resistance decreases with heat, so the yoke heating effect is cancelled. Zenith 16D25 and 16D25Q chassis place a larger-value thermistor in series with the plate load of the vertical oscillator tube. It increases the drive as the yoke heats up to prevent the decrease in height.

Color

In addition to RCA and Magnavox, Admiral also is promoting a color set this year. This is not as great a trend as might appear, since both Magnavox and Admiral sets are built for them by RCA. There is little circuit change from the 1960 models. Service and convergence adjustments remain almost identical.

This gradual branching out to different companies may be the approach that will finally get color off the ground. It is evident that as large as RCA is and as much money as they have spent promoting color, sales have just not materialized. The positive negative attitude that many service technicians have taken against color has also been a strong sales deterrent.

Fine tuning

We find more of the "preset" type of fine tuning this year. This allows the customer or technician to set the fine tuning once for stations used. Manufacturers rely on the newer low-drift tuners to stay on frequency over long periods of time. Manual overall fine tuning is not used in as many models for 1960. Usually some simple method of presetting the fine tuning is provided in the form of an external knob or button. However, some must be set with a nonmetallic screwdriver after removing the channel-selector knob.

G-E has an oscillator centering adjustment on top of its vhf tuner to compensate for capacitance changes when changing the oscillator tube. It also aids in oscillator adjustment when power tuning is used, since this mechanism blocks access to the individual channel skips.

So far we have gotten an overall impression of the 1960 sets. Next month we will go into a little more detail and discuss some interesting circuits, look at remote-control units and survey this year's new tubes. TO BE CONTINUED
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- A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service in use.
- Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only.

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

MOSS ELECTRONIC, INC.
3849 TENTH AVE., NEW YORK 34, N. Y.

SEE PAGE 95 FOR COMPLETE DETAILS
SUPERIOR'S NEW MODEL 770-A The FIRST Pocket-Sized

VOLT-OHM MILLIAMMETER

USING THE NEW "FULL-VIEW" METER
71% MORE SCALE AREA!!

Yes, although our new FULL-VIEW D'Arsonval type meter occupies exactly the same space used by the older standard 2½" Meters, it provides 71% more scale area. As a result, all calibrations are printed in large easy-to-read type and for the first time it is now possible to obtain measurements instead of approximations on a popular priced pocket-sized V.O.M.

FEATURES:
* Compact—measures 3½" x 5¾" x 2½"
* Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
* Housed in round-cornered, molded case
* Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

The Model 770-A comes complete with self-contained batteries, test leads and all operating instructions.

$15.85 NET

SUPERIOR'S NEW MODEL 79

SUPER-METER — WITH NEW 6" FULL-VIEW METER

A Combination VOLT-OHM MILLIAMMETER.

Plus CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.

Also Tests SELENIUM AND SILICON RECTIFIERS.
SILICON AND GERMANIUM DIODES.

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development. In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter state, SICO used its new full-view 6-inch meter.

The Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on call. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads—Only $38.50 NET

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MOSS ELECTRONIC, INC.
3849 TENTH AVE., NEW YORK 34, N. Y.
SUPERIOR'S NEW MODEL 82A

Multi-Socket Type

TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into numbered socket as designated on your chart (over 600 types included).
3. Press down the quality button — THAT'S ALL! Read emission quality direct on bad-good meter scale.

Production of this Model was delayed a full year pending careful study by Superior's engineers on this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar-looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82A the number is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage, if any, indicates automatically.

Model 82A—Tube Tester. Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL

TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyatron, Miniatures, Sub-miniatures, Nosals, 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.

The Model TW-11 operates on 105-130 Volt 60 Cycles. Comes housed in a handsome, portable Saddle-Stitched Texan case. Only...

$36.50 NET

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NO MONEY WITH ORDER — NO C.O.D.

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

RADIO-ELECTRONICS

SEE FOLLOWING PAGE FOR COMPLETE DETAILS
SUPERIOR'S NEW MODEL 83

C.R.T. TESTER
Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

ALL COLOR TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.

- Model 83 provides separate filament operating voltages for the older 6.3 type and the newer 8.4 types.

- Model 83 employs a 4" air-damped meter with quality and calibrated scales.

- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the reij switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.

Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

MODEL 83—C.R.T. TUBE TESTER: Total Price $38.50—Terms $1.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

SUPERIOR'S NEW MODEL TV-50A

7 Signal Generators in One

- R.F. Signal Generator for A.M.
- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Cross Hatch Pattern Generator
- Marker Generator

A versatile all-inclusive GENERATOR which provides all the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Specifications

BAR GENERATOR: The Model TV-50A produces an actual Bar Pattern on your TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 29 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Generator will produce a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOTTED PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the following additions which are a "must" for the Pattern Generator. The Dotted Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A provides all the most frequently needed marker points. The following markers are provided: 100, 200, 300, 400, 500, 1,000, 1,500, 2,000, 2,500, 3,000, 3,500, 4,000, 4,500, 5,000, 6,000, 7,000, 7,500, 8,000, 8,500, 9,000, 9,500, 10,000 Kc. The Model TV-50A Generator provides a variable 500 cycle to 20,000 cycle signal which you can adjust to any color burst frequency.

MODEL TV-50A Generator. Total Price $47.50—Terms $1.50 after 10 day trial, then $5.50 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

SHIPPED ON APPROVAL

MOSS ELECTRONIC, INC.
Dept. D-489 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied, I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after 10 day trial positively cancelling all further obligation.

Name ____________________________ Address ____________________________

CHY ____________________________ Zone ______ State ______

DECEMBER, 1959

Total Price $42.50
$12.50 within 10 days. Balance $6.00 monthly for 5 months.

Model 77 Total Price $12.50
$6.50 within 10 days. Balance $6.00 monthly for 5 months.

Model 89 Total Price $12.50
$6.50 within 10 days. Balance $6.00 monthly for 5 months.

Model 8-A Total Price $15.85
$3.85 within 10 days. Balance $4.00 monthly for 5 months.

Model 8-A Total Price $15.85
$3.85 within 10 days. Balance $4.00 monthly for 5 months.

Model 79 Total Price $15.85
$3.85 within 10 days. Balance $4.00 monthly for 5 months.

Model 82A Total Price $36.50
$6.50 within 10 days. Balance $6.00 monthly for 6 months.

Model 82A Total Price $36.50
$6.50 within 10 days. Balance $6.00 monthly for 6 months.

Model TV-11 Total Price $47.50
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Model TV-50A Total Price $47.50
$11.50 within 10 days. Balance $6.00 monthly for 6 months.

All products net. F.O.B., N.Y.C.
TODAY'S BEST QUALITY BUY

TELEVISION

By ROBERT B. COOPER, Jr.

THE summer of 1959 will go down in the record books as a very unusual one indeed. In certain areas of the country, E skip was more prevalent and occurred more often and lasted longer than in any year to recent memory. David Beal of Tucson made a 21-inch RCA and a few signals conical bring him 255 skip loggings on 23 days during June! DXer Beal also logged a pair of new Mexican stations. XHNL is a new one on channel 2 in Monterrey. This station has been reported on channel 10 in the past, and has been heard on channel 2 on one occasion in California. Heard, we say, because to date no dxer has been able to frame a video signal to go with the XHNL sound. Another new station in Mexico is the channel 6 satellite operating in the area south of Mexico City, repeating XEW, channel 2, which originates in Mexico City.

El Salvador

Donald Ruland, dxing from Holly Hill, Fla., early on the evening of June 17 found YSU channel 4, San Salvador, El Salvador, coming through with an excellent signal. Dxer Ruland also logged signals from the Dominican Republic (HIT-4), Puerto Rico (WKAJ, WAPA, WAPA-A) and many Cubans during the summer months.

Strong Es and short Es

As a general rule of thumb, when E skip shortens down to 600 miles or less, it is a sign of a very dense and extremely strong opening. Walter Owen Jr. snagged WSYR, 3, Syracuse, N. Y., over a short 400-mile skip path on June 11. At the same time he was logging WSYR, an amateur in Massachusetts was logging 144-me signals from a ham in Illinois. Until Owen's TV dx report of short 400-mile skip on channel 3 showed up, scientists were not sure how the vhf 144-me signal got from Illinois to Massachusetts. Now they are fairly certain it was a rare form of E skip.

FM dx—E skip mostly

Several FM dx enthusiasts got their feet wet during the summer dxing season, and not a few heard their first E skip on the FM band. Bill Finn, Milwaukee, Wis., made his FM set really go to work on June 11 with 12 FM skippers heard in a 1-hour period. Finn's FM total—101 stations. The most experienced FM dxer known to this writer, Bruce Elving, Duluth, Minn., heard E skip from New England, including WKBR-FM, Manchester, N. H., his 33rd state on FM on July 23. July 25 was a ground-wave day with four low bands in the 400-mile range. S/Sgt. Donald Lee, stationed at Homestead AFB, Florida, logged stations in Texas and Ohio on skip.

From the FM dx reports of Wayne Bue, Meyersdale, Pa., and D. G. Bennie, Kinston, N. C., it appears there were probably at least 12 days for dxers in the area east of the Rocky Mountains during which FM E-skip reception was possible.

Predictions

E Skip: Reception in the 700-1,500-mile range dwindles considerably dur-
TELEVISION

Meteor Showers

Date | Max. Burst Rate | Best Direction
--- | --- | ---
Nov. 22-30 | 1800-2000 | NW-SE
| 2300-0000 | SW-NE
Dec. 10-14 | 0300 | N-S
| 0600 | NW-SE
| 2130-2200 | SW-NE
| 0600-0630 | SW-NE

ing the months of November-December, although dxers can begin to look for E skip with more frequency after Dec. 10, with 95% of wintertime E-skip openings occurring between 4 and 8 p.m. Dxers in the southern USA will find skip more frequent than their northern cousins.

Trops: Wintertime ground-wave reception is poor at best. Fringe areas have pulled in from 100 to 150 miles in most dxing locations. What dx occurs will be over bodies of water (such as the Great Lakes, Gulf of Mexico) and then only for distances of 200-300 miles.

F2 Skip: The reason for watching BBC and other European television is now upon us, and it promises to be about the last such year for another six. These dxers with converters for the European channels know the best hours are the mornings from 7 am LST to 12 noon. F2 dx will die down in intensity after the first week of December, but promises to pop back in for a 3-week run after the first of the year.

TURRET TROUBLE

Two drops of oil cost a customer of mine $6. The other day this customer phoned at 9:30 at night and told me to come over to his house and fix his TV set. He said he couldn't turn the station selector switch on his Philco model 1475, farther than to the next channel and back again.

On the phone I advised him to check all rf and oscillator coils and to see that they were in place. But he wanted no part of that job. I had thought that one of the coils had worked itself loose jamming up the turret. I had wanted my customer to fix his set because I did not want to leave my shop at that late hour. Well, I went to his house.

After removing the chassis and examining the front end with the aid of my portable light (socket with clamp attached and 40-watt bulb) and magnifying lens (I find this handy when checking the fine brass springs to which are attached contact points) I found nothing broken or out of place. Therefore I could only assume that the shaft of the turret was jammed. I applied two drops of machine oil and that did the trick! Of course, I believe a customer is entitled to a little extra service like dusting the high-voltage department plus whatever adjustments are necessary that will make for a better picture. He was well satisfied.—Edgar Reynolds

RCA WTV-38A (K)

VOLT-DHM-MILLIAMMETER

only $29.95 includes batteries, probe and cable with slip-on alligator clip, ground lead and clip, assembly and operating instructions (available factory-wired and calibrated—only $43.95)

Exclusive features make this RCA VOM kit the buy of a lifetime! Extra 1 volt and 0.25 volt (250 mv) ranges for wider usage in transistor servicing—new handle clip accommodates probes and test leads for extra carrying convenience. Assemblies in a breeze!


SPECIFICATIONS: Input Resistance—20,000 ohms per volt on DC, 5,000 ohms per volt on AC. Accuracy—± 5% DC—± 1% AC (full scale). Regular Scales—2.5, 10, 50, 250, 1000, 5000 volts, AC and DC; 50 ma, 1, 10, 100, 500 ma, 10 amps (DC). Extra Scales—250 mv. and 1 volt (DC). Frequency Response—AC flat from 10 cycles to 50 kc. (usable response at 500 kc).— Ohms—3 ranges: Rx1, (0.2 thousand ohms), Rx100 (200,000 ohms), Rx10,000 (20,000,000 ohms).—Dimensions—W. 5½", H. 6", D. 3¼".

RCA WTV-38A (K)

3-INCH OSCILLOSCOPE

only $79.95 (complete with Low-Cap, Direct Input Probe and Cable) (also available factory-wired and calibrated—only $129.95)

The first scope kit with "get-up-and-go!" Use it for practically everything—video servicing, audio and ultrasonic equipment, low level audio servicing of pickups, mikes, pre-amps, radios and amplifiers, troubleshooting ham radio, hi-fi equipment, etc.—and you can take it with you, on the job, anywhere.

FEATURING: voltage-calibrated frequency-compensated, 3 to 1 step attenuator—scaled graph screen and calibrating voltage source for direct reading of peak-to-peak voltages. "plus-minus" internal sync...holds sync up to 4.5 Mc...shielded input cable with low capacitance probe included—weight only 14 pounds—includes built in bracket to hold power cord and cables.

SPECIFICATIONS: Vertical Amplifier (Narrow Band Position)—Sensitivity, 3 mms per inch; Bandwidth, within ± 0.2, 20 cps to 150 kc. Vertical Amplifier (Wide Band Position)—Sensitivity, 100 mms per inch; Bandwidth, within ± 8db, 5.5 cps to 5.5 Mc. Vertical input impedance—At Lowcap, cable input...10 megohms, 10 muf (approx.)—At Direct-cable input...1 megohm, 90 muf (approx.)—Sweep Circuit—Sawtooth Range, 15 cps to 75 kc., Sync, external, ± internal; Line Sweep, 150 adjustable phase.

RCA WTV-77E (K)

VOLTHYMST

only $29.95 (also available factory-wired and calibrated—only $49.95)

Think of it...an RCA Volthymst Kit at this low, low price! You get famous RCA accuracy and dependability, plus the easiest to assemble kit you've ever seen!

FEATURING: ohms-divider network protected by fuse—ultra-slim probes and flexible probes—padded leads—on-handle stores, leads, power cord—-separate 1½ volts rms and 4 volts peak-to-peak scales for accuracy on low-ac measurements—front-panel lettering acid-etched.

SPECIFICATIONS: Measurcs: DC Volts—0.02 volt to 1500 volts in 7 overlapping ranges, AC Volts (RMS)—0.2 volt to 1500 volts in 7 overlapping ranges, AC Volts (peak-to-peak)—0.2 volt to 4000 volts in 7 overlapping ranges, Resistance—0.2 ohms to 1000 megohms in 7 overlapping ranges. Zero-center indication for discriminator alignment. Accuracy—3% off full scale on dc ranges; ± 5% of full scale on ac ranges. Frequency Response—flat within ± 5%, from 40 cycles to 5 Mc on the 1.5, 5, and 15-volt rms ranges and the 4.14, and 40-volt peak-to-peak ranges—DC Input Resistance—standard 11 megohms (1 megohm resistor in probe).
CIRCUIT BOARDS ARE GETTING BETTER

Representatives of a state federation of service technicians remarked last spring, after a conference with manufacturers: "Printed circuits are likely to be with us for some time, and we may have to learn to live with them." Fortunately, the very articulate reaction of the service field to certain features of these new components has made manufacturers examine their products from the points of view of serviceability, excellence of construction and reliability. Practically every 1960 TV set board has new features designed to make servicing quicker and easier. The four boards on this month's cover are by no means the only examples of such improvement.

The Motorola board used in their 17P6 portable is possibly the most interesting of the group on the cover (in the foreground). It is the only one of the four that has conductors on both sides. This has the advantage of permitting crossovers, thus making for straighter and simpler "wiring" patterns. The obvious disadvantage—difficulty in following circuit lines—is negated by using black lines to indicate conductors on the opposite side of the board. All conductors are color-coded to indicate their functions. A green line is immediately recognized as a grid circuit, for example, and a green line with red dots is a plate circuit. The type number of each tube is printed on the board and pin 1 indicated.

All leads to other parts of the receiver are terminated in a row of contacts along one edge of the board. The whole board can then be clipped into a strip near the front of the receiver, making all contacts almost instantaneously. With the help of a special extension harness (or less conveniently, by disconnecting the strip, which has leads long enough to clear the chassis) the board can be connected into the circuit while standing up behind the set for more convenience in servicing.

Philco approach

The Philco board, which appears just behind the Motorola on the cover, supplies a great deal of information to the technician. Tube type numbers and functions (6CG7, HOR OSC, 6DR7, VERT OUT?) are both given, test points are indicated, and the lances that act as terminals and test points carry indications like "VERT HOLD, B +275, 2 AUDIO." Conductors are all on one side of the panel, and the underchassis pattern is reproduced in a distinctive pale blue on the component side.

Security-sealed circuitry

RCA refers to its board (third from front on the cover) as "road-mapped." All conductors are on one side of the board, and an exact replica of the wiring is carried on the other side in a white-dot pattern, as are all tube and component codes.

The road-map feature is a system of locating components. The diagrammatic views of the board in the service data are divided into a grid by a series of letters on the sides and numbers on top and bottom. Thus a component whose coordinates are, for example, A5, can be located immediately.

Terminals where leads leave the board are lettered, the same letters appearing at corresponding points on the schematic. Some of the earlier boards also had jumper wires between certain conductors. These were identified with double letters, one of which was J. Thus MJ on one part of the board is connected to MJ on another. The "security-sealing" refers to a coating of wax over the conductors, and to the firmness with which they are secured to the board.

Emerson board

Some of the features of this board

Solder in left top corner was applied with 250-watt gun, using plenty of time. Conductor at lower left was lifted only with considerable difficulty.
Motorola board functions while standing behind chassis for servicing.

(shown at rear) seem intended to help the assembler as well as the service technician. Component and tube codes are given, and the codes so printed as to indicate the mounting holes for the components. If resistors or capacitors are long, lines are drawn from the lettering to the mounting holes. Outlines of some parts, such as coils or capacitors standing on end, are also drawn on the board. Some triangles, and circles, which looked rather important at first, are for use in assembly. While inquiring about these, it was brought out that new boards in the design stage at Emerson will carry a great deal more information, including voltages.

This board is the only one that does not have the conductor pattern printed on the side of the board that has the component information. It is very translucent and obviously depends on the technique of using a light on the other side of the board to trace circuits.

A functioning schematic

The Westinghouse See-Matic board (not shown on the cover) has a number of interesting features. The component side of the board is absolutely blank—all lettering is on the conductor side. Since the conductors are right in sight, no circuit lines are necessary, and instead component symbols are drawn to show their position on the other side, with lines connecting to the proper conductors (see photo). The values of resistors and capacitors—rather than codes—are printed next to the symbols, together with pin type numbers and pin identification (G, P, K, etc.). Some components, such as coils and transformers, are identified by the component code near their symbols, and straight lines represent wire jumpers on the other side of the board. Test points are indicated by circled letters.

The result is that each Westinghouse board is its own built-in schematic, and in many cases the technician can repair it without any additional service data.

Some very useful features appear on the boards of other manufacturers not represented on the cover. In the G-E board, for example, ground-circuit conductors are indicated by the familiar triangular chassis symbol. Component codes and schematic symbols are both shown, and even the tubes are drawn in schematic style. Asterisked numbers refer to terminals at which leads go to components off the boards, and are of course duplicated on the schematic.

Other features

The boards inspected showed a strong tendency to group components for simpler mounting. Numbers of Centralab Couplers, Erie Fuses and similar combinations were found. Boards are in most cases more rugged than earlier ones, and the conductors can be soldered with little danger of peeling them from their support. Even after a 250-watt Weller gun was held on one small conductor for a full 2 minutes, it could be loosened only with difficulty. Large amounts of solder were flowed onto other conductors with no loosening effect on the foil.

Some of the boards have a wax layer over the conductors. It can be soldered through without difficulty. Practically all this year's boards have a solder-resist over all parts of the conductors except the portions where solder is desired. Thus solder is found only at points instead of covering the whole surface of the conductors.

One aid not supplied by a set manufacturer is the Circuitrace feature of Sum's Photo Facts. Important items on the component side of the board are pointed out with arrows terminating in black squares with white numbers. The same black squares and white numbers appear at corresponding points on the schematic, making it possible to locate up to 40 test points on some boards. A somewhat similar service is performed in the manufacturers' data on "road-mapped" sets, like the RCA, G-E and Emerson. Tables of important components with their coordinates are printed, enabling the technician to locate them rapidly.

Another aid is RCA's 24-page booklet Printed Circuit Servicing Techniques. It describes general techniques, as well as the special features of a number of circuit boards, both of RCA and other manufacturers, and including both TV and radio circuitry.
In moisture, salt spray or areas of heavy industrial contamination, AMPHENOL's new 214-103 Marine Core Twin Lead provides amazing low-loss performance. Measured signal loss of polyfoam Marine Core submerged is 20% less than other foam type lines, 25% less than tubular lines, and up to 93% less than standard twin leads. Marine Core gives vital signal protection where other twin leads fail!

Extremely flexible, Marine Core's performance secret is simple: Proper spacing ratios between conductors and between conductors and line surface, a discovery of AMPHENOL engineers.

A tough, brown virgin polyethylene jacket protects Marine Core's double self-sealing cores of polyfoam. Conductors are 7/28 pure copper for longer life. Availability: Coils of 50, 75 and 100 ft., put-ups of 500 and 1000 ft.

The circuitry in the oversize plug of Socke-tenna appears to be good for safety—isolating the antenna circuit of the TV set from the AC power line—but has no other apparent utility. One capacitor, as shown in the diagram, was shorted to itself and appeared to have no function beyond holding the wire in place! Since the cable had two parallel wires, most of the potential pickup on one wire was probably being cancelled out by pickup on the other one. A single wire would no doubt have been more effective.

The maker used a specially molded oversize plug to hold the simple isolating network and useless capacitor. He used such heavy lead-in wire that the spade lugs for the set hookup kept
TELEVISION

breaking off. Possibly he wanted to give
purchasers the illusion they were buying
something substantial to make up for the
fact that Socke-t-enna actually gives
them poorer reception.

Regular readers may recall that in
earlier days of television, when numer-
ous "midget wonder" antennas were
advertised and sold, Radio-Electronics
tested some of them (page 8, May,
1954). At that time we found that
"... these miracle antennas should
work much like simple pieces of wire
of similar dimensions." At least one of
these has reappeared, apparently en-
couraged by the commercial success of
recent arrivals.

Other antennas that plug into the
electric light socket are appearing. A
supposedly "radar" type, with a short
dipole as well as the socket connection,
was also tested. It acted about as well
as an indoor dipole of the same dimen-
sions, and gave reasonably good pic-
tures, though no difference was noted
on inserting and removing the line plug
or reversing it in the socket. An "im-
proved" version, without the dipole, is
rumored. If it appears, it may be ex-
pected to operate more like the Socke-
tenna.

Customers Are Funny

EVERY so often, a drab day is bright-
ened unexpectedly by a customer we
could associate only with aggravation.

Two of us drove up to a lady's house
one morning a few days ago. We
planned to check the performance of
her set while a test pattern sponsored
by a distributor was being broadcast.

Little did we realize that a half-hour
later we would have liked to roar with
laughter; the customer's past record
of nuisance calls and nagging had condi-
tioned us to expect the worst. That was
the reason for two of us going on the
call.

However electronically ignorant, de-
spite the fancy home, she was as usual
breathing down our necks as we made
minor adjustments. As is customary,
voltage was turned all the way down,
since we were not the least interested
in 400-cycle audio.

I remarked that I'd take a look at
the antenna and left the livingroom.
Just as I kicked the tower, I noticed
through the window that the test pat-
ttern was replaced with the distributor's
commercial, picturing a stacked Lazy-X,
identical to the one we had installed
here. Upon my return, a minute or so
later, the Indian head reappeared on
the screen. As usual, there was noth-
ing wrong with either set or antenna.

But, suddenly, the lady was content.
As we left, she blurted: "Hi! that's
funny, I never knew you guys were
using the TV to look at the aerial. A
lot safer than climbing the tower, isn't
it?"

Fortunately, our ear-to-ear grins did
not arouse any suspicions.

Ever since that day, she has been a
model customer, convinced that our
shop is tops!—Paul Boller
How far can you go in electronics... without a degree?
Two years ago, when Richard F. Brani was first asked to review his field engineering progress at IBM, he'd been recently promoted to computer instructor. Now, he has a new and more crucial responsibility: Group Manager of 20 field engineers who keep a SAGE computer operating at its peak, bulwarking America's air defenses. Here's his story.

Given Important Assignment. "In my first four years with IBM, my field engineering career has taken several giant steps forward—despite my lack of a college degree," reports Dick Brani. "When I joined the Company, my special training consisted of graduation from a technical school, an F.C.C. license, and some Army engineering training. Now, I have a responsible management job in the SAGE Project. My knowledge of electronics has grown tremendously, and my future looks as promising as I could wish it."

"How did I make this progress? IBM believes that—after comprehensive training—technicians like me can handle assignments generally performed by graduate engineers. And IBM has been proved right. Hundreds of technicians are now functioning successfully as IBM field engineers."

20 Weeks' Computer Training. Dick Brani joined IBM in the fall of 1955. He was immediately enrolled in a 20 weeks' computer units training program. "You learn how the different units of large-scale computers like SAGE operate...how the computer itself can help diagnose and locate trouble...and how to make fast, precise repairs," he says. "Once assigned to a SAGE Site, field engineers may also attend classes—during regular working hours, by the way—to keep up with advanced developments in electronics. Our site, for example, recently had a course on the new, increased-capacity SAGE 'memory'."

Advances Rapidly in Four Years. "I know of few other companies that offer technicians better or more valuable training than IBM," Dick Brani says. "This training can prove an 'open sesame' to engineering and management opportunities not usually available to men lacking college degrees."

After his training, Dick Brani's abilities won him a position as instructor in IBM's education program. For two years, he taught courses in computer units and systems. Then, a little over a year ago, he was promoted to Group Manager of 20 field engineers assigned to install—and maintain—a SAGE computer at a new site. "I'm responsible for the successful operation of the computer. I have to check out repairs my men do, schedule maintenance activities and supervise all new engineering changes."

What is SAGE? SAGE is a vital part of America's air defense system. At the core of the SAGE system is a network of fast, extremely reliable electronic computers. In each sector of our nation, a SAGE computer is constantly in operation, 24 hours a day, helping the Air Force prevent surprise aerial attacks. Here's how SAGE works: The computer receives radar data from many observation points. It checks this information against known air traffic for the sector and presents to the Air Force a pictorial display of the air situation. If need be, the computer can guide a BOMARC missile to a target for certain interception.

Counseling to Develop Strong Leaders. "My most challenging duty as a SAGE Group Manager? Helping the men in my group advance and develop," replies Dick Brani. "One way I do this is by periodically rotating my men so that they become familiar with all phases of large-scale computer operation. But the most effective way is through counseling—just sitting down with a man and discussing his progress, his prospects, his career goals. IBM encourages frequent and intensive counseling. By this method the Company finds and develops the strong leaders it needs to stay at the head of its field."

SAGE Program Still Growing. "My future? I can advance to still more important responsibilities in SAGE field engineering," says Dick Brani. "SAGE has grown tremendously since its inception a few years ago, and it's still growing rapidly. Or, I can move into major spots in education, personnel, management, development engineering—or nearly any activity you can name. My future at IBM is limited only by my ability as an individual."

If you have a minimum of 3 years' technical schooling after high school—or equivalent experience—you may be eligible for 20 weeks' training as a computer units field engineer. While training, you receive full pay plus living allowance. Your starting salary will be determined by the extent of your education and experience.

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TOUGH-DOG DEPT.

By H. A. HIGHSTONE

Wednesday, 9:47 a.m. It was cold outside but the customer coming in with the Stewart-Warner 17-incher was hot, capital H. His box had gone dead again—fourth time in two weeks. In the shop it would sit sullenly on the bench, playing hour after hour without batting an eye. But, after a day or so back in the customer’s house—out would go the 1-amp line fuse.

The customer’s line voltage had been triple-checked. He vowed he’d never noted lamps burning overbright. If anything, he said, they sometimes burned a bit on the dim side. Even so, after this fourth visit, I asked the power company to hang a recording voltmeter on his house for 24 hours.

The power company’s troubleshooter never got that far. Instead, he fixed the TV set for me, so to speak. Dropping across 240 volts. The arithmetic is pain-fully obvious—voltage supplied the TV set instantly rises to 180! (The small liberty of assuming that the hot and cold resistances of the heater are identical is taken.)

High resistance

Broken neutrals are rare. However, high-resistance neutrals are not uncommon. (It was a high-resistance neutral which had been clobbering our Stewart-Warner.) When appreciable resistance develops, it almost invariably does so in what is called the neutral bar of the main disconnect switch. Disconnect switches exposed to the weather are especially apt to develop this sort of trouble.

The neutral bar (see Fig. 3) is a solid piece of copper or brass to which are attached, with screw terminals, (A) the neutral conductor coming from the power transformer, (B) the neutral ground conductor for the residence, and (C) the neutral conductor leading into the house.

In this Stewart-Warner case, connection A (Fig. 3) had become so loose as to be practically open. This did not result in an open neutral, however. Current in the neutral took the alternate route through the ground conductor attached to B, then through the earth to the ground connection, always provided for power-transformer center taps.

Resistance of the earth between residence and power transformer ground may be considerable. Thus the neutral is not actually opened if A becomes disconnected but, on the other hand, it may be only half-closed. In Fig. 2 this would not result in 180 volts being thrown at the TV set, but voltages as high as 150 might appear.

It wasn’t a heater, but a big home freezer which had been latched onto the transformer leg opposite the fuse-blowing Stewart-Warner. And impedance goes down pretty close to zero for an instant when the motor in such a freezer starts up.

We never checked, but the lights in the house were probably connected onto the same transformer leg as the freezer, thus explaining the customer’s statement that his lights occasionally seemed a little dim but never overbright. Anyway, a brief workout with a screwdriver on the neutral bar wrapped up this case of trouble for good.

After explaining the facts of life, the power company man let me in on another little doozie which often baffles amateur electricians but good. It just might baffle you, too, so take notes.

Fig. 4 shows again the elementary schematic of a power transformer secondary supplying a home. Somehow or other, the fuse has blown in the bottom leg. Obviously this has no effect upon devices connected to the top leg of the transformer secondary. However, this blown fuse does not deprive the TV set of electricity. This happens because the TV is now in series with the 3,000-watt electric water heater, designed to operate on 240 volts. Voltage across this series combination is only 120, of course, which leaves the TV set with less than 90 volts to do business with.

Enough to make the tubes light, the oscillator drop out and give a TV technician something closely resembling a bad time.

Not that bad times are any novelty for TV fixers, of course. Anyone for joining the Foreign Legion and having things a little easier for a refreshing change?

Case No. 285,948,652,904: Here’s a clue to the occasional TV set which burns out tubes at a disastrous rate

Fig. 1—Basic home-wiring circuit.

Fig. 2—Neutral line has been broken and 180 volts is applied to the TV set.

Fig. 3—The neutral bar—solid piece of copper or brass with screw terminals.

Fig. 4—Not a thing wrong with the TV here; nevertheless no sound, no picture.
One of the most satisfying ways to log TV DX is to capture the test pattern or ID slide on film. However, most articles dealing with photographing cathode-ray tube images or TV pictures deal with strong, local signals. The TV DXer is often faced with trying to photograph a TV signal that is barely readable or very unstable to begin with. Both of these situations call for unusual photographic procedures for the DXer to get optimum results.

First, let's review some of the principles of getting a picture from your TV screen. Since the TV picture is a light source, your set should be in a darkened room—dark enough so the screen will photograph black when the TV is off. This is the blackest black you can get in the final picture. Of course, flash must not be used.

One complete frame of a TV picture takes 1/50 second, and a shorter exposure will not get a full frame. A slightly longer exposure generally does no harm so the standard 1/25 second is good. (In countries using a 25-frame-per-second system, the 1/25-second exposure is ideal.)

The light from the screen is usually low, and for this reason a fast film and lens are desirable. The actual combination varies with the condition of the TV set, but f2.8 with Tri-X film is a good starting point.

A large screen is easier to get in focus; but if you can focus the camera on the screen and have the screen almost fill the negative, there will be little difference between a 7-inch and a 27-inch set.

Shooting the unstable picture

What about unstable DX pictures? They may be unstable because of interference, rapid fading, ghosts, or combinations of these. Under these conditions, many TV sets synchronize differently on each field (half-frame), adding to the confusion. Under these conditions, a photograph of a single field will give the clearest picture. In other words, take your picture at 1/60 (or 1/50) second. This gives only every other line, but if interlace is not good you can get a clearer picture from a single field. Lens should not be opened.
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Fig. 1—(Top) The pattern on the screen. Snow makes it impossible to identify. (Bottom) A longer exposure tends to cancel the snow, giving a distinguishable picture: WMAL-TV, Washington, channel 7.

up any wider, as each line is just as bright as before. This method also applies to photographing a rapidly moving scene.

Weak signals
A more interesting case is where the signal is steady but weak, perhaps so weak that it is not readable. If synchronization is stable and the picture is the same for a second or more, a considerable photographic improvement is possible. Snow is really just random noise and, being random, it rarely occurs twice at the same spot. With a fixed picture, the picture details always fall at the same place. If the total light from each point is added, there could be about as much white as black at each point from the snow, while the white and black of the picture remain steady, causing increased detail to show.

This can be done photographically. Adjust the set's hold controls for maximum stability and turn the intensity down until the snow just vanishes in the blackest portion of the picture. Set the contrast just high enough to get good whites, but not so high that the white portions become defocused. Then increase the camera exposure to a second or so and stop down to around f/16 to keep the longer exposure from overexposing the film. The results are amazing, as shown in Fig. 1. One photo (Fig. 1-a) was taken at f/2.8, 1/25 second on Tri-X, and the other (Fig. 1-b) was taken immediately afterward at f/16, 1 second on the same film. The TV was a 17-inch set with a cascode tuner and a short wire for an antenna, about 69 miles from the TV station. Almost all ID slides are shown for

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several seconds, and it is possible that this could be the sole identifying means of a TV dx.

One word of warning: cameras with focal-plane shutters may give peculiar results, especially at fast shutter speeds. These can be reduced if the camera is set so the focal-plane shutter operates from bottom to top. The shutter then tends to follow the scanning on the screen, as the image in the camera is inverted.

If you do your own photographic printing, one other method can improve your final print. Take several pictures of the same test pattern or ID slide with the camera in precisely the same place each time. Either underexpose them or overexpose them, and then carefully stack the negatives so the picture elements all coincide and use the stack as a single negative. Although not as easy as the single long exposure, the principle is the same. It can also be done with rapidly fading or jittery pictures to give some improvement.

So the next time you are trying to record that very snowy or jittery test pattern or ID slide, try to ID it with your camera. You may be surprised by the results!

Rob the TV Man—Pay the Undertaker

PULL that plug out of that wall! Don't work on that set with it turned on!"

I looked up to find that my customer was really serious. After explaining that we always work that way, I continued checking her television set.

"Don't kill yourself. I just moved here and I want to live in this house!"

She then related this story:

The husband of her next-door neighbor in suburban Altadena, Calif., had electrocuted himself while attempting to repair his TV set. His wife came home to find him crouched behind the set with his hands on the chassis and his head against the high-voltage section.

The sight of the burned face had made a lasting impression on the women of the neighborhood who came in to assist and comfort the terrified wife.

On my return trip to the shop I stopped by the service shop of a friend, Mel Rector of Rector's Radio & Television in Pasadena, and related my experience. He told me that the same man had brought in some tubes to be tested.

Two of them were bad, but when Mel put the new replacement tubes on the counter the man turned to walk out, explaining that he could get them "wholesale."

Later that day Mel received a call from the coroner asking the approximate time he had tested the tubes, as a clue in establishing the time of death.

The dead man's widow paid for a funeral because he tried to save the price of a service call.

—William G. Rhone

DECEMBER, 1959

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2. WATCH IT REACTIVATE THE PICTURE TUBE — You actually see and control the reactivation directly on the meter as it takes place, allowing you for the first time to properly control the reactivation voltage. This eliminates the danger of stripping the cathode of the oxide coating. It enables you to see the speed of reactivation and whether the build-up is lasting. You will see if the cathode contamination is too great and if the picture tube is too far gone to be reactivated.

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4. UNIQUE HIGH VOLTAGE PULSE CIRCUIT — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

5. VISUAL LIFE TEST — Enables both you and your customer to see the life-
expectancy of any picture tube before you make your decision. This test virtually eliminates resistance to picture tube replacement when necessary.

6. TESTS, REPAIRS AND REACTIVATES SPECIAL LOW SCREEN VOLTAGE TUBES — Many new type picture tubes use special low voltages of approximately 50 volts. The CRT-2 will test, repair and reactivate these types with the same thoroughness as the regular types with complete safety.

7. SEPARATE FILAMENT VOLTAGES — Including the very latest 2.35 volt and 6.4 volt types as well as the older 6.3 volt types.

8. TESTS, REPAIRS AND REACTIVATES "SP" PICTURE TUBES — Found in the newest Sylvania and Philco TV sets. These picture tubes have different base pin connections than standard picture tubes and there is always an element of risk that the tube may be burned out when tested with ordinary picture tube testers. The CRT-2 is designed to accommodate this new base pin arrangement and will test the tube with no danger of damage.

ADDITIONAL FEATURES

- Employs the time proven dynamic cathode emission test principle
- Special 45° meter with heavily damped movement for smooth action, accuracy and long life
- Provides separate shorts test for each element in the picture tube
- Filament continuity is shown on a separate low indicator
- An easy to read instruction manual contains all the latest testing information on old and new type picture tubes
- Wound in handsome hand-rubbed oak carrying case with special compartment for MULTI-HEAD and line cord.

*patent pending

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- Transformer, socket and wiring leakage capacity

out-of-circuit checks:
- Quality of condensers . . . (This includes leakage, shorts, opens and intermit-
tents)
- Value of all condensers from 50 mmfd. to .5 mmfd.
- Quality of all electrolytic condensers (the ability to
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OUTSTANDING FEATURES

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AC VOLTmeter... True Peak-to-Peak measurements as low as 3 volts of any wave form including sinewaves, square waves, pulse trains and practically any other wave form... Scale divisions are easily read and marked. Sensitive Color TV gating pulses... Measures from 0.1 volt to 1500 volts with circuit loading of 10 Megohms... Unlike most other V.T.V.M.'s there is no loss of accuracy on the lowest AC range.

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**SPECIFICATIONS**

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- DC Rms... 0 to 1 billion ohms, 10 ohm center scale — Rxl/100/1/100
- RF... Peak reading demodulator supplied for use on all DC ranges
- Zero Center... — calibration is done with r-f wave and scale. Scale from 10 db to -10/2/2/10/5/60 based on the D.C. unit. 100 db output in 600 ohms, 5000 db output in 600 ohms.
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TELEVISION

all-in-one TV and home service organizations growing?

ALL-IN-ONE service organizations which repair TV, appliances, windows, locks, plumbing and hi-fi sets, all paid for on a single monthly bill, are spreading. In February, 1959, RADIO-ELECTRONICS took note of an outfit called Mr. Service Club, operating in the Chicago area ("TV Service à la Carte," page 118). This 24-hour-a-day group is similar in many ways to a new one on Long Island called the Allied Homeowners Association. The AHA is located in Roslyn, N. Y., and may just possibly be the beginning of an important trend. In any case, it is well worth watching.

This organization has about 2,000 members who go through the association for any kind of home repair from roofing to radio. When a call for home service comes in, the AHA, having almost 200 different "contractors" from which to choose, picks out a service organization close to the homeowner and gives the call to him. The contractor does the job and bills AHA. At the end of the month, the group bills the customer for all the various repair work done for him, takes 10% of his payment and sends the rest to the contractors.

Many may ask why any repair technicians bother giving 10% of their hard-earned money away to a middleman? Out on Long Island many service technicians do it because being on the list of "contractors" for this service go-between brings them new customers they wouldn't otherwise get. Besides, these customers always pay their bills, with few or no kicks because they've been credit-checked before being accepted as group members.

Al A. Brown, of Page TV and Hi-Fi, Bethpage Long Island, says, "I always give priority to customers from the AHA. They never squawk about a reasonable bill, and they don't expect to get 20% off on tubes." Art has been a full-timer for 5 1/2 years, with the group for a year.

Sol Feld, owner of Tower TV in Bellerose, N.Y., feels the same way. Says Sol, who's had his own place for 10 years, "I go out on all Allied Homeowners calls myself. I find that they are the best sort of customers to have. They're ready to trust me because they
TELEVISION

feel I've been 'recommended' by their organization's headquarters."

AHA has been in operation for just 2 years. It charges members $10 to join, $5 per year thereafter. Credit is checked by a regular credit agency before members are accepted.

After a job is completed, if there is any argument or disagreement between the repair organization and the customer, the organization's president, Arthur Yeckes, steps in to settle it. The organization has a powerful weapon because loss of status as a contractor can mean loss of a great many customers, and they're good paying customers, too. AHA says that three or four real complaints will throw any service dealer off their list as a contractor.

Around Roslyn, TV service technicians charge $4 per house call, get list for tubes and pull the set only if there's no other way to fix it.

The customer reaction

Customers like belonging to this organization for several reasons. One is that they can phone day or night, usually get much faster service than they've been used to in the past. Too, they like paying only one bill per month. They also have confidence in AHA contractors, because they feel they've been preselected, and know they have somebody to go to if there's any problem after the job has been done.

Service organizations say that, although they have to wait from 10 to 40 days on most bills, and sometimes even 60 days, they always get paid without any muss or fuss.

There are reports that the all-in-one home-repair club idea is spreading. There's one in Los Angeles called the United Home Services Club, and there are reports of others starting in Detroit and St. Louis.

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**LOWEST MICROPHONICS**

**hum...noise...**

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**MICROPHONICS:**

Negligible in amplifiers requiring an input voltage of at least 50 mv for an output of 5 watts.

**HUM AND NOISE LEVEL:**

Better than -60 db relative to 50 mv when the grid circuit impedance is no greater than 0.5 megohms (at 60 cps), the center tap of the heater is grounded and the cathode resistor is bypassed by a capacitor of at least 100 mfd.

Ask your Amperex distributor about Amperex voltage amplifiers, rectifier and output tubes for both circuits.

**SPEAKERS** put the emphasis on quality, which is on the inside where you can't see it, but can sure hear it. See what we mean? For literature, write...

**Amperex ELECTRONIC CORP., 290 Duffy Avenue, Hicksville, L.I., N.Y.**
TELEVISION

EFFICIENT servicing requires that we recognize the common causes of waveform distortion. It is not enough to observe only that a waveform is distorted. We must try to interpret the distortion, and to get a clue to the circuit trouble which causes it.

The sawtooth wave is a basic waveform used in TV receiver circuits. A typical sawtooth is shown in Fig. 1-a. Now, consider a situation in which the coupling capacitor in a sawtooth circuit opens partially, causing differentiation of the waveform. The distorted sawtooth then appears as in Fig. 1-b.

On the other hand, if the shunt circuit capacitance in a sawtooth circuit is excessive, the waveform becomes integrated as shown in Fig. 1-c. Unless we have studied waveform analysis, the distortion would remain meaningless.

The third basic distortion seen in sawtooth waveforms is transient ringing, illustrated in Fig. 1-d. This occurs only in L-C or L-C-R circuits. Most of the time, transient oscillation is damped out. In some instances, it is filtered out with a low-pass filter which passes the sawtooth frequencies but attenuates the ringing frequency.

There is practically no limit to the utility of a scope, if we learn to read the waveform distortions displayed by faulty circuits.

More data please

On page 100 of the May 1955 issue of RADIO-ELECTRONICS you mentioned a type of video sharpening circuit which depends on gamma accentuation. Can you tell me where I can find more information on this?—C. E. W., Jr., Joelton, Tenn.


Practical conversion?

I would like to replace the 10BP5 in a Philco 49-1040 with a 17-inch rectangular picture tube. Could you recommend an inexpensive conversion?—J. N., Brooklyn, N. Y.
Mounting the new tube would be a difficult job, and extensive circuit revisions are required. The sweep system and yoke would have to be completely reworked. We do not recommend this type of conversion.

New tuner

How can we install a Standard Coil Neutrode type cascode tuner in an RCA 6T54? Are any circuit changes necessary? - H. S., Brooklyn, N. Y.

The RCA 6T54 is a 21-mc split-sound receiver, but with the sound takeoff from the output of the second if stage. Hence, you can use the tuner intended for intercarrier receivers. Fig. 2-a shows the present coupling circuit from the tuner to the first if tube. The basic plan for conversion is shown in Fig. 2-b, which uses mutual-capacitance coupling. Wiring connections can be made as shown in Fig. 2-c. Note that T1's original primary is removed and the 19.5-mc trap, L2, is retained. Exact values for Cm cannot be given but will fall between 30 and 68 µf. The value of Rg will fall between 1,000 and 10,000 ohms. To determine the values for best picture quality, use a sweep and marker generator. Adjust capacitor and resistor values for the correct if response curve. A larger value of Cu results in less bandwidth. Likewise, a larger value of Rg gives less bandwidth (and higher gain).

Scope patterns

In the Gernsback Library book Sweep...

20 WATT STEREO AMPLIFIER with built-in pre-amp and all controls. Model 20LJK...$59.50.

PRE-AMPLIFIER Self-powered, 10 controls...$207.5K...$44.50.

60 WATT BASIC AMPLIFIER Model 200K...$79.50.

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PRE-AMPLIFIER Self-powered, 10 controls...$207.5K...$44.50.

60 WATT BASIC AMPLIFIER Model 200K...$79.50.

Many other kits available— At dealers or manufacturer with check or M.O.

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No. 66—Basic Audio Course...$2.75
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□ 66 □ 64 □ 58 □ 56 □ 48

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You're ready to get on the air. Here's the book you've been looking for. A simple guide to hi-fi—without schematics, circuits, engineering, or jargon. It may not be for you but it definitely is for your neighbor, wife, friend, or relative who asks you all those "silly" questions like—"Is stereo better than hi-fi?" Tells how to get started, what kind of equipment is best suited for the individual, explains components vs. package systems. In place of schematics the reader will find delightfully humorous and always informative cartoons to guide him along the way. When the layman or beginner finishes this book—you'll be amazed. Never again will they ask you "What's a woofer?" Hi-Fi Made Easy will make your life a lot more liveable. And you know you'll enjoy reading this too. Get a copy today—get several.

TELEVISION

and Marker Generators, is the resting position of the scope beam always at the center screen? If the horizontal sweep is increased, the pattern is spread out. When retrace is slower than the trace, it compresses the pattern (Fig. 3).—O. T., Los Angeles, Calif.

It is customary to discuss scope patterns with the beam reference position at center screen. Of course, this is not

Fig. 3—Normal and distorted sine wave displays: a—When sweep oscillator generates linear sawtooth and there is no compression in horizontal amplifier, true sine wave is displayed: b—When sweep oscillator nonlinear, or compression in the horizontal amplifier, or both, pattern can be caused by setting sync-amplitude control too high, causing double triggering of sweep oscillator.

Antenna matching

How critical is the impedance match of antenna to amplifier? I am in an area where I fight signal problems of all kinds and am concerned with the least discrepancy in the system. I used 78-ohm Yagis for several years, then was able to get only 300-ohm Yagis. Now I am using 500-ohm Yagis. The input to the single-channel amplifiers

uses the circuit shown in Fig. 4. It is evident that the input impedance does not change greatly with R1, RG-11/U and 59/U cables are used in the system.

—L. G., Chicago, Ill.

Impedance matching throughout the

Fig. 4—R1's value can be changed considerably without greatly changing the input impedance to the pad.
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Westinghouse Furniture TV & Stereo


DECEMBER, 1959
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Reel of Needle Pulse Tape Phasing Lamp—Adjusting Tool and Full Instructions $7.50 Post Paid

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TELEVISION

antenna system is best for maximum signal transfer. Anyone who doubts it needs merely to see the improvement in contrast when proper impedance matches are made. A signal which is well down in the snow is often cleaned up remarkably. On the other hand, with long cable runs in strong-signal areas, correct impedance matching eliminates line ghosts and produces a sharper picture. In this instance, a mismatch may occur at both ends of a cable, to result in a line ghost. Line ghosts are re-

Fig. 5—Basic test setup to check 300-ohm impedance: a—300-ohm delay line; b—300-ohm delay line; c—5 feet long can be used to check mixer input impedance; d—input impedance is 300 ohms, a practical flat trace is obtained on an r-f sweep test.)

reflections. In this type of work, do not assume any values. Tuner input impedances are often greatly different from 300 ohms. Antenna impedances can differ widely from rated values. Baluns give the best match with low signal loss. The match should be checked with a sweep generator and scope, on the operating channel frequency (Fig. 5).

FM with a TV tuner

How can I convert an r-f tuner strip to receive FM stations? Channels 3, 6, 8 and 10 are vacant here. I have a shunt capacitance across each coil, using a grid-leak meter. In some cases I could not pick up FM transmissions, and at other times the antenna would not track. The receiver is a Tech-Master 1920-N.

—J. D., Brooklyn, N. Y.

The 1930-N is an intercarrier receiver, with the sound if tuned to 4.5 mc. This 4.5-mc frequency is generated by beating the TV FM sound against the picture carrier through the picture detector. In other words, an additional oscillator signal, removed by 4.5 mc from the broadcast FM signal, would have to be supplied. The fact that you occasionally managed to hear an FM broadcast was due to an interfering signal which happened to be removed 4.5 mc from the frequency modulated broadcast signal.
TELEVISION

TV SERVICE ON CREDIT?

By MIKE MARTYNEC

OUR shop is slightly more than 5 years old and employs three technicians. We extend credit to our customers on all service charges that run higher than $15. Yet losses due to bad debts are kept below 1/2% of our annual gross. How do we do it? Let's follow a normal call and find out.

The phone rings at the shop. "Good morning, Mike's TV." All necessary data are obtained: address, type of receiver, screen size, nature of the trouble, phone number, a.m. or p.m. call, and "Have we served you before?"

"No."

"How will you pay the technician? Check, or shall he bring change with him?"

At this point we know just where we stand. There is no chance of the technician going out, making his repair, and then having Mrs. Jones saying, "I'll be in Friday to pay you."

Of course, with an old customer, we check our files to see whether she has been prompt in paying as promised.

Assuming Mrs. Jones requested credit at the time of the original phone call, we point out that, if the repair is a normal one and costs between $10 and $15, cash will be expected. If it exceeds this, then the balance may be charged, if we are satisfied with where her husband works, how long he has been there, where else she has charged and when she intends to pay the balance.

Extending the situation further, assume Mrs. Jones has received her monthly statement and is a month behind in payment. We call or write her, explaining it is necessary to complete the account. If there is no reaction within a week, we make another phone call and explain that we must turn her account over for collection by such and such a date. "I'll be in Friday."

If nothing happens Friday—she doesn't show up—Monday morning the account is turned over to a reliable collection agency. We lose 50% of the account this way, but it is well worth it. At this point we are dealing with a very small percentage of our customers and apparently came up with a bad credit risk.

By using a reliable agency, we do not always lose the customer. She will sometimes call again, and expect to be on a cash basis only.

How much credit the shop should extend is hard to say. But, as a general rule, credit should be extended until you start losing a little on bad debts. If a local credit union exists, you can check the customer's credit reference with them. There is a charge for this service.

All we have at our disposal, in this phase of the service business, is general information and experience. How about your tricks of the trade? END

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NOW! A down-to-earth guide to MODERN TEST PROCEDURES

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Almost anyone can repair TV's, radios and other electronic equipment. After the trouble has been located, the trick is to know how to use instruments fast and accurately. Actually, it's amazing what you can do with only a few instruments—providing you know how to use different kinds for the different jobs: to select the right ones; to use them; how to connect them into circuits; how to set controls; how to read them; and how to follow professional test procedures every step of the way. And that's exactly what this new 16-page book with its more than 150 high-speed pictorial operation procedures sketches and pattern designs teaches you.

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NEW TUBES & SEMICONDUCTORS (Cont'd)

5F6V, 6F8V

Triode-pentodes in 9-pin miniature envelopes, designed primarily for service in television receivers, with the triode serving as a vertical deflection oscillator and the pentode as a general-purpose or if amplifier. Except for heating ratings, the 5F6V is identical to the 6F8V. The 5F6V heater is rated at 4.7 volts, 600 ma; the 6F8V at 6.3 volts, 450 ma.

Design maximum ratings of these Tung-Sol tubes with the triode used as a vertical oscillator and the pentode as a class-A amplifier are:

<table>
<thead>
<tr>
<th>Triode Pentode</th>
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<tbody>
<tr>
<td>Vh</td>
</tr>
<tr>
<td>Vb supply</td>
</tr>
<tr>
<td>Vi</td>
</tr>
<tr>
<td>Vm (peak neg pulse)</td>
</tr>
<tr>
<td>I (ma) (average)</td>
</tr>
<tr>
<td>I (ma) peak</td>
</tr>
<tr>
<td>P (watts)</td>
</tr>
<tr>
<td>P0 (watts)</td>
</tr>
</tbody>
</table>

Typical operating characteristics are:

<table>
<thead>
<tr>
<th>gm (umhos)</th>
<th>8,000</th>
<th>6,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rb (k ohms)</td>
<td>6</td>
<td>200</td>
</tr>
<tr>
<td>Rz</td>
<td>40</td>
<td>-</td>
</tr>
</tbody>
</table>

3E5A, 2E5A, 6E5A

A sharp-cut off tetrode in a 7-pin miniature envelope designed for high
designed for high

3E5A is identical to the 2E5A and 6E5A.

Typical operating characteristics of the Tung-Sol 3E5A are:

| Vh | 2.9 |
| Vr | 450 |
| Vc | 250 |
| Vp | 140 |
| Rr (K ohms) | 150 |
| gm (umhos) | 8,000 |
| Ia (ma) | 10 |
| Ia (ma) | 0.95 |

Rectifiers for printed circuits

A series of silicon printed-circuit rectifier assemblies that can be mounted in any desired configuration on high-
temperature printed-circuit boards has been introduced by International Telephone & Telegraph. The diffused-junction rectifiers used in the assemblies come in versions for single- and three-phase power supply applications in half-wave, doubler, center-tap and

DECEMBER, 1959

www.americanradiohistory.com
NEW TUBES & SEMICONDUCTORS (Cont'd)

bridge circuits. They are hermetically sealed and operate at temperatures up to 150°C. Basic ratings are available up to 3 amps dc output and 800 volts in a single-phase assembly as well as up to 4.5 amps dc in three-phase units.

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Conant Laboratories announces that all of their rectifiers in series 160, 160-C and 160-ERM, either copper oxide or selenium, can be supplied with flat nickel-silver filiform leads. These leads are equivalent to No. 23 Awg solid wire and can be formed to fit printed conductors or turret terminals, or can serve as the sole mounting means.

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Eliminates that hard soldering job.

Model No.
PT-1

Fix loose pin connections in seconds. Pays for itself in time saved on one job alone, 3" long.

Patent 2,078,969

INTERRUPTED operation of picture tubes due to defective solder connections at socket pins is easily corrected through the use of the BEANS Perfect Pin Crimper. Actually a 3-in-1 tool that can also be used as a channel-selector wrench and screwdriver, it serves to notch pins and element leads to provide solid electrical connections. Pin keeps its original form.

IT'S DANDY . . . IT'S HANDY

"you'll like it"

Available at your parts distributor. Another fine product from:

BEANS

Mfg. Co. Factory
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TRY THIS ONE

UNIVERSAL TEST-LEAD HINT
If you own a pair of universal test leads, you have probably tried fitting one of the test clips onto the end of one of the prods. Such an arrangement just doesn't work, for the clips are specifically designed to fit only the larger-size banana plugs at the instrument end. To overcome this difficulty, take a 1-inch piece of wire solder and put it into the clip's barrel as shown. This will let the tip of the test prod make a snug force fit in the clip so that the prod can be clipped to a chassis or wire lead as desired.—James C. Conrad

SOLDERING THE UNSOLDERABLE
A rather simple soldering technique developed at the University of California Chemistry and Metallurgy Laboratory now makes it possible to solder a wide range of materials previously joined only by ultrasonic processes.

The technique requires, in addition to the usual soldering materials, only a hand grinder with an abrasive grinding wheel of medium grit. To solder such "unsolderable" materials as stainless steel, aluminum, ceramics and glass, the grinder is turned on and the abrasive wheel (preferably preheated by grinding metal or by applying heat with a torch) is brought to bear on a soft solder such as Wood's metal or 40-60 lead-tin. The soft solder melts and flows onto the surface of the wheel; the solder-loaded wheel is then applied to the surface to be soldered until a slight amount of abrasion has taken place, using the pressure one would ordinarily use in grinding. The heat generated by the friction again melts the solder, which flows onto the freshly abraded surface and forms a positive bond. The surface of the other material is also given this treatment if it is not ordinarily tinned with solder alone.

After this tinning operation, the soldering process is performed in the usual

RADIO-ELECTRONICS
manner with standard 50-50 lead-tin solder. Soldering flux or surface cleaning is unnecessary. Pieces to be joined with this technique need not be of the same material—metals, ceramics, soft glass and Pyrex can be soldered in any combination desired.—Warren J. Smith

AUDIO TEST RIG

To save a trip to the shop with an audio chassis, I use this simple audio

INPUT TO TRANS

INPUT TO VOICE COIL

PHONO PLUG

PHONO TURNABLE & TEST RECORD

test rig—turntable, capacitor substitu- tor and output unit, as shown, built into a carrying case. It lets you check for a variety of common faults in the home and speeds servicing time.—Harvey Muller

RUSTPROOFING HARDWARE

To keep the bolts and nuts used in an antenna installation from rusting, I coat them with plastic rubber before I put the antenna up. I've found that this weatherproofing prevents rust and makes the antenna easier to dismantle when the customer decides to buy a new one. It's a real help in salt-water climates too.—Chester A. Clifford

“SPAGHETTI” IN A TUBE

Do you need some spaghetti for a short length of wire or the lead of a component? A coating of plastic rubber (you can buy a 4-ounce tube at most hardware stores for a dollar) applied to the wire will form into insulating spaghetti in about 30 minutes. Once dry, the liquid latex rubber possesses about the same insulating qualities as latex rubber. It won't ever dry out and become brittle. If one coat of the insulation doesn't seem adequate, apply a second coat about 15 minutes after the first.—J. C. Alexander

RESIST-O-PEDIA

FREE! with any of 5 Handy-Pak Carbon Resistor Assortments
65 to 77 Values
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Service Technicians! YOU EARN MORE...

YOU RATE with the public when you own the PHOTOFACT® service data library!

"With Sams PHOTOFACT I am able to give my customers faster service. I like the Circuit-Trace feature—it makes servicing printed circuits much easier and not so time-consuming."—Henry Kiers Hull, Iowa

YES, if you are one of the thousands of owners of a complete PHOTOFACT Service Data Library, you are enjoying maximum earnings. It's inevitable, because no matter how expert you are, you can always save more time on any job, get more jobs done daily—EARN MORE, DAY IN AND DAY OUT...

Moreover—as the owner of a complete PHOTOFACT Library, you know your customers' sets best. You can actually show each customer you have the PHOTOFACT Folder covering his very own set. Result: You command public respect and acceptance which paves the way to more business and earnings for you...

HOW TO STAY AHEAD...

Today, the truly successful Service Technicians are those who own the complete PHOTOFACT Library, who can meet and solve any repair problem—faster and more profitably. And these men keep ahead because they're on a Standing Order Subscription with their Distributors to receive all new PHOTOFACTS as they are released monthly.

For PHOTOFACT Library Easy-Buy Plan details and Standing Order Subscription, see your Sams Distributor today, or write to Howard W. Sams...

TEXAS DEFINES RETAILERS

The new Texas state tax law affecting electronic parts sales says in part, "Retail sale shall mean any transfer exchange or barter of any item taxable . . . to the user. Retailer shall mean and include any person in this state who manufacturers, produces . . . items for resale, distribution . . . to the user.

"Distributor shall mean and include every person other than the retailer who distributes or sells any item under this chapter . . . If any distributor shall sell or distribute any item . . . to any person not holding a valid permit as required under this chapter, said distributor shall qualify as a retailer."

TRIPLE GUARANTEE

The Television & Electronic Service Association of Greater Buffalo is running ads stressing a Triple Guarantee which Buffalo set owners get if they deal with members of the Association. The cooperative newspaper advertisements point out that work done by association members is backed up by the set maker and the Greater Buffalo Association as well as by the service organization which does the work.

RUMORS, OLD AND NEW

TSA (Seattle) Service News reminds us of some unhappy rumors which never came to pass, happily: "1948 TV will destroy the radio industry.

1948 TV will destroy the movie industry.

1952 Western Union is going to capture all TV service business with a national service chain.

1956 Transistors will destroy the tube industry.

1956 The single gun color picture tube will solve all color TV problems.

1956 Discount houses will put set retailers out of business.

1959 Japanese imports will destroy our American standard of living." (We don't think so.

—Editor)

NCFEA MARKS YEAR

The North Carolina Federation of Electronic Associations, Inc., has finished its first year and is looking forward to greater activity in the next 12 months. The NCFEA had its first annual meeting in Charlotte, N. C., in late September. The bulletin of the Association, The Printed Circuit, is mailed to over a thousand service

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RADIO-ELECTRONICS

www.americanradiohistory.com
ARE YOU ON THE LIST?

Radio-Electronics is publishing a detailed list of the known television service associations in North America. If you belong to an association that isn’t on our list or want to get the name and address of the one closest to you, drop a postcard to: Association Editor, Radio-Electronics, 154 West 14 Street, New York 11, N.Y.

NORTH CAROLINA FEDERATION OF ELECTRONIC ASS'NS, INC.
520 Main St.
Durham, N.C.
Garland Hole, Secretary

ASHVILLE TV ASSN
Creaseham Radio & TV Service
Asheville, N.C.
Steve Creaseham, President

CALDWELL COUNTY TV ASSN.
Box 17
Whitnet, N.C.
Herbert Griffin, President

CAPITAL AREA RADIO & TV ASSN.
Box 1285
Hickory, N.C.
Frank Starr, President

CUMBERLAND COUNTY RADIO-N.E.C.
2731 Bragg Blvd.
Fayetteville, N.C.
Fred Owens, President

ELECTRONIC TECHNICIANS' ASSN.
Box 5133
Winston-Salem, N.C.
Dave Drage, President

GREENSBORO TV SERVICE ASSN.
Spring Garden St.
Greensboro, N.C.
Joe Woods, President

WILMINGTON TV SERVICE ASSN.

GREENSVILLE TV SERVICE ASSN.

TELEVISION ELECTRONIC SERVICE ASSOCIATION OF KANSAS, INC.
Box 81
Chanute, Kan.

WICHITA CHAPTER
TESA OF KANSAS
841 S. Poplar St.
Wichita, Kans.
Harmer Miller, president

SALINA CHAPTER
TESA OF KANSAS
333 N. Chaffin St.
Salina, Kans.
Fred Wells, president

MIDWEST CHAPTER
TESA OF KANSAS
2204 N. Main St.
Great Bend, Kans.
Carlos Taylor, president

DODGE CITY CHAPTE
TESA OF KANSAS
713 W. W煦 St.
Dodge City, Kans.
Peter Noggin, president

SOUTHEAST CHAPTER
TESA OF KANSAS
3234 S. Lewis St.
 Coffeyville, Kans.
Glenn Miller, president

PRAKT CHAPTER
TESA OF KANSAS
460 E. 1st St.
Pratt, Kans.
Lloyd Myers, president

AB C CITY CHAPTER
TESA OF KANSAS
426 North St.
Arkansas City, Kans.
Roger Thompson, president

PITTSBURG CHAPTER
TESA OF KANSAS
1327 N. Broadway
Pittsburg, Kans.
Robert Moore, president

CHANUTE CHAPTER
TESA OF KANSAS
Box 94
Chanute, Kans.
Paul Mettinger, president

HUTCHISON CHAPTER
TESA OF KANSAS
Box 23
Chanute, Kans.
Wm. Warren, president

Making and using various types of printed circuits. Explains correct way to interpret and use various styles of data shown in service literature. Describes best procedures to follow when only a data for TV sets available. A "must" book for your reference library.

Sample problems illustrate each phase of printed circuit troubleshooting. A "must" book for your reference library.

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TECHNICIANS' NEWS (Continued)

offered to advance your technical knowledge and skill.

d. Take refresher courses whenever possible.

e. Start taking courses in various phases of electronics such as sound, hi-fi, medical electronics, air conditioning. New gadgets and devices are being made available to the home owner and business firms. Be ready for them.

f. Last but not least, campaign for licensing. A license to operate will gain for you professional recognition and prevent the harmful element from entering our field."

ETG (MASS.) MEETS

At the last two meetings of the Electronics Technicians Guild of Massachusetts talks and demonstrations by Philco (September) and Motorola (October) were scheduled. Mr. Hy Leve, president of the group for 25 years, was honored with a Certificate of Lifetime Membership.

TUBE-TESTER FRAUD CASE

Five men charged with mail fraud in selling tube testers pleaded not guilty in St. Louis Federal Court before Judge Roy W. Harper, who set the trial for Jan. 4. All five were officials or employees of Midwest Electronics of St. Louis. The charges concerned misrepresenting a tube-testing machine sold by Midwest.

ST. LOUIS GROUP ELECTS

Television & Electronics Service Association of St. Louis elected Ray Wirtel president, succeeding Fred Reichman, who became chairman of the Board. Ralph Newberry was chosen executive vice president; Gene Love, first vice president; Morton Singer, secretary; Wilma Tompkins, treasurer; Al Wulf, sergeant-at-arms.

PITTSBURGH BBB REPORTS

A study by the Better Business Bureau of Pittsburgh reveals that there were 80 more customer complaints on TV sales and service in the first six months of 1959 (868) than in the first half of 1958 (288). The BBB checked 10 categories people complained about, finding more unhappy customers for home improvement and furniture and floor coverings, than for TV-radio.

There were 700 validated complaints involving unethical business practices in the home-improvement field in the area during the same period, an increase of 46 over 1958. Furniture and floor coverings caused 464 complaints, an increase of 81.

The complaints for TV-radio sales-service broke down for the 1959 period to: 22% were unhappy about nonfulfillment of contract or guarantee; 18% didn't like service or installation; 14% didn't get promised adjustment of some complaint; 19% got defective sets; 10% bad goods misrepresented. It is interesting to note that most of these TV-radio complaints related to sales, not to service.
CBS LABORATORIES
LEADER IN RESEARCH AND DEVELOPMENT

Pioneered in the creation of a practical color television system
Put on the air the world's first color TV broadcast
Developed airborne, guidance and electronic countermeasure systems
Produced revolutionary color television microscope
Co-operated with CBS Electronics in engineering improved electron guns and screens for color TV
Designed closed-circuit color TV for medical use
Also a leader in acoustics, recording, solid state physics, semiconductor, vacuum tube and advanced electronic systems research and development

CBS ELECTRONICS
LEADER IN TUBE QUALITY AND DEVELOPMENT

Producers of receiving tubes top-rated by leading radio and TV set makers
Manufactured first practical color picture tube, CBS-Colortron
Introduced first Bantam GT receiving tubes
Originated first Bantam Jr. subminiature tubes
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Designed first receiving tubes rated for Continuous Television Service

CBS DIVISIONS WORK TOGETHER FOR YOU...
The CBS family habit of being first helps guarantee you the quality of performance that only leadership can deliver. This leadership is your further assurance that:
• CBS tube quality cuts your call-backs.
• CBS tube quality insures your customers of dependable performance.
• CBS tube quality guarantees profits for you.
Ask for the leader with the top-rated name your customers know and trust. Ask first for CBS.

CBS ELECTRONICS
Danvers, Massachusetts
Electronic manufacturing division of Columbia Broadcasting System, Inc.

Receiving, industrial and picture tubes • transistors and diodes • audio components • and phonographs

DECEMBER, 1959
PHILCO 51T1634

Complaint: Picture takes a long time to light. When it finally does, blooming is evident at high-brightness setting.

The two 2-megohm deposited-carbon resistors in the high-voltage cage had increased in value. They are connected between the plate and filament of the two 1X2's. Replace these resistors.—Harry C. Keller

G-E 16T, 16C, 17T, 17C SERIES

Lack of brightness, despite plenty of high voltage on some of these older models, can sometimes be confusing.

I've run into two of these models in the past week with this trouble. In both cases the difficulty was traced to lack of sufficient voltage at pin 10 of the CRT (grid 2). The 01-s coupling capacitor, C911, had become leaky and the vertical-blanking half of V9, a 12SN7-GT, was drawing too much current, causing a large voltage drop across R320, the 100,000-ohm resistor coming from the B-boost, resulting in low voltage at the CRT.—Eugene W. Klemm

OSCILLATION AT 640 KC

A radio receiver was brought in with weak volume. Even a nearby local station could barely be heard, and there was oscillation when it was tuned to 640 kc. Voltages, and resistances of coils and resistors, were closely checked against the values given in the servicing data, but none of the readings seemed abnormal. I was sure that the trouble was in the mixer stage but all readings were double- and triple-checked without results.

When you order merchandise by mail...

- Be sure to include your address with postal zone number (if you have one).
- Type or print if you can—if not, write clearly.
- Don't send cash—use checks or money orders.
- Include allowances for postage charges if you know the weight of what you’re ordering. (Parcel post rates are not affected by the new postal rate increases.)
TECHNOTES (Continued)

After almost despairing of ever finding the trouble, I thought of checking the capacitance of the mixer's plate load, the primary of the 455-kc input if transformer. This transformer was apparently normal since it seemed to tune to resonance at 455 kc. I bridged a small mica capacitor across the primary leads outside the shield. Volume increased and the set no longer oscillated at 640 kc. The transformer was replaced and the repair was completed.

The small capacitor in the if transformer was almost completely open. The remaining capacitance tuned the transformer primary to 640 kc. When the set was tuned to this frequency, it acted as a tuned-grid tuned-plate oscillator.

—Alfred L. Hollidin

TINNY TAPE RECORDING

A Crescent tape recorder, model 907, developed the symptom of tinny recording. Trouble was found to be due to open-circuiting of the frequency-compensating feedback capacitor. This capacitor is 750 µf and is connected from pin 6 of the 12AX7 audio amplifier to a 220,000-ohm resistor. The other end of the resistor goes to pin 1 of the 12AX7.

—A. R. Clawson

ZENITH 19K20

Complaint: No picture, no sound, good master. The brightness control does not work.

The low-voltage rectifier circuit resistor between the 60- and 40-µf filters is open. This is a 4,000-ohm 10-watt unit.

—Harry C. Keller

Our new set arrived, dear. It gets color, black-and-white, uhf, AM-FM, shortwave and who knows what else!

DECEMBER, 1959

PREPARE FOR ALL USA Commercial Radio-Telephone Operator's License EXAMS!

RADIOTELEPHONE LICENCE MANUAL


1. The name and address of the publisher, editor, managing editor, and business manager of this publication are:

2. The name of the person by whom the publication is owned is:

3. The liability of the persons named as officers of this publication is:

4. The number of copies of this publication, classified and sold to each of the following classes of subscribers:

5. The number of copies of this publication, classified and sold to each of the following classes of subscribers:

BUY FROM YOUR FAVORITE DISTRIBUTOR at above price or add 10% on direct mail orders to:

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BOOKSTORES: ORDER FROM BAKER & TAYLOR CO., HILLSIDE, N.J.
BUILD 16 RADIO CIRCUITS AT HOME with the New Progressive RADIO "EDU-KIT®

All Guaranteed to Work!

PRACTICAL HOME RADIO COURSE only $22.95

NOW INCLUDES
- 12 RECEIVERS
- TRANSMITTER
- SIGNAL TRACER
- SIGNAL INJECTOR
- CODE OSCILLATOR
- No Knowledge of Radio Necessary
- Additional Parts or Tools needed
- Excellent Background for TV
- Free Alignment Tool Kit
- FREE Manuals
- WRENCH SET
- CERTIFICATE OF MERIT

UNCONDITIONAL MONEY-BACK GUARANTEE

The Progressive "EDU-KIT®" is an outstanding practical home radio course in the field of electronics / communications, making use of most modern home methods of training. You learn radio theory, construction, servicing, basic B & C, and TV repair. code, FCC authorizations and regulations. You will learn how to identify radio symbols, how to read and understand schematics and layouts, how to operate electronic equipment, and how to build radios. Today it is no longer necessary to spend hundreds of dollars for a radio course. You will receive a basic radio education, and work many times the value of the radio course.

FREE EXTRAS

- SET OF TOOLS
- RADIO & ELECTRONICS TESTER
- ELECTRIC SOLDERING IRON
- TESTER INSTRUCTION MANUAL & MEMO PACKET
- GUIDE AND TV BOOK
- FCC AMATEUR LICENSE TRAINING
- ADDITIONAL PRINTED COURSE,
- ALIGNMENT TOOL
- WRENCH SET
- CERTIFICATE OF MERIT

WHAT THE "EDU-KIT®" OFFERS YOU

The "EDU-KIT®" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock bottom price. This set of twelve complete radio / electronics communications training, making use of the most modern home methods of training. You will learn radio construction, servicing, and B & C with TV repair; code, FCC authorizations and regulations. You will learn how to identify radio symbols, how to read and understand schematics and layouts, how to operate electronic equipment, and how to build radios. Today it is no longer necessary to spend hundreds of dollars for a radio course. You will receive a basic radio education, and work many times the value of the radio course.

THE KIT FOR EVERYONE

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 will construct radio circuits, perform jobs, and conduct experiments under actual operating conditions.

New Students

You begin by examining the various radio parts included in the "EDU-KIT®". You then learn the theory, and the wiring of these parts. Then you will build a simple radio. With this first set, you will enjoy listening to radio while you learn. As you progress, you will build a more advanced radio receiver, and, working at your own pace, you will find yourself constructing more advanced multi-lap radio circuits, and doing work like a professional radio technician.

Included in the "EDU-KIT®" course are sixteen Receiver, Transmitter, Code Oscillator, and TV sets. These circuits are not standard "breadboard" experiments. But genuine radio circuits, constructed by professional engineers and tested to make you a radio technician. You will learn to build a radio receiver, a transmitter, a code oscillator, and even a TV set.

In addition, you receive Printed Circuit materials, including Printed Circuit boards, Printed Circuit instructions. You also receive a useful set of tools, complete electronic soldering iron, a self-contained Static Tester, and a R.F.C. code oscillator, in addition to the F.E.C. type Questions and Answers for the Radio License Examination. Also included is a four-page "Radio Training" booklet, including "Construction, Training for All," whether you are in the radio field or are equipped to learn radio for personal use. We will also supply you with the latest "Radio Training" booklet to keep you up-to-date.

All books and reference materials are included.

No experience required.

THE "EDU-KIT®" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio circuits, each circuit being an actual, working circuit as delivered. The kits are completely assembled and ready to operate. Each circuit is clearly labeled and instructions. You also receive a useful set of tools, a professional electrical soldering iron, and a self-constructed Static Tester. The "EDU-KIT®" also includes Code Oscillator, in addition to the F.E.C. type Questions and Answers for the Radio License Examination. You will also receive a four-page "Radio Training" booklet, including "Construction, Training for All," whether you are in the radio field or are equipped to learn radio for personal use. We will also supply you with the latest "Radio Training" booklet to keep you up-to-date. All books and reference materials are included.

THE "EDU-KIT®" is complete.

UNCONDITIONAL MONEY-BACK GUARANTEE

The Progressive "EDU-KIT®" is the only educational radio kit of its kind. It is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded. The Progressive "EDU-KIT®" is the only radio kit of its kind to be returned to the manufacturer, and a refund will be made if the recipient does not receive satisfaction. If you are not satisfied, you may return the kit, and your money will be refunded.
THE WHOLE MULTI-MILLION DOLLAR MARKET HAS HEARD THAT

ASTATIC PLUG-IN CARTRIDGES

ARE THE ONLY COMPLETE LINE THAT MEETS EVERY SALES OPPORTUNITY

AS EASY AS CHANGING A LIGHT BULB
... NO INSTALLATION OR SERVICE PROBLEMS

You've had the message by now—that millions of plug-in phono cartridges have already been sold... that Astatic Plug ins represent a tremendous multi-million dollar replacement market... and that THE ONLY COMPLETE, SINGLE SOURCE PLUG-IN LINE ON THE MARKET IS ASTATIC!

So why not use the message? Act now to cash in on this RICH and SKY-ROCKETING MARKET. Get into the plug-in business and get into it all the way—never missing a single sale—with THE COMPLETE ASTATIC PLUG-IN LINE.

EASY, AUTOMATIC SALES WITH ASTATIC MERCHANDISING PACKAGE

You sell from this plastic display-merchandiser which is pilfer-proof, holds an assortment of a dozen cartridges. Information under each cartridge tells the customer which model he needs. Colorful, attractive window card—free of charge—tells 'em you've got 'em!

CALL YOUR DISTRIBUTOR OR WRITE FOR FULL DETAILS

THE Astatic CORPORATION, CONNEAUT, OHIO

IN CANADA: CANADIAN ASTATIC LIMITED,
TORONTO, ONTARIO

EXPORT SALES: ROBURN AGENCIES INC.,
431 GREENWICH ST., N. Y. 13, N. Y., U. S. A.

GO BY BRAND
—GO BUY ASTATIC

A MODEL FOR EVERY APPLICATION—STEREO OR MONAURAL—DIAMOND OR SAPPHIRE TIP

DECEMBER, 1959

PROFESSIONAL SCOPE for TV and hi-f applications. Model S-10-A Craftsman: 5-inch screen, edge-lit graph screen, vertical calibration, response de-7 mc, 18 lb., 12 1/2 x 7 x 10 1/4 inches.—Waterman Products Co., Inc., 2146 Emerald St., Philadelphia 26, Pa.

TRANSISTOR RADIO KIT model DYN-1 transistor, 1 diode. Earphone, ferrite antenna. Uses flashlight battery. Assembles with screwdriver. — Superex Electronics Corp., 4-6 Radford Place, Yonkers, N. Y.

COMMUNICATIONS RECEIVER model HE-10, 455 kc—31 mc in 1 bands; ham bands marked on dial, band spread. Sensitivity 1.25 µv, 10-db signal-to-noise ratio, selectivity 60 db at 10 kc, image rejection 40 db at 3 mc. 5-meter, bfo and rf gain controls, ave and noise limiter switchable, 8 tubes, hinged-top metal case. Available as kit, model KT-200.— Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

FM RADIO RECEIVER model R-80, 6 tubes plus rectifier, 4-inch speaker. Antenna supplied. 8% x 5% x 6% in.—Blonder-Tongue Laboratories, Inc., 9 Alling St., Newark 2, N. J.


TWIN FM AND AM TUNERS model SR-445 in one case with common power supply on FM chassis, space for future insertion of multiplexer adapter. FM sensitivity 2 µv, 40-db quieting, local-distant switch. AM rf stage, response 20-7,000 cycles. Ferrite antenna. FM SR-443, or AM SR-442 available separately.—Stromberg-Carlson Div. of General Dynamics, Rochester 3, N. Y.

FM TUNER model LT-60. Sensitivity 1.5 µv, 20-db quieting 8-tubes. Afe, Afe-defeat, tuning meter, image rejection 40 db, if rejection 70 db, hum — 60 db, factory wired and tested, complete with case.—Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

FM-AM TUNER KIT model HFT92 prewired, pre-aligned front end and if transformers. Dial indicator traveling "eye", cathodefollower output. Sensitivity FM 1.5 µv, 30-db quieting, AM 20 µw at 20-db signal-to noise ratio. FM selectivity (1) 240 kc down 6 db, AM 6 db down 8 kc. FM drift 20 kc or less from...
NEW PRODUCTS (Continued)

cold start, hum 60 db down, output 0.8 volt. FM image rejection 30 db. AM 40 db. AM distortion under 2% at 70% modulation. Ratio-detector slope 600 ke wide. Available for 60 cycle.-EICO 33-00 Northern Blvd., Long Island City 1, N. Y.

BOOKSHELF SYSTEM TR-10U Tri-ette. 9 drivers; 12-inch

inch woofer or wide-range speaker. Panel removable for most tweeters. Finished on all edges.--Rockford Special Furniture Co., 2024-23rd Ave., Rockford, Ill.

BOOKSHELF SPEAKER Model Carlo modified Helmholtz resonator, response 70-15,000 cycles; 2 Janszen electrostatic tweeters with crossover network, tweeter and mid-range level controls. Enclosure unfinished gum hardwood, tube port, 25-15,000 cycles, 30 watts, 16 ohms. 13% x 25 x 11% in. Similar system, DP-11U Duette, 8-inch woofer, horn tweeter, 36-14,000 cycles; 23 watts, 16 ohms; 12½ x 54 x 18¼ in.; Jensen Mfg. Co., 6001 S. Laramie St., Chicago 38, Ill.

BOOKSHELF ENCLOSURE. Economy model 108 partially rear-loaded resonator takes 6-inches-

inch tweeter or wide-range speaker. Panel removable for most tweeters. Finished on all edges.--Rockford Special Furniture Co., 2024-23rd Ave., Rockford, Ill.

TWEETER IN CABINET, model 5-348. Variable level control, crossover included. re-

sponse 1,200-15,000 cycles, impedance 15 ohms. 3¼ x 11 x 4½ in.-- Olson Radio Corp., 269 S. Forge St., Akron, Ohio.

DISC CHANGER model AG 1024 low-cost stereo 4-speed


MOBILE TRANSISTOR AMPLIFIER model KN-3225, 25 watts, 10,000-10,000 cycles 73 db, hum and noise 67 db, idling current under ¼ amp. 6 trans-

sistors, tone control, microphone, phone inputs. Power line plugs into cigarette-lighter receptacle in car or boat, 12-volt source. Output impedance 4, 8, 16 ohms. Metal cabinet, 10½ x 6 x ¾ in high, shown with phone turntable mounted atop amplifier.--Allied Radio Corp., 100 N. Western Ave., Chi-

cago 86, Ill.

MINIATURE TAPE RECORDER made in Germany. 3-

inch reels, 3½ inches per sec-

ond, uses 6 standard flashlight cells, speaker self-contained, output for headphones or ampli-

fier-speaker. 5 lbs, 7 x 3 x 11 in. North American Industries, Dept. GP-59, 101 W. 31st St., New York 1, N. Y.

STEREO AMPLIFIERS series G-7000, dual 20-watt power amplifier and control section, dual concentric bass and treble controls, balance, stereo reverse loudness control, rumble filter, tape-head input, low-impedance

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taped outputs, distortion 1% at rated output, channel separation 40 db, hum and noise 58 db down. Similar series G-7700 28

watts per channel, add scratch filter, speaker phasing switch. General Electric Co., 1255 Boston Ave., Bridgeport, Conn.


STEREO AMPLIFIER model 360. Dual 20-watt outputs with complete controls for each channel. 10 pilot lights indicate inputs in use. Noise and rumble filter switches. Null balance circuit uses switch to reverse phase of one channel while gain is adjusted for silence; releasing null and noise. 50 db, tape head inputs, loudness switch, AM broad-band switch, scratch and rumble filters, separate bass and treble controls each channel balance, stereo reverse. Wood cabinet optional. Fisher Radio Corp., 21-21 44th Drive, Long Island City 1, N. Y.

STEREO TAPE DECK model MS-4. 2-speed mechanism, response 20-15,000 cycles, 72 db counter, pushbutton controls, track at 3% and 7¼ ips. Arkay International, Inc., 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y.


CRYSTAL STEREO PICKUP cartridge series 80 medium output; 0.8 volt, response 30-15,000 cycles, linear response, 1% accuracy. Plays and records quarter-track, 100 cycles, compliance 1.3 x 10⁻⁶ em/dyne, separation 20 db, tracks 6.6 grams.—Astatic Corp., Conneaut, Ohio.

STEREO PICKUP CARTRIDGE model 280 Phasemove response 2 db 20-20,000 cycles, output 15 millivolts, per channel, 4 terminals plus optional metal case ground. Channel separation 25 db minimum. V-400 cycles, compliance 1.3 x 10⁻⁶ em/dyne, separation 20 db, tracks 6.6 grams.—Astatic Corp., Conneaut, Ohio.

Guard stylus for stereo, mono and 78 discs slip into place readily. —Pickering & Co., Inc., Plainview, N. Y.

NONCONTAMINATING POTENTIOMETER series 61, high-voltage wire-wound control for use in food processing and chemical production. 2½ watts, 10,000 volts dc, 2-inch diameter x ¾ inch.—Clarostat Mfg. Co., Inc., Dover, N. H.

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DECEMBER, 1959

135
S2, S3. Normally the tank (LC) determines the frequency, but this tone is not audible when a key is not depressed. When a key is depressed, the corresponding switch unit closes S1a connects the desired C1capacitor to tune the desired frequency and S1-b transmits an audio signal to the amplifier.

If the arm were set at the grounded end of R1, the corresponding C1 would shunt L and lower the Q. If it were set at the other end, C1 would be across the V1's grid and V2's cathode. These decisions are made by a relatively small potential difference (due to amplification). As a result, a relatively small cathode at C1 can tune very low frequencies. Normally, R1 is set to mid-range and can vary frequency over about a 20% variation. As an example of the low capacitance required, C1 may be only .012 µf for 55 cycles. For 62 cycles use .009 µf; for 68 cycles, .01 µf. Note the second output from V2 to terminal A, through a low-pass filter. This output simulates a flute and may be used in place of the rectifier output if desired.

DIRECT-COUPLED AMPLIFIER
Patent No. 2,892,043
Louis Duskey, San Nuan, Calif.

It is convenient to use a single power supply for an entire de amplifier, but this causes unneeded feedback. In the amplifier shown here, the problem is avoided by separate supplies for each stage. Two stages are shown; each has a push-pull. This makes possible a cascode amplifier which does not have to have decoupling network. The method described works equally well in transistor amplifiers.

With zero input, potentiometer R is set for equal plate currents in the first stage. This assures that the de component will not be passed on to the second stage. There is no feedback between stages because there are no common grounds.
NOTEWORTHY CIRCUITS

CLASS-A POWER AMPLIFIER

This circuit provides a high-quality one-transistor audio power amplifier. The driver transformer's primary must be matched to the source impedance for optimum performance. This transformer's secondary matches the 2N554 or the 8- or 16-ohm tap. Try both and use the one that gives the best results.

The output transformer is a universal transistor output type. The 24-ohm tap provides the best match with a 2N554. Power output of this stage is 2 watts with 7% or less distortion. Typical power gain is 34 db and current required is approximately 0.5 amp.

—Motorola Semiconductors

LINEAR-SCALE OHMMETER

The standard ohmmeter has a scale which is rather nonlinear and gives poor accuracy in the high values because of crowding. An interesting idea has been proposed in the Russian magazine Radio (Moscow, 3-59). It uses the fundamental circuit shown in Fig. 1. In this circuit, resistor R1 is a reference resistance and resistor R2 the unknown resistance. Then:

\[ R2 = R1 \times \frac{I1}{I2} \]

which shows that R2 is proportional to I1, and that a meter measuring I1 will be linear in terms of R2 if I1 is kept constant. Moreover, since the result is a relative measurement, it is independent of variations of the supply voltage or even of sensitivity.

Practically, measurement is made in

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NOTEWORTHY CIRCUITS (Continued)

two steps. First, the meter is placed in series with R2, and potentiometer R3 is set to give a full-scale reading. Second, the meter is placed in series with R1, and resistance R2 is read directly off the meter's ohm scale. Needing to say, reference resistances R1 are in powers of 10 for simplicity and single scale. Widely different values of R3 are needed for the various ohm scales. This difficulty is eliminated by using the internal resistance of a pentode tube as illustrated in Fig. 2. This resistance is adjusted by steps through the screen grid voltage, and the grid bias control becomes a vernier adjustment.—A. V. J. Martin

POWER PACK
The transistor power pack can be used to operate 20-50-watt transistor transmitters or other devices in that power class. T1 is wound with 500 turns of No. 30 enamelled wire taped and connected as shown. It may be wound on a core salvaged from any small transformer with a 14-inch square center leg. T2 is a 12-volt vibrator transformer whose secondary is rated at 600-volt ct, 100-ma.

When higher power outputs are required, two transistor packs are connected in series at the output to give 100 ma with a 400 volt tap. If the circuit does not oscillate, phasing is wrong. To correct, reverse T2's primary leads.—Bendix Semiconductors.

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Business and People

General Electric, Receiving Tube Dept., Owensboro, Ky., designed a new receiving tube display rack to help service technicians streamline tube sales and simplify inventory control.

Winegard Co., Burlington, Ia., is in the midst of a promotion program to boost antenna sales. The trade promotion is backed by a national Big TV Show Time consumer campaign. Ads in Life, Better Homes & Gardens and other consumer magazines, feature TV stars Loretta Young, Ward Bond and Walter Brennan.

Heath Co., Benton Harbor, Mich., for the second successive year was awarded one of advertising’s top honors, a certificate from the Direct Mail Advertising Association for its outstanding campaign. The award was made to Clifford M. Edwards, Heath director of advertising and sales promotion, at the DMAA Awards Breakfast during its convention in Montreal this fall.

JFD Electronics, Brooklyn, N. Y., featured its Hi-Fi Helix TV antenna on the
BUSINESS AND PEOPLE (Continued)

"Alcoa Presents" ABC-TV network program last month. Announcer Brooks Taylor did the commercial which was supplemented by advertisements in TV Guide and other consumer and trade publications and direct mail.

Henry Lohne was elected senior vice president of Sylvania Electric Products with overall responsibility for the Electric Systems Div. He had been vice president and general manager of that division in Waltham, Mass., and will continue to make his headquarters there.

Sencore, Addison, Ill., recently held a Time-Saving Clinic for the Van Nuys (Calif.) Society of Radio & TV Technicians, showing the advantages of troubleshooting with Sencore equipment. California representative Mark Markman (pointing to the new Sencore transistor radio service lab) and Ed Flaxman, Sencore sales manager (in dark suit), are shown explaining the equipment.

Pyramid Electric Co., Union City, N. J., is under full sail on four service technician promotions—on its transistor radio maintenance kit, Bakers' Dozen silicon rectifier promotion, Sweetheart Assortment (with a gift for the ladies) and VIP special assortment (the technician receives attaché case with a purchase of an assortment of TD capacitors). Reps Jim Williams, William White, "Roly" Wedemeyer, Mike Stobin and Jack Berman (left to right) are shown receiving their VIP badges from Jack K. Poff, Pyramid sales manager, Distributor Div. The badges will also be awarded to distributor countermen in line with the promotion.

Mort Gaffin was appointed manager, special advertising and sales promotion programs, for RCA. He was formerly director, new Business and promotion, NBC spot sales.

Winegard Co., Burlington, Iowa, has been granted US Patent No. 2,891,748 for its universal tripod antenna roof mount introduced in 1956. The Jigger mount, as it is called, permits quick installation on any type of surface without guy wires or chimney brackets. A hammer is the only tool required in making an antenna installation.

Edward J. Keenan was named director of RCA Institutes Home Study School. He comes to the company from Franklin Institute, Rochester, N. Y., where he held a similar position.

P. R. Mallory & Co., Inc., recently broke ground for a new 12,000-square-foot addition to its Distributor Div. warehouse in Indianapolis. Ray Sparrow, executive vice president, is shown digging the first shovelful of dirt as.

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Apartment - 39 Outlets-One Antenna-No Amplification: The Del Rio - 10236 Old River School Road, Downey, Calif.

Apartment - 48 Outlets-Two Antennas 24 Outlets each-No Amplification: The Paramount Riviera - 12447 Paramount Blvd. Downey, California.

RADIO-ELECTRONICS
J. E. Templeton, Distributor Div. manager, swings the pick at the informal ground-breaking ceremony.

Edward J. Naretta (left) was named sales director of G-C-Textron, Inc., (Rockford, Ill.), newly formed super sales division's Group 1 which includes five manufacturing divisions: General, Cement, Teleo Electronics, G-C Electrocraft, G-C Electronics Div. and the G-C Industrial & Government Div. Previously he was sales manager of G-C's Walsco Divisions. Dan O'Connell (right) joined G-C Textron as sales director of Group 2 which comprises Walsco Electronics, Audiotex and American Microphone. He comes to the company from Radion where he was one of the company's vice presidents.

Vocaline Co. of America, Old Saybrook, Conn., designed an Inside Story display for its new Communicate Citizens band radio. The display consists of a complete transceiver housed in a clear plastic case to show chassis, circuitry and parts.

EIA PRODUCTION AND SALES
(first 8 months) 1959 1958
Receiving tube factory sales 278,508,000 251,657,000
TV picture tube factory sales 5,913,985 4,992,862
TV set production 3,880,620 2,950,455
Radio production 8,963,044 6,193,529
FM radio production 290,892 134,655
TV retail sales 3,126,981 2,862,452
Radio retail sales 4,357,421 3,806,519
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ELECTRONICS

RADIO ELECTIONS

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TIPS ON SOLDERING for experimenters and production engineers, 2-page bulletin, No. 101, covers effects of raw metals, use of antimony in solder, and silver scavenging. Charts of physical characteristics are also included.—Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

SILICON POWER RECTIFIERS are described with complete specifications showing surge ratings, temperature range and dimensions in 1-page bulletin, No. 7155.—Syntron Co., 604 Lexington Ave., Homer City, Pa.

BATTERY CHARGERS for 6- and 12-volt storage batteries in cars and boats are pictured and described. One page leaflet includes prices on these two compact chargers.—Terado Co., 1068 Raymond Ave., St. Paul, Minn.

ADDITIONAL 1959 TV MANUAL is a 4-page brochure describing a manual of supplementary data on 1959 sets along with all other service manuals published by the company.—Supreme Publications, 1760 Balsam Road, Highland Park, Ill.

MATCHING EQUIPMENT CABINETS identical with the company's speaker enclosures are shown with detailed dimensions.—R. T. Beazley Co., Darien, Conn.

MOVIES ON TUBE MANUFACTURE and associated subjects are described with running time. Five subjects are included in this 2-page listing of 16mm sound films available on free loan to organizations. Produced in England by Mullard.—International Electronics Corp., 81 Spring St., New York 12, N. Y.

ARE YOU DESTROYING TRANSISTORS? is bulletin No. 2, Vol. 2, in the company's "Tube Tips" series. It's a 4-page

OPPORTUNITY ADLETS Rates—50c per word (include name, address and details). Minimum of 10 words. Cash or check payable to COYNE company all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Mail orders or telephonic orders accepted. Copy for February issue must reach us before Dec. 15, 1959.

PRINTING PRESSES, type, supplies. Lists to THUMB-EAGLE SERVICE, Mechanicsburg, Pa.

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LEARN CIVIL and criminal investigation at home. Earn steady, cool pay. INSTITUTE APPLIED SCIENCE, 1928 Sunnyside, Dept. 295, Chicago 22, Ill.

FM TUNERS, 56-165 wavemeters, 1 tube complete, $14.00. GEUTMANN, 1 East 167 St., Bronx 52, N. Y.

PRINTED CIRCUIT BOARDS for industrial projects, industrial prototypes, prototypes. ELECTRONIC UNION, Box 127, Stamford, Conn.

RADIO & TV TUNES at Manufacturers' Prices! Guaranteed! Unmarked! Bound Book! No rebates or points! UNITED RADIO, Box 1000, Newark, N. J.

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NEW LITERATURE (Continued)

discussion aimed at the practicing technician.—CBS Electronics, 100 Endicott St., Danvers, Mass.

SEMICONDUCTOR DIODES are listed with complete data and dimensions in 12-page Characteristics and Replacement Guide. The company’s entire line of diodes is included along with a chart listing Sylvania replacements for many EIA types.—Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N. Y.

SEMI-CONDUCTOR DIRECTORY is a 12-page listing of all transistors, diodes and rectifiers stocked by this mail-order house. Shows hundreds of types by number, manufacturer and application.—Lafayette Radio, 165-08 Liberty Ave., Jamaica 35, N. Y.

PICTURE-TUBE WALL CHART. Bulletin PF-298 lists electrical characteristics, dimensions, basing and replacement possibilities for 360 TV picture-tube types.—CBS Electronics, 100 Endicott St., Danvers, Mass.

TRANSISTOR DESIGN DATA for entertainment devices is contained in 32-page booklet Entertainment Transistors for Every Design Approach. Over 50 transistors are thoroughly detailed for use in high fidelity, organs, toys, intercoms, radios, portable and car radios.—Sylvania Electric Products, Inc., 1100 Main St., Buffalo 6, N. Y.

TRANSISTOR DISSIPATION RATINGS for Pulse and Switching Service is the title of a 4-page Bulletin AN-181, for circuit design engineers and technicians. Nomographs show permissible peak dissipation when used with the table supplied.—RCA Semiconductor & Materials Div., Somerville, N. J.

CABINETS AND ENCLOSURES for equipment and speakers Bulletin R-14 shows add-on furniture, stereo consoles and record cabinets.—Rockford Special Furniture Co., 2024 23rd Ave., Rockford, Ill.

PHONOGRAPH PICKUP CHART Bulletin PF-295 is an 8-page cross-reference guide to 27 cartridges which replace over 500 models of various manufacture. Exact-size silhouettes are shown along with each model number.—CBS Electronics, 100 Endicott St., Danvers, Mass.

SERVICING PRINTED WIRING in typical radio and TV receivers is explored and explained in a 24-page manual, Printed Circuit Servicing Techniques. Use of manufacturers' data, soldering, component removal and replacement are thoroughly dealt with.—RCA-Victor TV Div., Camden 8, N. J. $1.

CORRECTION

The values of capacitors C16, 17, 19 and 20 are incorrect in the parts list for the transistor transceiver on page 56 of the October issue. These capacitors are all 100-µ, 3-volt units, as indicated on the schematic. We thank C. W. Burkland of Newton, Iowa, for calling this to our attention. (See also Correspondence Column.)

DECEMBER, 1959
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ECHOES OF BATS AND MEN, by Donald R. Griffin. Anchor Books, Doubleday & Co., Garden City. N. Y. 4½ x 7 in. 156 pp. 95c

This charming little book is No. 4 of a Science Study Series created by the MIT Physical Science Study Committee (Radio-Electronics, February, 1961, page 49). In language big enough to be understandible to the layman, but quite readable to the engineer, the story of echoes is presented as a phenomenon in straight physics, from a biological point of view, and as applied in sonar and radar.

The author, who with Robert Galambos ("Bats and Radar", Radio-Craft, April, 1945) performed some of the earliest experiments with modern apparatus on bats, gives some interesting examples of the use of echoes by other animals. He also details experiments in finding obstacles by sound that the reader can perform, and tells of experiments designed to find how blind persons "sense" obstacles. The chapter on sonar and radar contains some interesting comparisons between man's equipment and that of the bat.

Other titles in the series are Magnets, Soap Bubbles (a fascinating story of surface tension), How Old Is the Earth, and The Neutron Story.—FS

UNDERSTANDING TRANSISTORS, by Milton S. Kiver. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. 6 x 9 in. 64 pp. 50c.

This little book introduces transistor fundamentals to those who already have some vacuum-tube background. In addition to providing a brief but sound theoretical foundation, it includes sections on the various types such as junction, drift, tetrode, surface barrier and other transistors. It illustrates practical applications in typical circuits.

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This book tells how to repair, paint, print and photograph your own printed circuits, and how to replace components on printed boards.

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NEW BOOKS (Continued)

There are chapters providing actual layouts for making printed circuitry for a radio, an oscilloscope, radio controls and a wristwatch transmitter.

One section describes the latest miniature batteries and other parts associated with printed boards. Others show how to calculate inductance and capacitance in these circuits, and how to mount and solder parts on them. This book is required reading for everyone planning to work with printed wiring.—IQ


Many books have been written to provide the would-be amateur radio operator or "ham" with the technical training he needs to get on the air. This book does not attempt that job. Instead it provides a wealth of practical information: what hams are, what equipment they use, how to get a ham license, how to operate on the air.

Much equipment for sending, receiving and simple test work is shown, with prices. Numerous amateur stations in operation are shown. There are sections on selecting parts for home operation, the "Q" signals and other important items.


This new edition is for experimenters who want to know more than how to build from diagrams, without going into higher theory. It contains much useful information not easily obtainable elsewhere. It begins with semiconductor theory, transistor construction and characteristics. Biasing networks, amplifiers, hi-fi are explained with the help of equations and schematics. Practical information is given on service techniques, switching, computers.

It explains transistor specifications and symbols and contains a complete JEEDE listing and interchangeability guide. Diagrams show receivers, amplifiers, triggers, oscillators, etc.—IQ


This basic text on electronics for the serious student has numerous clear illustrations and clear physical descriptions. It provides good preparation for further study in engineering or physics. Familiarity with elementary calculus is assumed.

The book begins with electrons in motion and emission. Tube and transistor fundamentals follow. Feedback, oscillators, amplifiers, high-frequency tubes, detectors, wave shapers, noise, are included. About 250 problems taken from school examination papers, with answers, appear at the end.—IQ END

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- 3RD CHANNEL OUTPUT

A completely new stereo high fidelity amplifier with a high quality of reproduction, versatility of operation, and distinctive styling. A full range of controls enable you to enjoy the utmost in listening pleasure in any situation.

Deluxe features include: unique "Blend" control for continuous variable channel separation—from full monaural to full stereo, 4-position Selector, Mode, Loudness and Phase switches. Also provided are outputs for 8 and 16 ohm speakers. Hum-free operation is insured by the use of DC on all pre-amp and tone control tubes. Harmonic distortion, less than 0.25%. IM distortion, less than 1%. Hum and noise, 74 db below full output. Designed with the kit builder in mind, assembly is simple—no special skills or tools required.

Complete with deluxe cabinet and legs, all parts, tubes and detailed instruction manual. Shpg. wt., 26 lbs.
KT-250 Stereo Amplifier Kit 6.45 Down Net 64.50
LA-250 Stereo Amplifier, wired 8.95 Down Net 89.50

OUTSTANDING DESIGN—INCOMPARABLE PERFORMANCE

LAFAYETTE STEREO/MONOAURAL BASIC POWER AMPLIFIER KIT

KT-310 IN KIT FORM 47.50
LA-310 COMPLETELY WIRED 72.50

- 36-WATT STEREO AMPLIFIER—18-WATTS EACH CHANNEL
- 2 PRINTED CIRCUIT BOARDS FOR NEAT, SIMPLIFIED WIRING
- EMPLOYS 4 NEW PREMIUM-TYPE 7189 OUTPUT TUBES
- RESPONSE BETTER THAN 35-300,000 CPS ± 1/2 DB AT 18 WATTS—LESS THAN 1% HARMONIC OR INTERMODULATION DISTORTION

A super-lively performing basic stereo amplifier, in easy-to-build kit form. Dual inputs are provided, each with individual volume control, and the unit may be used with a stereo preamplifier, for 2-18 watt stereo channels, or, at the flick of a switch, as a fine 36-watt monaural amplifier—or, it desired, it may be used as 2 separate monaural 18-watt amplifiers. CONTROLS include 2 input volume controls, channel reverse switch (AB-BA), Monaural-Stereo switch, DUAL OUTPUT IMPEDANCES are 8, 16 and 32 ohms permitting parallel (monaural) operation of 3 speakers systems of 8 to 16 ohms. INPUT SENSITIVITY IN 0.45 volts per channel for full output. TUBES are 2-6AN8, 4718E; GE-24 rectifiers. SIZE 9.3/16" x 10.9/16" with controls) x 5¼" x 15¼". Supplied complete with performed metal case, all necessary parts and detailed instruction manual. Shpg. wt., 22 lbs.
KT-310 Stereo Power Amplifier Kit 4.75 Down Net 47.50
LA-310 Stereo Power Amplifier, Wired 7.25 Down Net 72.50

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LAFAYETTE STEREO TUNER KIT

The Most Flexible Tuner Ever Designed

KT-500 IN KIT FORM 74.50
LT-50 COMPLETELY WIRED 24.50

- Multiplex Output for New Stereo FM
- 11 Tubes (including 4 dual-purpose) + Tuning Eye + Selenium rectifier Provide 17 Tube Performance + Prealigned IF's + Tuned Cascade FM + Dual Cathode Follower Output

More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. FM specifications include grounded-grid triode low noise front end with triode mixer, dual-tuned dual limiters with Foster-Seyler discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± 1/2 db, full 200 kHz bandwidth and sensitivity of 2 microwatts for 30 db quieting with full limiting at one microvolt. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate by-pass tuning and separate volume control for proper balancing when used for stereo programs. Simplified tuning is provided by magic eye. Automatic frequency control "locks in" FM signal permanently. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal case, a step-by-step instruction manual, schematic and pictorial diagrams. Size 1 13/16" W x 10/16" D x 4 1/8" H. Shpg. wt., 22 lbs.
KT-500 7.45 Down Net 74.50
LT-50 Some as above, completely factory wired and tested 12.45 Down Net 124.50

LAFAIETTE PROFESSIONAL STEREO MASTER AUDIO CONTROL CENTER

Solves Every Stereo/Monaural Control Problem!

KT-600 IN KIT FORM 79.50
LA-600 COMPLETELY WIRED 134.50

- UNIQUE STEREO & MONOAURAL CONTROL FEATURES
- AMAZING NEW BRIDGE CIRCUITRY FOR VARIABLE 3D CHANNEL OUTPUT & C/OSS-CHANNEL FEED
- PRECISE "NULL" BALANCING SYSTEM
- RESPONSE 5-40,000 CPS ± 1 DB
- 6 CONCENTRIC FRONT PANEL CONTROLS

A REVOLUTIONARY DEVELOPMENT IN STEREO HIGH FIDELITY.

Provides such unusual features as a Bridge Control, for variable cross-channel signal feed for elimination of "shaping" (envelope-generated separation) effects. Also has full input mixing of monaural program sources, special "null" stereo balancing and calibrating system. 24 equalization positions, all concentric controls, variable and scratch filters, loudness switch. Clutch type volume controls for balancing or as 1 Master Volume Control. HCS channel reverse, electronic phasing, input level controls. Sensitive 2.5 millivolts for 1 volt out. Dual low-impedance outputs (plate followers), 1500 ohms. Response 5-40,000 cps ± 1 db. Less than 0.2% in distortion. Uses 7 new 2021 low-noise dual triodes. Size 14" x 4 1/8" x 10 1/8". Shpg. wt., 16 lbs. Complete with printed circuit boards, case, professionally illustrated instructions, all necessary parts.
LAFAIETTE KT-600—Stereo Preamplifier Kit 7.95 Down Net 79.50
LAFAIETTE LA-600—Stereo Preamplifier, Wired 13.45 Down Net 134.50

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NEW! Lafayette 50 Watt Complete Stereo Phono System

Unquestionable Economy—Elegant Styling

LAFAYETTE 36-WATT INTEGRATED STEREO AMPLIFIER KIT

NEW! KT-236 IN KIT FORM 52.50

- 36 - WATTS MONO OR BINAURAL - 18 - WATTS PER CHANNEL
- FREQUENCY RESPONSE 15-30,000 CPS ± 1 DB
- UNIQUE "BLEND" CONTROL
- CONCENTRIC CLUTCH - OPERATED VOLUME CONTROL
- DUAL CONCENTRIC BASS AND TREBLE CONTROLS.
- 4 - EL84 TUBES IN PULL PULL.

An outstanding achievement in kit engineering. This exciting new amplifier kit combines dual preamplifiers and dual 18 watt power amplifiers on one compact chassis. Its complete versatility allows connecting both stereo and monophonic sources permanently, with instant selection provided by the turn of a switch. Controls include an amazing new "blend" control which provides continuously variable channel separation from full monophonic to full stereo, thus insuring the correct degree of stereo separation for individual listening tastes and room acoustics. Additional features are: Concentric clutch-operated volume control for independent or simultaneous level adjustments of both channels; Dual concentric bass and treble controls furnish 4 independent tonal adjustments; Selector Switch provides for Aux., Tuner and Phone. Dual output impedances are 8 and 16 ohms. Harmonic distortion is less than 0.15% at normal listening level. IM distortion is less than 0.3%. Hum and noise 70 db below rated output. Complete with case, legs and detailed instructions. Shp. wt., 24 lbs.

KT-236 Stereo Amplifier Kit 5.25 Down 52.50

LAFAYETTE 50-WATT INTEGRATED STEREO AMPLIFIER KIT

NEW! GARRARD RC121/11 IN KIT FORM 69.50

- COMpletely Wired 94.50
- CONSERVATIVELY RATED AT 70 WATTS
- INVERSE FEEDBACK
- VARIABLE DAMPING
- METERED BALANCE AND BIAS ADJUST CONTROLS
- AVAILABLE IN KIT AND WIRED FORM

Here's ultra-stability in a 50 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wire range linear Chicago output transformers, variable damping control, meter for bias and balance and gold finish chassis. Frequency response 10-100,000 cps ≤ 1 db. Hum and noise 90 db below full output. IM distortion less than 1/2% at 70 watts, less than 0.3% below 20 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ≤ 1 db. Output impedance 4, 8 and 16 ohms. Handsome decorative case perforated for proper ventilation. Size 14½ x 10 x 7¼" including case and knobs. Shp. wt., 40 lbs.

KT-400 In Kit Form 6.95 Down 69.50

LAFAYETTE STEREO RADIO

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MONEY-BACK GUARANTEE

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DECEMBER, 1959

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University's newly engineered 8" high fidelity speakers especially designed for 'big system' performance from the smallest enclosures.

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The transcription turntable that's

HARD TO GET but WORTH WAITING FOR

It's the Thorens TD-124 ... hailed by hi-fi fans ... acclaimed by critics ... highly recommended by leading technical and consumer publications

Demand for the famous Thorens TD-124 transcription turntable has exceeded expectations. We've had trouble keeping up with orders in some cases. We are pleased at the unexpected demand, but unhappy that we cannot serve all of you immediately.

Looking back now, we can see how irresistible these TD features (most of them lacking in competing turntables) are to the person who wants true stereo fidelity:

- 4 speeds ... TD-124 gives you all of them: 16⅔, 33⅓, 45, 78.
- 11⅛ pound table for smooth running ... 12" TD-124 gives you more rotating mass than professional 16-inch turntables.
- Exclusive double-table with clutch for fast starts ... lets you start record with needle in groove.
- Precision, hairline adjustment for all speeds ... a simple knob that's easy to turn while record is playing ... no screwdriver, no special wrench, no mechanic's license needed.
- Built-in illuminated strobe ... you can see it and use it while record is playing to set electrically exact speed (or you can adjust speed by ear to musically exact pitch to play record along with any musical instrument).
- Easy arm installation or change ... no metal drilling, no unsightly holes after arm change.
- Built-in precision circular level ... same kind used on precision instruments ... plus large knurled leveling screws ... lets you check and adjust turntable level any time.

These are just a few of the outstanding features of the precision Swiss-crafted Thorens TD-124. See them all and hear this fabulous turntable at your franchised Thorens dealer's today. You'll agree that it's the turntable you've been waiting for.

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SWISS MADE PRODUCTS - MUSIC BOXES • HI-FI COMPONENTS • SPRING-POWERED SHAVERS • LIGHTERS
DIRECT-DRIVE and 6CD6-GA

Here's how you can get better service from the 6CD6-GA!

Have you had difficulties with 6CD6-GA's operating in direct-drive circuits? If so, this message is most important to you. Here's a simple way to "lick" the problem.

In horizontal-output circuits utilizing transformer or auto-transformer coupling to the deflecting yoke the damper tube is usually connected across a portion of the flyback transformer, and acts to reduce "ringing" after each flyback pulse.

- Waveform of flyback pulse at the plate of horizontal-output tube in a typical transformer-coupled circuit.

In most direct-drive circuits, those in which the horizontal coils of the deflecting yoke are connected in series with the horizontal-output transformer, the damper tube is not connected across any portion of the high-voltage transformer. Therefore, high-amplitude "ringing" voltage may be present. Should the negative peaks of the "ringing" voltage exceed the maximum plate-voltage rating of the horizontal-output tube, the tube may be damaged. Thus, premature failure of a horizontal-output tube may occur because of improper conditions.

- Waveform at the plate of horizontal-output tube in a typical direct-drive circuit.

Possibilities of premature failure of the popular 6CD6-GA when used in direct-drive circuits can be reduced by lowering the negative peaks of the flyback pulse. This is done very simply as shown below in Fig. C. Add a 5,000-ohm 5-watt resistor in series with "C". ("C" is part of the existing circuit, usually about 33µf).

- Typical direct-drive circuit, with 5,000-ohm 5-watt resistor to be added shown in broken line. To provide adequate ventilation and H-V insulation, the resistor should be spaced away from other parts, wires, shields, etc.

VOLTAGES ARE IMPORTANT, TOO!

Check screen-grid, cathode, and control-grid voltages. If the control-grid voltage is low, check waveform and amplitude of the sawtooth driving voltage at the control grid. Make horizontal-oscillator circuit adjustments, if necessary. Check B+ and line voltages.

RCAS-6CD6-GA TUBES ARE DYNAMICALLY CHECKED IN DIRECT-DRIVE CIRCUITS!

To insure top performance and long life, production samples of RCA-6CD6-GA tubes are factory-checked in direct-drive circuits under typical operating conditions. Keep your profits up by keeping 6CD6-GA callbacks down. Check and adjust horizontal circuits. And, if you replace a 6CD6-GA, always replace with RCA!

Do you have your copy of the RCA Triple Pindex? Ask your RCA Tube Distributor about this useful servicing aid today.

CORRECT HORIZONTAL ADJUSTMENTS ARE IMPORTANT!

Incorrect setting of the horizontal-drive and linearity controls can cause excessive cathode current. To assure long life of the 6CD6-GA, measure its cathode current, and adjust drive and linearity controls for lowest current consistent with linearity. To measure cathode current in the RCA Victor KCS-68 and KCS-81, and other chassis utilizing similar direct-drive horizontal-output circuits, simply remove the B+ fuse and connect a dc milliammeter across the fuse holder, as shown in Fig. E.

Correct horizontal adjustments are achieved by reducing the cathode current to the lowest value consistent with linearity. If the linearity control is operated to maximum red line, the cathode current will be reduced to a value which will reduce the "ringing" to a minimum.

ANOTHER WAY RCA HELPS YOU IMPROVE YOUR BUSINESS

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