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(See page 44)

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FEBRUARY, 1962
New Tubes Use Fiber Optics

A new vidicon tube with a fiber-optics faceplate has been announced by RCA Electron Tube Div. RCA is also making available to the industry samples of a fiber-optics orthicon and two cathode-ray tubes with glass-fiber faceplates.

The new vidicon is a 1-inch tube 6 1/2 inches long. There are more than 500,000 individual fibers in the useful area of the face. Each is .0006 inch in diameter, about one-fifth the diameter of a human hair. The tube has a resolving ability of about 600 TV lines.

The following five areas are ones where fiber-optics principles in electronic tubes might be advantageous: lower noise, greater photometric efficiency, electron multiplication, universal amateur symbol for laughter, or the recognition of something important or startling. The transmitting frequency is 145.0 mc.

The first reported reception of the howl satellite signals came from a Navy amateur stationed at Marie Byrd Land in Antarctica. With the large number of amateurs (200,000 in the United States alone) as compared to military and other official stations for observing satellites, it is hoped that new information of value will be obtained. Many hams have had experience in tracking satellites, and have experimented with reflected signals from the Echo passive satellites.

Recently, hams have even used the moon as a reflector for coast-to-coast communication. This was, of course, done earlier by the military and Bell Laboratories, but the hams did it with a very small fraction of the power used by the bigger stations.

Unused Television Channels To Fixed-Station Users?

FCC Commissioner Robert E. Lee has suggested that additional frequencies for a number of non-broadcast services can be provided by assigning nonallocated uhf TV channels to them. Commissioner Lee believes that more than 50 channels would be available, opening some 2,000 frequencies to such uses as police and fire departments, industrial plants and other public and private services that need more frequency space. He suggests that existing TV stations would be protected by permitting such operation only at distances of 150 miles or more from TV stations operating on the same channel.

Commissioner Lee has been an advocate of moving TV entirely to private services that need more frequencies for a number of non-broadcast services.

Coast Guard Testing New Distress Signal

A new type of distress signal, designed to clear the 2182-kc radio-telephone channel for distress messages, has been put into operation on New York and San Francisco.

The signal consists of two tones, 2,200 and 1,300 cycles per second, alternating 4 times a second over a period of 45 seconds. It will indicate to all stations listening on the 2182-kc frequency that a vessel or aircraft is in serious trouble or that a person has been lost overboard, and that distress traffic is to follow. Upon hearing the signal, all stations must cease transmitting on the distress frequency and listen for the distress messages.

This will allow the Coast Guard to clear this normally cluttered channel when they cannot clearly make out an incoming low-power distress message.

The system was adopted by the International Telecommunication Union at its 1959 Geneva Convention. The alarm generator may be used with any transmitter that has a speech amplifier with an input impedance of more than 40 ohms, and requires a 48-volt power source. Upon pressing a button, it transmits two sinusoidal notes following each other every 1/4 second for 45 seconds. It uses four identical transistors and three diodes, mounted on three boards. One contains the 2,200-cycle oscillator and switch, another the 1,300-cycle circuitry and the third the 250-msec multivibrator that switches tones, plus the output amplifier.

Radio-Controlled Moods

Technological control of human behavior is receiving heavy emphasis by the Military, the American Medical Association learned at its recent annual clinical meeting in Denver, Colo.

Dr. Otto Schmitt, head of the Department of Biophysics at the University of Minnesota in Minneapolis, described the electrical method which injects sinusoidal notes into the nervous system to stimulate or depress certain emotions, and the chemical method of implanting radio-controlled pellets containing chemicals, which are activated by an outside signal.

Dr. Schmitt also states that approximately 50 special sensing instruments may be placed in the body to test reactions under stress.

A part of the recent military (Continued on page 10)
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- Thoroughly neutralized against oscillation; output impedance balanced to prevent radiation back to antenna.
- Same 300-ohm lead that carries signal also carries 15 volts ac to POWERMATE. No tubes or batteries to replace.

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**Pilot Radio Head Dies**

Isidor Goldberg, one of the very earliest of the radio pioneers, died Nov. 23, at the age of 68. During his career he had been active in practically all areas in the field, from simple broadcast equipment through short wave and television to high fidelity, in which Pilot, the firm he founded, is now most active.

Mr. Goldberg worked for the old Electro Importing Co. (E.I. Co.) as a boy of 16. Shortly thereafter he began to make components, and in 1922 organized the Pilot Electric Mfg. Co. In the late '20's the Pilot Wasp, possibly the first of the widely marketed radio kits, appeared. It was followed by the Super-Wasp, a very popular ac kit.

In 1928 Pilot and Gernsback's Radio News cooperated in a pioneer television broadcast, in which TV images were flashed across the Hudson River. In more recent years, the company became one of the leading makers of high-fidelity equipment.

Mr. Goldberg remained president of the company up to his death.

---

**"Lighthouses in Sky" Coming**

A complete, global, all-weather navigational system using Transit satellites as guides may be in operation by the end of 1962. This prediction was made by Rear Admiral Jack P. Monroe, director of the Astronautics Div. of the Navy, as a result of successes in launching recent Transit satellites.

A ship could fix its position to within 1/10 mile in any kind of weather by tuning in on one of the lighthouse satellites. At present, Admiral Monroe said, a navigator is lucky to come within 2 miles by using celestial navigation.

The latest Transit satellites carry a small oval-shaped atomic generator, weighing 4½ pounds and measuring about 5 x 5½ inches, to (Continued on page 14)
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SAFETY GLASS REMOVAL (MODEL ICC388)
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HORIZONTAL SWEEP CIRCUIT ADJUSTMENTS

Detailed instructions help you solves the troublesome problem of adjusting the horizontal circuits (oscillator, linearity, and width)—avoids guesswork!

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The Making of a Magnet. Bell scientists test new superconducting electromagnet, the small cylindrical object being removed from helium bath at minus 450 degrees F. An early experimental design produced a field strength over 65,000 gauss.

OUT OF SOLID STATE SCIENCE COMES A POWERFUL NEW MAGNET

Bell Telephone Laboratories’ creation of a powerful superconducting electromagnet once again illustrates the role of materials research in the advancement of communications.

It has long been known that certain materials called superconductors have a zero electrical resistance at temperatures near absolute zero. A solenoid of superconductive wire carrying a large current should be capable of producing an extremely powerful magnetic field without the bulky power equipment that is needed for conventional electromagnets.

A formidable obstacle blocked the way, however. The strong magnetic field tended to destroy the wire’s superconductivity.

Bell Laboratories scientists studying superconductors—as part of their endless search for new materials for communications—were led to the discovery of a number of alloys and compounds having exceptional superconductive properties. One of these materials, a compound of niobium and tin, was found to possess a startling ability to retain its superconductivity in intense magnetic fields of over 100,000 gauss. Bell scientists went on to show how the brittle, intractable material could be made into a wire and hence wound to make an extremely powerful electromagnet.

By finding a low-cost way to create enormously powerful magnetic fields, Bell scientists have brought closer new applications of magnetism in communications. Intense magnetic fields provide an invaluable tool in research, and offer an attractive means for containing hot plasma in thermonuclear experiments.

The new magnet is another example of how Bell Laboratories research not only works to improve Bell System communications but also benefits science on a broad front.

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Dynakit specifications are always based on reality rather than flights of fancy, so our Dynatuner specification of 4 microvolt (IHFM) sensitivity appears somewhat archaic when practically all competing tuners imply greater sensitivity in their advertising. Performance is what counts, however, so we invite you to compare the DYNATUNER directly with the most expensive, most elaborate FM tuners available.

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Naturally, the Dynatuner includes provision for an internal multiplex adaptor. The FMX-3 will be available soon and can be added at any time for full fidelity stereo FM reception—your assurance that DYNAKIT always protects you against obsolescence.

Slightly higher in the West. Write for detailed information on this and other Dynakits.

RADIO-ELECTRONICS (Continued from page 10) power two of the four radio transmitters, the other two by solar cells and nickel-cadmium batteries.

Brief Briefs

"High fidelity" from your hot-air heating system is promised by one manufacturer, who makes a unit that mounts on the hot-air duct above the furnace and carries music to every register in the house. "If two units are used—one on the hot-air ducts; the other on the cold-air return—a stereo effect results," says the manufacturer, Roger-Mark Corp. of Chicago. . . .

Ultra-pure fused quartz is announced by General Electric Co. The new pure quartz has higher heat resistance—deforms at half the rate of ordinary quartz at temperatures of 1,200°C or higher. . . .

RCA announces development of a new thermoelectric material—an alloy of germanium and silicon—that produces more electricity direct from heat than any previously known materials. A platelike arrangement of the new material with a square-foot surface heated to 1,000°C can produce up to 10 kilowatts, according to the report. . . .

Alternator-rectifier system to replace the dc generator in motor cars has been announced by Motorola. Silicon-diode rectifier and transistorized voltage regulator form part of the equipment. System is rated at 600 watts.

New superconducting supermagnet developed by Westinghouse is only a pound in weight, develops a flux density of 43,000 gauss. Niobium-zirconium wire, in a bath of liquid helium, carries the fantastic currents required.

Calendar of Events

ERA Annual Convention, Jan. 23-27, Hollywood Beach Hotel, Fla.
IRE Winter Convention on Military Electronics, Feb. 7-9, Ambassador Hotel, Los Angeles, Calif.
Pacific Electronic Trade Show, Feb. 9-11, Shrine Exposition Hall, Los Angeles, Calif.
International Exhibition of Electronic Components, Feb. 16-20, Parc des Expositions, Paris, France.
IRE, AIEE, NBS Scintillation and Semiconductor Counter Symposium, Mar. 1-3, Shoreham Hotel, Washington, D.C.
EIA Committee and Section Meetings, Mar. 14-15, Statler Hilton Hotel, Washington, D.C.
EIA 18th Annual Convention, Mar. 23-25, Pirk- Congress Hotel, Chicago, Ill.
IHFM High Fidelity Show, Mar. 25-26, Ambassador Hotel, Los Angeles, Calif.
IRE International Convention, Mar. 26-29, Coliseum, New York, N.Y.

Research Man Heads RCA

Elmer W. Engstrom, RCA research engineer for many years, became president of the company at the end of last year. Engstrom has been with the company for 31 years, and a vice president since 1955. Before his elevation, he was in charge of the RCA research laboratories in Princeton, N. J. Active in several fields, some of his most prominent
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work has been in connection with color television. It may have been this to which chairman of the board David Sarnoff referred in stating that the selection "reflects our confidence in his ability and experience, particularly in those areas where RCA anticipates great future growth."

A. Hoyt Taylor Passes

Dr. Albert Hoyt Taylor, one of the earliest radar pioneers, died in California at the age of 82. As early as 1922, Dr. Taylor noted—while making experiments in Navy radio communications—that passing ships on the Potomac created an interference pattern. He reported this to the Navy, and suggested that the effect might be used to detect enemy vessels. Continuing his work, he was able to detect planes at a distance of 50 miles by 1932, and in 1938 installed the first radar on a battleship. This work—especially after the outbreak of World War II—was done in cooperation with other inventors and developers, notably Sir Robert Waston-Watt of Britain. Dr. Taylor received the United States Medal of Merit after the war, and was also recipient of the Stuart Ballantine Medal from the Franklin Institute, the Medal of Honor from the Institute of Radio Engineers, the John Scott Medal and the Pioneer Award of the Professional Group of Aeronautical and Navigational Electronics. He was a Fellow of the Institute of Radio Engineers, American Institute of Electrical Engineers and the American Physical Society. He was president of the Institute of Radio Engineers in 1929.

Appleton Receives IRE Medal

Sir Edward Appleton, principal and vice-chancellor of the University of Edinburgh, has been awarded the 1962 Medal of Honor of the Institute of Engineers. It will be presented to him at the March 28 International Convention banquet. The medal was awarded to Dr. Appleton "in recognition of his pioneer work in investigating the ionosphere by means of radio waves."

The directors announced the 1962 officers at the same meeting that granted the Medal of Honor. The 1962 president is Patrick E. Haggerty, president and director of Texas Instruments, Inc. The vice presidents are Andre M. Angot, technical director of Telecommunications Radioélectriques et Téléphoniques, Paris, France; C. A. Hunter, president of Hunter Mfg. Co., Iowa City, Iowa, and research professor at the State University of Iowa.

The directors also made five other awards and elevated 78 leading radio engineers and scientists to the status of Fellow of the Institute of Radio Engineers.

Secretary-Eliminator Developed

A multi-lingual phonetic type-writer for transforming the human voice into typed symbols was described at the 62nd meeting of the Acoustical Society of America in Cincinnati, Ohio, by Dr. Tosei Sakai of Kyoto University, Kyoto, Japan.

Using 5,000 diodes and 3,000 transistors, the unit has three subsystems—a phoneme classifier, the control system and the speech analysis system. At present, the type-writer translates speech sounds into codelike symbols, but further research will permit segmentation into linguistic symbols. The unit has an unlimited linguistic and transmission distance possibilities, says Dr. Sakai.

Optical Maser a Welder

Light from a laser (optical maser) can weld titanium, unaided by any other power source, says Lieut. Col. Elmer M. Morse, chief of the Air Force Aeronautical Systems Div. Laboratory at Dayton, Ohio.

Morse has shown, he said, cut a dime-sized piece of titanium alloy in two, trained laser light on it and made spot welds with no difficulty.

Sound Researcher Wins Nobel Prize

The 1961 Nobel prize in medicine was awarded to Dr. Georg von Békésy, for researches into the action of sound in the human ear. Dr. Békésy proved by actual experiment, using solutions containing aluminum and coal particles, how sound waves actually travel in the ear. His experiments proved that the older theories of hearing, long considered inadequate but never superseded by better ones, were in fact invalid, and that the inner ear, or cochlea, works much like a microphone in converting sound energy into electrical energy and transmitting it to the brain.

Communications With Computers

A new communications system, using computer techniques, has been unveiled by the ITT Information Systems Div. It blends communication and computer technologies to process and switch telegraphic messages and data at speeds running up to at least 1,000,000 bits per second. The computer's memory contains such information as lists of all possible addresses or messages recorded and sent, instructions as to steps to be taken with regard to messages bearing any of these addresses, instructions as to priority, etc. Thus, the president of an international company, for example, could dictate a duplicate message to each of the branches of a certain division of his company throughout the world, and have them delivered at 9 o'clock the same morning, which might be several days later, with correct direction for the International Date Line.

The device is expected to have great value in processing and reporting important information for companies or other organizations.
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Is it a “coaching service”?
Some schools and individuals offer a “coaching service” in FCC license preparation. The weakness of the “coaching service” method is that it assumes the student already has a knowledge of technical radio. On the other hand, the Grantham course “begins at the beginning” and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC type test so you can discover daily just which points you do not understand and clear them up as you go along.

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The now famous Grantham Guarantee protects your investment. When such “insurance” is available at no extra cost, why accept less?

Is it a “memory course”?
No doubt you’ve heard rumors about “memory courses” and “cram courses” offering “all the exact FCC questions.” Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this “meaningless” material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand — choose Grantham School of Electronics.

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February, 1962
ABOUT ELECTRONIC IGNITION
Dear Editor:

In the December 1961 issue, Mr. J. S. Pitman raises a question as to the reliability of the thyratron ignition system described in the September 1961 issue. The author himself points out that a serious problem exists.

Commander Smithey states that the 2D21 thyratrons need replacement approximately every 4,000 to 5,000 miles. Relatively simple circuit analysis suggests that peak cathode-current pulses are of the order of 5 to 10 amperes, which is many times the 0.5-amp rating of the 2D21. Use of a high-current thyratron would solve this problem, even though it would not reduce circuit complexity.

However, Mr. Pitman does have a point. The failure rate of a system is a function of the number of components, and a complicated system using the minimal number of components and conservative operation yield a simple system which has all the performance advantages you listed for the thyratron-tube system, and has much lower initial and maintenance costs.

W. F. PALMER
Palmer Electronics Labs
Carlisle, Mass.

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UNCrimp THE JOINT

Dear Editor:

There are many who disagree with the "Technician's Guide to Good Soldering" (November 1961 issue), which recommends wrapping or crimping.

Crimping may be desirable in missile electronics where no maintenance is anticipated. Since the equipment will undergo only a half-hour's use before plunging into the ocean, it is not likely that any connecting wire will have to be removed from a terminal. Otherwise, there is a compelling case for crimpless joints—if not from the viewpoint of the wretched field engineer whose job it is to keep the equipment in working order.

Of course, crimping is highly desirable from a production foreman's point of view because it requires less soldering care and, therefore, speeds his work. Ultimately, however, it is the customer-user whose judgment is important, not the production foreman.

With a little care, you can get perfectly reliable joints without even bending the end of the lead. We have yet to hear any objections raised against crimpless soldering to the holes in etched-circuit boards (though some technicians deplore the expedient that calls for bending each lead, slightly where it emerges from the back of the board).

This plea for crimpless soldering (Continued on page 22)
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SEE OTHER SIDE

"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., Cayuga, N.Y., says of his position with The G.E. Advanced Electronic Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."

"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRLD-TV.

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."

FROM FACTORY LABORER TO HIS OWN BUSINESS that rang up sales of $158,000 in one year. That's the success William F. Kline of Cincinnati, Ohio, has had since taking NRI training. "The course got me started on the road," he says.

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(Continued from page 18) does not represent simply a fanatical minority view. Tektronix, for example, favors crimpless joints; and it is generally acknowledged that Tektronix produces some of the finest, most reliable, most easily serviced equipment in the industry.

DALE L. HILEMAN
San Francisco, Calif.

ELECTRONIC IGNITION—IN USE
Dear Editor:
Here’s to three cheers for Commander Smithey and your grapes to J. S. Pitman. Enjoying that surging, economical power more every day! I added an option—a switch that keeps the filaments on and heated for short stops. Be glad to hear of any hints that come up. Try 500 µfd for C4.

WM. SENDER
Parma, Ohio

AMPEREX TRANSISTORS ARE AVAILABLE
Dear Editor:
We noticed in your “Transistor Roundup” in the December 1961 issue that Amperex does not appear among the list of transistor manufacturers.

Amperex has a number of transistors in various types that sell for $5 or less. We have approximately 25 franchised semiconductor distributors and are listed in the Newark Industrial, Burstein-Applebee and Radio Shack Industrial mail-order catalogs.

We will be pleased to furnish your readers with our list of distributors as well as a free copy of our semiconductor catalog upon request.

It may be interesting to note that our Slaterville, R.I. plant has been in full production for over a year, and that a number of original transistor types are being manufactured there.

M. SMOLLER
Manager,
Advertising & Sales Promotion
Amperex Electronic Corp.
230 Duffy Ave.
Hicksville, N. Y.

TAIL-LIGHT INDICATOR
Dear Editor:
Those who wish to build the Tail-Light Indicator on page 108 of the April issue, but do not care for the expense of transistors and photocells, might try one of these ideas.

On cars with 12-volt batteries you might try the circuit shown here. When both tail lights are lit, the relay will not energize. But if either light should fail, the indicator (mounted on your dash) lights. If necessary, the polar relay can be shunted to the proper current range. The tail lights must be replaced with 6-volt units as they are in series with the relay coils, but use a 12-volt indicator lamp or a series resistor and a 6-volt lamp.

ROBERT G. CASEY
Seine, France

ATTENTION TECHNICIANS
Dear Editor:
I am not satisfied with the present New York TV service license bill sponsored by ESFETA (Empire State Federation of Electronic Technicians Associations).

Any license bill is administered by a license board. Men appointed to this board are those suggested by the state trade association (ESFETA).

The Department of Education does not determine the scope of the license examination that will be used under the license law (after the grandparents get in). The contents of these examinations are determined solely by the members of the license board. This, in effect, means that the standards of our license law would be set forth by the technicians’ organization and not the State Education Department. The department merely prints the examinations; it does not compose them.

ESFETA does not require all their members to be qualified technicians and they have even abandoned in recent years their one-time requirement that all officers must be qualified technicians.

With this combination we are finding a lowering of the average technical standards by those who will be placed in a position to set the standards of our industry under the license law. Therefore, unless the qualifications for the position of license-board member is more strongly specified in the present bill, we have no guarantee of a good license law. If enough New York State technicians voice their opinion for high standards of the board members, we can have it. Write today before it is too late.

MELVIN COHEN
RD No. 1
Hudson Falls, N. Y.

(ESFETA members are asked to state their opinions. After all, there are two sides to every story. As the proposed law states, a certain number of board members are to be service technicians, so only technicians will be able to fill these positions. And like any appointed office, someone has to do the selecting. They may not select the best men all the time, but this holds true for every organization.—Editor)
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These manufacturers have announced that they will be marketing color television sets this fall.

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THE NEXT PHASE OF TV

A Future L-P Television Record Is Possible...

ACCORDING to the head of the Federal Communications Commission, Mr. Newton Minow, as well as a majority of TV critics, a sizable percentage of today's television programs have sunk to an incredible low, so low, indeed, that more and more people turn to other forms of entertainment.

The flight from television is by no means new; it is of long standing. In recent years, serious attempts have been made to lure distressed TV audiences into pay-TV presentations, where viewers could see worth-while, adult television fare. But pay TV—as we have pointed out on this page before—does not seem to be the solution to the acute problem.

In the meantime, the country is turning more and more to high fidelity and stereo, where people can enjoy first-class music and all that goes with it—at the expense of TV, by doing without it.

The thought seems obvious—why not combine high-fidelity TV with high fidelity and stereo? NOT BROADCAST TV, BUT YOUR OWN SELECTED TV, on a regulation TV receiver?

Indeed, RCA has experimental tape recorder models that can do just that, but so far none are for sale. Prerecorded TV programs might be the stimulus that could lead to their manufacture at prices that could put them within the reach of the home viewer.

In our opinion, tape records do not seem to be the only solution for a number of reasons. One is that the country has grown used to phonograph discs in high fidelity and stereo. They are simple to handle, particularly long-playing (L-P) ones.

Why not, then, record TV special programs, such as "My Fair Lady," and hundreds of others, with sound and video on L-P records? Then we could feed the TV output of such programs of our own selection into our present television set, using its video circuits. (We do this now when we feed audio from a record player into the TV's audio system.) Then we would not be a captive audience, listening and viewing mediocrity, interspersed with often- offensive commercials.

The idea, simple and obvious as it is, has so far been technically unfeasible, even if you could record electronically the wide frequency range. To record normal TV impulses on an L-P record, it would have to be enormous in dimensions—about 20 feet in diameter for a 1/4-hour program. Obviously, such a system is unworkable.

Yet there seem to be other solutions to the problem. The writer suggests one which, when worked out technically, would seem feasible for the future.

To begin with, why use TV impulses? Why not use a special kind of motion picture and record complete motion pictures on a flat disc? We can do this readily today with optical micropictures.

For over 50 years, French manufacturers have made special optical lenses about 3/4 inch long and about 3/32 inch in diameter. On the flat end is cemented an almost invisible photographic bit of microfilm. Usually the subject is a comely girl. The lens is often mounted in one end of a pen or pencil. The picture, sharp and clear when viewed against the light, nevertheless measures only 1/32 x 3/64 inch.

With modern techniques, we can reduce even this size considerably yet get excellent pictures, plus an optical sound track.

The entire motion picture would run in a tight spiral, not in a groove, of course, but on a disc, similar to today's records.

As we wish to use both sides, obviously the record cannot be transparent, but the film spiral must be mounted on a white or, better, a mirrored surface such as polished aluminum, for instance.

The optical pickup head, which follows the picture track, also carries a lamp which throws a powerful beam of light on the picture, reflecting the film image into the pickup head. Here we can do two things: One would be to throw the enlarged motion picture onto a screen, pick off the sound with a photoelectric cell, and leave out the TV set entirely.

That, we believe, is not the best way. It is more logical to install the picture record and its associated gear in the top of the future TV set, where it belongs. Then we attach a special, small TV camera to the pickup head, and feed the output to the TV receiver. This, we think, solves the problem in a sensible way.

Let us caution here that TV records on flat discs are a project for the future. Enormous technical difficulties must be overcome, despite its attractive possibilities. Such records, even if finally mass-produced, would probably always cost far more than present L-P records.

When TV tape records were first contemplated, no feasible solution seemed in sight for many years, until Ampex finally evolved its brilliant super-speed, revolving magnetic transducer head. A similar breakthrough might make disc TV recording possible.

Certainly, in the future, TV set manufacturers would provide better hi-fi speakers to anticipate the new demand that is bound to follow such TV records. Yes, such receivers would be more expensive, because they must combine TV, hi-fi and stereo.

Coming back to the TV records—they naturally would be expensive too at first. Yet, as always, mass production would surely lower the prices. If a hit musical or smash drama were assured a good percentage of income to its producers from a million or more TV records of the productions, they would not have to worry about audience attendance—indeed, we can foresee the time when such productions would be exclusively for a "record" audience first, then later played to a live audience.

The world's great operas, symphonies in the best concert halls—all can be recorded in audio and video on L-P in the future. There seems to be no limit once the system has been perfected.

Does all this spell the doom of live TV? Certainly not in the slightest. Television has its own peculiar and unrivaled pre-eminence that no home-use recording can ever challenge. News, sports, spot events, talks by eminent politicians, debates, vaudeville, panel shows and dozens of other functions—if put on intelligently and in good taste—will always have a good audience. The two systems of entertainment need never compete with each other—nor should they. —H.G.
FM antennas for better listening

Types of antennas and their characteristics

By EDWARD M. NOLL

The antenna has always been important in FM. But with stereo multiplex FM, a good antenna is absolutely vital, even in metropolitan areas. The signal-to-noise ratio of the stereo signal is far below that of a conventional mono FM signal, and if the signal at the receiver input is inadequate, the multiplex subcarrier will not be strong enough to lock in the receiver's multiplex circuits. Poor stereo separation or complete absence of stereo may be the result.

A good antenna keeps local signals well above the level at which interference and background noise can mess up the reproduced program. At the same time, longer distance signals can be raised above the noise level, reducing fading and interference. The stronger the signal delivered to the tuner input, the more it can be made to exceed the background noise of the receiver.

Sensitivity of FM tuners is usually given in terms that relate microvolts of signal to background quieting. This figure is generally presented as the minimum signal strength required for a certain amount of db quieting (usually 20 or 30 db). To say a receiver has a sensitivity of 1 mv for 30-db quieting indicates that an incoming 1-mv signal will reduce the normal no-signal background noise level of the receiver by 30 db. If the incoming signal is strong enough to press down the background noise by 40 db, the background, in a practical sense, can be called noiseless. A correctly installed antenna can do much to optimize the weaker and more distant FM stations. By correct antenna positioning and orientation, these signals can be raised above the background noise. They can be made strong enough to dominate interference from local stations on nearby channels.

Built-in antennas are included with most FM receivers and tuners. The built-in antenna is usually a piece of 300-ohm Twin-Lead stapled to the cabinet. Such a simple antenna is often good enough for the stronger local stations. But reception is better when the antenna is improved.

Attic- or window-mounted antennas help considerably if it is not possible to go to a roof-mounted outdoor type. A ribbon-line folded dipole (Fig. 1) can be stapled to attic rafters or other convenient mounting. The length of such a ribbon antenna can be about 4½ to 5 feet. Solder the ends together as shown. Break one lead at its center and attach the 300-ohm transmission line that must be run between the folded dipole and the antenna terminals of the FM unit. As shown, the antenna is most sensitive when placed broadside to the received signal. When the transmitters in the area are located in differing directions, mount it broadside.
Fig. 3—A folded dipole and reflector for FM (above) and its radiation patterns at 88 mc (right), 78 mc (below) and 108 mc (lower right).

Fig. 4—Folded dipole and reflector with its horizontal directivity pattern.

Fig. 5—End-fire folded dipole and its single-lobe pattern. The table shows length of the quarter-wave section.

Fig. 6—Stacked S-folded dipoles.
IN-PHASE FEED

Fig. 7—Turnstile feed arrangements and their effect on the antenna pattern.

Amphenol

Fig. 8—The folded-dipole turnstile is a popular FM antenna.

The horizontal radiation pattern for the folded-dipole and reflector combination at the center and two end frequencies of the FM band is given in Fig. 8.

Table II shows the SWR and gain figures of the various styles of antennas at specific frequencies in the FM band. Notice that the gain of the dipole and reflector combination decreases with frequency. Remember that the reflector must be cut long enough to act as a reflector at the low end of the band. The effectiveness of the combination declines toward the high-frequency end.

A gain antenna must be oriented carefully for best reception from the weaker FM stations you wish to receive. Such an antenna does have some back pickup and can handle strong signals that arrive from the back. The single dipole is least sensitive to signals in line with its individual antenna elements.

When a folded-dipole driven element is used, a 300-ohm transmission line is customary. For a straight dipole, a lower-impedance line can be used. This can be 75- or 150-ohm ribbon line or a 50- or 72-ohm coaxial line. Many FM receivers and tuners have terminals for connecting either high- or low-impedance lines.

Occasionally two driven elements are used, as shown in Fig. 5. In this arrangement two driven dipoles are employed. One dipole is driven in a manner that will place it in quadrature (90° related) with respect to the second dipole. This can be done by using a section of transmission line 90° (a quarter wavelength) long between the points of attachment to the two dipoles. The physical length of this 90° section is determined by multiplying the quarter-wavelength free-space dimension times the velocity factor of the particular transmission line. Typical lengths are shown in the diagram.

The advantage of this so-called end-fire arrangement is that a cardioid (heart-shaped) horizontal directivity pattern is obtained. It has a broad forward pattern that makes the antenna sensitive to many angles of arrival as far as its forward directivity is concerned. The side and rear pickup of the antenna is quite poor so noise and interference pickup from the back are minimized. It performs well for a loca-
tion where signals arrive over a rather broad angle in the forward direction.

**Turnstile antennas**

A popular FM antenna is shown in Fig. 6. The driven element is basically a folded dipole. The folded dipole is shaped into a figure-8. This gives a much broader figure-8 horizontal directivity pattern. Such an antenna sacrifices its pickup, to some extent, in a direction exactly broadside to the antenna element. Its pickup at angles quite divergent from the broadside line is improved. Also, it does not have sharp minima in line with the antenna element. Stacked S-folded dipoles permit higher gain.

An FM antenna can be made sensitive in more than two directions by using two in-phase dipoles mounted at right angles (Fig. 7). The horizontal directivity of this arrangement is like a clover leaf. However, there are now four minima and, in orienting such an antenna, they can be troublesome if signals are arriving from several directions.

The most common form of turnstile antenna is shown in Figs. 8 and 9. One of the dipoles is fed in quadrature with the second. This 90° feed arrangement consists of an electrical quarter-wave section of line between the two right-angle dipoles. The 90° feed arrangement of the turnstile pair provides an omnidirectional horizontal pattern as shown.

Such an antenna need not be oriented when it is installed because its pickup is uniform at all compass angles. There are some minimum positions which are not very deep, and therefore, not particularly objectionable. Conical driven elements can be used to get a still more uniform omni-directional pattern.

**Parasitic antennas**

Additional parasitic elements (Fig. 10) can be added to increase the gain of an FM antenna and sharpen its directivity. This style of antenna is used to best advantage in fringe and far-fringe areas. When long-distance FM stations arrive from different directions, such an antenna is used with a rotator.

Yagi antennas have very high gain and a sharp horizontal directivity pattern. The greater the number of parasitic directors, the higher the antenna gain and the sharper the directivity pattern. If such an antenna is to be installed in a fixed position, it must be oriented very carefully in the direction of the signal.

Such an antenna picks up local stations reasonably well, even though they may not be in line with the most sensitive direction of the antenna. Hence in many locations such an antenna can be oriented in the direction of the weak distant signal and will still have enough pickup for the reception of local FM signals.

Yagi antennas of this type must be broad-banded if they are to have reasonably uniform sensitivity over the entire FM spectrum. When an FM enthusiast is interested in receiving a weak long-range station, it is possible to cut and Yagi to peak its sensitivity at a given frequency. It is possible, at times, to obtain a channel-6 TV Yagi antenna at a bargain price. The elements of this Yagi can then be cut down to a specific FM frequency. Spacing between elements need not be changed. The Yagi in Fig. 11 is a broad-band type. Note the booster mounted on the antenna. Optimum dimensions for the dipoles permit the combination to display a more uniform pickup over the entire 20 mc of the FM band. The reflector is cut into the low end of the band; directors, the high end. The patterns of the model in Fig. 12 show how the pattern sharpens when many elements are used. Hence the antennas must be oriented critically to get the most out of them.

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**Table I**

<table>
<thead>
<tr>
<th>FREQUENCY (MC)</th>
<th>( \lambda/2 ) FREE SPACE</th>
<th>CORRECTED FOR END EFFECT (IN)</th>
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<tr>
<td>88</td>
<td>67 in.</td>
<td>64 in.</td>
</tr>
<tr>
<td>98</td>
<td>62</td>
<td>59</td>
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<tr>
<td>108</td>
<td>51/2</td>
<td>48</td>
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</table>

**Table II**

<table>
<thead>
<tr>
<th>ANTENNA TYPE</th>
<th>SWR 18 MC</th>
<th>SWR 38 MC</th>
<th>SWR 106 MC</th>
<th>DB GAIN OVER REFERENCE DIPOLE 18 MC</th>
<th>DB GAIN OVER REFERENCE DIPOLE 38 MC</th>
<th>DB GAIN OVER REFERENCE DIPOLE 106 MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folded Dipoles Turnstile</td>
<td>1.8</td>
<td>1.3</td>
<td>1.3</td>
<td>2.0</td>
<td>3.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Quadrapole Yagi</td>
<td>1.5</td>
<td>1.9</td>
<td>2.5</td>
<td>2.0</td>
<td>3.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Folded Dipoles and Reflector</td>
<td>1.2</td>
<td>1.6</td>
<td>2.5</td>
<td>5.0</td>
<td>5.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Four-Element Yagi (Twin Driver)</td>
<td>1.5</td>
<td>1.4</td>
<td>1.5</td>
<td>6.6</td>
<td>7.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Six-Element Yagi (Twin Driver)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.5</td>
<td>6.7</td>
<td>8.5</td>
<td>10.2</td>
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<tr>
<td>Ten-Element Yagi (Twin Driver)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.5</td>
<td>6.7</td>
<td>8.5</td>
<td>10.2</td>
</tr>
</tbody>
</table>

The radiation patterns in Figs. 3, 9, 10 and 12, and the information in Table II are printed through courtesy of the Finney Co.
REGULATED LOW-VOLTAGE SUPPLY

for service bench or lab

Variable from 0.5 to 30 volts, 2- to 3-ampere output, 0.5% regulation—powers most battery-operated transistor equipment

By LEONARD J. D'AIRO*

WHEN servicing and testing battery-operated equipment, a rectified ac power supply often forms the power source. This supply must be able to provide the required operating voltage and current for the equipment and at the same time present a low-impedance source to the circuit, as does the battery it replaces. Also, there must be little or no ac ripple in the output.

A conventional regulated supply uses a fixed reference voltage to set the level of the regulated output voltage (Fig. 1). Because of it, the output voltage cannot vary more than a fraction of its set value. To get a variable voltage range and still have good regulation at any point in this range, the reference voltage must be variable. But to do so defeats the purpose of regulation.

It seems that the only possible solution is to connect a potentiometer across the output (Fig. 2), and take the variable output voltage between the wiper arm and ground. But this solution presents a new problem. Once large currents are drawn through the potentiometer by the load, the voltage drop across the resistance plays havoc with the output voltage. Once again we lose regulation.

But, suppose that instead of the potentiometer a transistor is used whose conductivity can be manually controlled (Fig. 3). Its action is similar to the potentiometer alone and it would be possible to control the output voltage as required without fear of voltage drop over a wide current range. Current is then limited only by the transistor used. This arrangement is the one that is used in the regulated power supply shown in the photographs.

The supply uses four power transistors and one small-signal transistor. Output voltage is variable from 0.5 to 28 volts with 0.5% regulation at any point. Maximum ac ripple is 40 mv, and the voltage output vs temperature drift is 0.75% between 30° F and 150° F. Output current ranges from 0 to 2 amperes at any voltage up to 15.

The completed power supply.

from 0 to 3 amperes at any voltage above 15.

The circuit

The complete circuit of the regulated power supply is shown in Fig. 4. A Minneapolis-Honeywell type DA3F3 (V1) power transistor is the positive line series regulator. A 2N102/13 (V2) and 2N217 (V3) are used as the control amplifier and sensing amplifier, respectively. A second DA3F3 (V5) in the negative lead acts as the variable series regulator and a 2N1031 (V4) is its control amplifier. The DA3F3 transistor was used because of its 30-amp maximum collector current, 100-watt dissipation and low cost. (The transistors may be obtained direct from Minneapolis-Honeywell Regulator Co., Union, N. J., at $5 each.) Total cost of the regulated supply will be about $80.

Referring to Fig. 4, rectified ac is applied across V1's emitter and ground. Fixed regulated output voltage is taken between V1's collector and ground.

*Author, Servicing Transistor Radios, Gernsback Library.
Variable regulated voltage is taken across V1's collector and V5's emitter.

Regulating action

Zener diode D6 sets the level and regulating range of V3's emitter to 27 volts. Resistors R5, R8 and R9 form a voltage-divider network for V3's base and bias V3 into conduction. (R9 is adjusted so V3's base is 3 volts more negative than the emitter. This sets the regulated output voltage at 30.) When V3 conducts, its collector tends to approach the same value as its emitter. Since the collector is connected directly to V2's base, this positive voltage (with respect to ground) causes V2 to conduct. V2's collector is connected to V1's base and to the supply voltage through resistor R2. The current V2 drawn through R2 causes a voltage drop across it that biases V1 into conduction.

If the current drawn by the load tends to increase, the output voltage will decrease in proportion due to the I/R drop across V1. This drop in output voltage is sensed by V3 as a decrease in base bias. This causes V3 to go out of saturation or conduction (depending upon the degree of change). V2, in turn, conducts less and approaches cutoff. Less current flows through R2 and the voltage drop across it decreases. V1 now conducts less, increasing its internal resistance and decreasing the output voltage.

Because R3 is connected between the emitter and V1's base, this transistor is normally biased at cutoff. Any voltage applied to it will not cause it to conduct. Therefore, to turn it on, some means must be used to bias it in the forward direction. We do this by connecting a starting resistor (R1) from the supply voltage to V3's emitter to turn the regulator on. (When V3 conducts, it starts V2 and V1 in turn.) The value of this resistor is small enough to turn the regulator on and yet large enough so as not to affect regulation. Diode D1 prevents the supply voltage from affecting the output (since it is back-biased), and, because of D6, the voltage at the emitter cannot rise above 27, regardless of the supply voltage.

Transistors V4 and V5 operate in much the same manner as V1 and V3 except that V4 conduction is manually controlled. V4 and V5 are actually emitter followers with the emitters leveling off at a voltage slightly less than that of the base. If the output requirements did not exceed 250 mw, the load could be connected between the wiper arm of R11 and ground. But, since the output is 112 watts maximum, V4 is used to multiply the 250-mw rating to 25 watts. V5 can then regulate 4 amperes at 28 volts. Resistor R12 limits V4's base current and prevents the base voltage from equaling the collector voltage (which can permanently damage or destroy the transistor).

The maximum input voltage applied to the regulator should not exceed 40 volts. This limit prevents breakdown between the collector and emitter of V1. As a protective measure, the variable autotransformer (T1) is used to adjust the input voltage to T2 so the rectified ac applied to the regulator never exceeds the 40-volt limit. T1 is necessary since the output voltage of the rectifier increases as the load current decreases. Meter M monitors this input voltage.

Construction hints

Any method of construction is feasible since there is no ac or rf signal to contend with. Layout and leads can follow any pattern that suits the constructor, provided, of course, that heavy enough wire (No. 10) is used to carry the large currents provided.

The supply shown in the photographs was built on a 5 x 10 x 3-inch aluminum chassis. T1 and T2, D2, D3, D4 and D5 and the filter capacitors are all mounted on the left-hand side of the chassis. The two regulator transistors are mounted on the front of the chassis, with a 1/4 x 3 x 10-inch piece of aluminum supplementing it as a heat sink. Transistors V3 and V4 are mounted above the chassis on the right-hand side, while V2 and the rear of the components are mounted under the chassis. All transistors must be insulated from the chassis. A transistor socket is used to mount V3. The voltage control (R11), power switch, meter switch and meter are mounted on the front panel of the chassis.

If desired, the power supply section (transformers and rectifiers) can be replaced by any convenient power supply capable of delivering the required voltage and current, such as the standard battery eliminator that often adorns the service bench.

Operation

After construction and wiring are complete, check to make sure you have made no mistakes. An output of 28 volts or more indicates satisfactory work. Connect a 30-ohm 50-watt wirewound resistor or equivalent load to terminals 1 and 2 of the regulator. This represents a 1-ampere load. Connect an accurate voltmeter to these terminals. Turn R9 to maximum resistance, input voltage down to zero. Apply power. Increase the input voltage to 34, and adjust R9 until the external voltmeter reads 30. Increase the input voltage to 40. There should be no change in the output-voltage meter reading. If the output voltage does increase, either D6 or D1 should be replaced. Decreasing the size of R4 may also help if D6 cannot be replaced. Vary the input voltage between 32 and 40. There should be little if any change—that is, no more than a 0.2-volt variation.

With the input voltage set at 40, vary the load current over the 3-ampere range. A gain of 0.005 should be no more than a 0.2-volt variation. If the change exceeds 0.2 volt by a large amount, D6 or V3 should be replaced, or R4 decreased (do not make R4 less than 150 ohms).

With the regulator operating properly, connect a load across terminals 1 and 3. Regardless of the load, the volt-

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Underchassis. Note the added sheet of aluminum fastened to the rear of the chassis for additional heat dissipation.
If the output voltage remains constant regardless of the setting of R11, then there is either a mistake in the wiring or V4 or V5 is defective.

One feature of this regulator is its "built-in" short-circuit protection which prevents the transistors from acting as fuses.

If the output current ever exceeds the maximum of 3 amperes, or prevents the transistors from acting, then there is either a mistake in the circuit, V3 will not conduct.

This action is the function of V3. As the load increases beyond 3 amperes, the voltage output decreases to a point where V3 cuts off completely. In turn, it causes V2 to cut off. With V2 no longer conducting, no current flows through R2. This places the base of V1 at the same potential as its emitter. V1 now no longer conducts and the output voltage drops to zero.

Even though the starting resistor is still in the circuit, V3 will not conduct as long as the overload or short remains. This is because the overload or short prevents V3's base voltage from building up to a point where it can conduct. Removing the short returns the circuit to normal and the regulator will once again start. For those who wish added protection, an spst pushbutton switch can be placed in series with R1. This switch can be used for starting the regulator after it has been shorted.

As an added note, because of the difference in characteristics between identical transistors, R1's value may have to be decreased to insure proper starting under full load. The value chosen should be such that it will start the regulator and at the same time not affect regulation.

R1-5,100 ohms, 5%
R2-4.7 ohms, 1 watt
R3, R4-330 ohms
R5, R10-100 ohms, 10 watts
R6-240 ohms, 2 watts, 5%
R7-2,700 ohms
R8-1,000 ohms
R9-pot, 5,000 ohms, 2 watts
R11-pot, 1,000 ohms, 2 watts
R12-330 ohms, 2 watts
R13-220K ohms
R5, R10-100 ohms, 10 watts
R3, R4-330 ohms
R2-4.7 ohms
R1-5,100 ohms, 5%
R7-2,700 ohms
R8-1,000 ohms
R9-pot, 5,000 ohms, 2 watts
R11-pot, 1,000 ohms, 2 watts
C1-1,500 µf, 40 volts, electrolytic
C2-1,500 µf, 40 volts, electrolytic
D1-IN625
D2, D3, D4, D5-1N124
D6-Zener diode, M27Z5 (Motorola)
W-6.5 volts dc
S1-30 volt toggle
S2-9 volt toggle
S3-10 volt toggle
S4-variable autotransformer, 1 amper
S5-rectifier transformer: primary, 117 volts; secondary, 32 volts, 4 amperes
TS-terminal strip, barrier type, 3 lugs
VI, V5-DA3F3 (Minneapolis-Honeywell, see text)
TS-terminal strip, barrier type, 3 lugs
V1, V5-DA3F3 (Minneapolis-Honeywell, see text)
D6-Zener diode, M27Z5 (Motorola)
W-6.5 volts dc
CHASSIS 558-1, -2

Model T1117

CHASSIS 558-1, -2

Model T1117

RADIO - ELECTRONICS
COLOR CIRCUITY

By LARRY STECKLER
ASSOCIATE EDITOR

FOR THE FIRST TIME IN SEVERAL YEARS there are some new color TV circuits—TV circuits designed and used by someone other than RCA. Up till now, no matter whose color set you bought, you were almost certain to get an RCA chassis. But this year Zenith announced its entry into the field of color TV. Here are the Zenith circuits in a side-by-side comparison with the latest RCA has to offer.

Let's examine the basic structure of the two sets first. The Zenith 29JC20 chassis is hand-wired, uses no printed boards or printed circuits and uses Zenith-designed color circuits. RCA's CT-C11 chassis has five printed boards and the latest improvements and advances in the circuits they have developed over the years.

The block diagrams (Fig. 1) show the arrangement of the color circuits in the two receivers.

Color amplifiers

Zenith takes the composite video information off the video detector through a capacitor and 4.5-mc trap (Fig. 2-a). This trap prevents any 4.5-mc signal from entering the color circuits where it might cause a 920-kc beat interference which would be visible on the screen. A 6GH8 and a 6AU6 color amplifier system get the color information from the composite video signal. The stages are similar to video if stages. They are stagger-tuned and provide an essentially flat response of about 1 mc.

RCA takes the composite video signal for the color circuits off the output of the first video amplifier (Fig. 2-b). No 4.5-mc trap appears in this circuit because it follows the video detector and the 4.5-mc signal does not reach the video amplifier.

There is only a single 6AU6 bandpass amplifier. Of course, there is already one additional stage of amplification as the color signal is taken off the first video amplifier plate rather than the detector.

Automatic color control

To minimize changes of color level caused by slight changes in the incoming signal level, Zenith applies automatic color-control (acc) bias—a gain-control signal developed at an ace-killer phase detector (Fig. 3)—to the grid of the first color amplifier. The amount of bias depends on the burst level input, which in turn depends on the strength of the incoming signal. RCA has no equivalent circuit.

Color killers

It is desirable to have the color amplifiers turned off during black-and-white programs—to prevent color streaks or confetti from appearing in the black-and-white pictures. Automatic bias voltage from the color-killer stage is applied directly to the control grid of the output (second) color amplifier (Fig. 4-a). This -50 volts cuts off the Zenith color amplifiers when there is no color program. When a color program is being viewed, the color killer is cut off and the -50 volts removed, allowing the color amplifier to operate normally.

RCA also has a color-killer circuit (Fig. 4-b). It too cuts off the color amplifier when no color program is on. The difference between the RCA circuit and Zenith's is mainly the KILLER THRESHOLD CONTROL. There is no such unit in the Zenith receiver. This control permits setting the killer so that the color amplifier will not be cut off, even when the color signals are very weak. This is extremely important in fringe areas where the color signal may be far...
down.

Both Zenith and RCA have controls to adjust the intensity of the color in a color picture. RCA calls this control COLOR SATURATION (Fig. 2-b). It is in series with the output of the color amplifier. Zenith calls the control COLOR LEVEL. It is in the cathode circuit of the second color amplifier and varies the bias of that tube (Fig. 2-a).

Should a viewer want to watch a color broadcast in black-and-white or should the color circuits be operating improperly, they can be cut off manually. The Zenith owner simply turns the COLOR OFF switch (Figs. 2-a and 4-a). It turns on the color-killer tube and turns off the color amplifier. In the RCA receiver, the KILLER THRESHOLD control will do the same thing (Fig. 4-b). It must be set so the color killer is turned on even when a color signal is present. Zenith's switch is a push-pull unit on the COLOR LEVEL control. RCA's color-killer control is on the back apron of the set.

Burst amplifier

From the plate circuit of Zenith's first color amplifier, the burst signal is coupled through a capacitor to the grid of the burst amplifier. This 6EW6 is gated with a positive 45-volt pulse so it conducts only during the burst-time interval. This separates from the burst the color signal, which is then fed to the afc phase-detector circuit (Fig. 5-a). The HUE control, a variable coil in the plate circuit of the burst amplifier, is part of a network which varies the phase of the burst signal.

In the RCA set, the composite video signal tapped off the chroma takeoff coil in the grid circuit of the color amplifier (Fig. 5-b) is fed to the burst amplifier grid. It too is gated so that only the burst signal is passed through amplified to the phase detector. The control in this set is called TINT and is a potentiometer off to one side of the burst-phase transformer secondary. In both cases this is a front-panel control.

Color oscillator

In the color sync circuits of the Zenith receiver, half of the 6GH8 acts as the 3.58-mc color oscillator, while the other half is used as a reactance control for the oscillator (Fig. 6-a). A variable coil in the oscillator section is set to fix the oscillator frequency, while the crystal maintains frequency stability. Phase is controlled by the afc phase-detector circuit in conjunction with the reactance tube. The RCA circuit is essentially the same. There are slight differences, however. Zenith's oscillator output is coupled to the primary of a tunable transformer with two secondary windings. With the transformer adjusted for correct demodulation, the 3.58-me signals appearing in the secondaries are 90° out of phase with each other. Also, one signal is in phase while the other is 90° out of phase with the burst signal.

The Zenith 29JC20 color TV chassis.

The RCA CTC11 color TV chassis.

Fig. 2—Zenith (a) color amplifier uses two tubes, RCA (b) only one.
former—which is 90° out of phase with the oscillator output. The operation of this circuit is very similar to the afc circuit used in horizontal oscillator systems.

RCA's 3.58-mc oscillator output is fed to a more conventional transformer with one primary and one secondary (Fig. 6-b). The additional secondary is avoided by taking off part of the oscillator output at the primary of the transformer (making it automatically 180° out of phase with the signal on the secondary) and feeding it to the phase detector. As in the Zenith circuit, color sync is maintained by coupling the burst signal into the afc phase-detector circuit and comparing it with the phase and frequency of the oscillator output.

In both sets, any deviation in phase or frequency of the oscillator signal in comparison to the incoming burst signal will cause either a positive or negative correction voltage, depending on the phase shift. This correction voltage is fed to the grid of the reactance tube, causing its plate current to decrease or increase—depending on the polarity of the correction signal—and correspondingly decreasing or increasing the oscillator frequency.

Demodulation circuits

Now we come to the major difference between the two sets. It is in the color demodulators. Zenith uses a two-tube 6JH8 circuit (Fig. 7-a). One tube is used as an R-Y demodulator, the other as a B-Y demodulator. These tubes are sheet-beam tubes that contain double plates and a pair of balanced deflectors to direct the tube current to either of the two plates. A control grid varies the intensity of the current flow through the tube. These tubes develop balanced output signals of both positive and negative polarities. This eliminates the need for phase-inverter stages to obtain G-Y (or a separate G-Y amplifier—following the demodulators. Instead, the G-Y signal is recovered from the negative outputs of the two demodulators. The three color-difference signals are fed directly to the respective color grids of the picture tube.

RCA uses a more conventional circuit (at least more conventional tubes). A separate half of a 6CG7 is used for each of the color-difference amplifiers and there are X and Z demodulators to produce the R-Y and B-Y signals fed to the respective amplifiers (Fig. 7-b). The G-Y signal is derived from the outputs of the two demodulators. As in the Zenith set, the color-difference signals are fed to their respective color grids in the color picture tube. The signals are matrixed in the tube itself, resulting in proper beam intensities for correct reproduction of red, blue and green on the screen.

At this point, let's take a little time out from our comparison of circuits to see what happens in the Zenith demodulators. In the 6JH8 tube, electrons flow from the cathode to either of the two plates in the form of a planar beam or sheet. After leaving the cathode, the control grid varies the intensity of the beam. The focus electrodes direct the electrons into the required sheet beam, which is then accelerated and deflected to either of the two plates.

The B-Y demodulator has the 3.58-mc CW signal coupled from the color oscillator through the quadrature transformer to the deflector plates. Since these plates are connected directly across the secondary of the quadrature transformer, the signal on one plate is 180° out of phase with the signal on the other. We get an output from a plate only when its associated deflector is receiving the positive cycle of the 3.58-mc signal. As the two plates are fed the same signal 180° out of phase, one is positive while the other is negative. This polarity changes each half-cycle. Therefore, the output at the plates switches back and forth from one plate to the other as each deflector receives the positive half-cycle. The color signal...
nal, which is also a 3.58-mc signal, is fed to the control grid of the tube. Since the deflectors are alternately positive every half-cycle, the output signals on the two plates are of opposite polarity.

The R - Y demodulator operates the same way, with two exceptions—the 3.58-mc CW signal fed to the deflectors is 90° out of phase with the signal on the B - Y deflectors, and the color signal fed to its control grid is lower in amplitude.

Convergence magnets

Zenith has a one-piece plastic assembly around the CRT neck to hold three coils and three of the four static convergence PM magnets around the neck of the picture tube. They are adjusted for convergence in the center area of the picture tube only, even if they affect the whole raster. A fourth, a blue magnet located near the base of the picture tube, affects the lateral movements of the blue electron beam, and also moves the green and red beams in the opposite lateral direction. RCAsystem is almost identical.

The dynamic convergence adjustments, 12 of them, are located on one Zenith dynamic convergence panel. RCA also mounts their 12 dynamic convergence controls on a single panel.

There you have it—the circuits, the controls, the comparison—and a sneak preview of something new the service technician will be anxious to study. It may be that the new Zenith is the first of a number of sets with new ideas and new circuitry. Or other manufacturers may stick to old and well known principles. If we master each new circuit before going further.

According to the factory instructions, the fixed swept oscillator must be tuned to 114 mc on the nose. The differential and sum frequencies generated between the variable and fixed swept oscillator determine the fundamental output frequency. Therefore, by aligning the fixed swept oscillator to a frequency, for example 24 mc higher than the frequency of the variable oscillator (when the variable oscillator is tuned to 24 mc according to the dial), should give the correct frequency setting of 114 mc to the fixed swept oscillator.

To do this correctly, connect the customary scope and marker generator to the TV receiver as though a general video alignment procedure were in the making. Adjust the sweep signal generator dial to the center intermediate frequency of the TV set—24 or 44 mc. Check this frequency with the marker generator or crystal marker harmonics on the scope. Be sure the sweep frequency control on the 360 is turned to the OFF position. With the sweep oscillator temporarily disconnected to eliminate spurious frequencies. Then check at 54 mc for the second harmonic to fall at 108 mc on the receiver dial. This will show if the variable oscillator is tuned to the correct frequency at the 108-mc portion of the dial.

Second, replace the grid cap of the fixed swept oscillator tube, 7193, and prepare to align this section of the instrument. The ceramic trimmer for this adjustment may be reached through the small hole in the top of the instrument case, so it is advisable to have it in the case before going further.

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First, align the variable oscillator trimmer to the correct frequency by adjusting it until the rf carrier is at 108 mc as determined on the dial of an accurately calibrated FM receiver with its antenna disconnected. Align the variable oscillator as per factory instructions with the fixed swept oscillator temporarily disconnected to eliminate spurious frequencies. Then check at 54 mc for the second harmonic to fall at 108 mc on the receiver dial. This will show if the variable oscillator is tuned to the correct frequency at the 108-mc portion of the dial.

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RADIATION METER
MEASURES MINUTE CURRENTS

Lab-quality electrometer requires no special parts—is also useful as high-intensity radiation alarm

By ELLIOTT A. McCREADY

The electrometer is an instrument rarely found outside the laboratory. Like the high school physics type electroscope, it is made to work by the electrostatic forces between two charged bodies. It is a highly sensitive instrument for measuring both a minute electric charge and the current dissipating this charge.

This instrument can be built from readily available parts for around $30 (less if you have a usable meter. Its input resistance is 10^10 ohms and its input capacitance 12 µF. It can be used to measure currents as low as 10^-14 ampere; can be scaled in roentgens with a maximum reading of 0.5 and (with the modification described) 10 roentgens per hour. The higher r/h scale makes it usable as a fallout alarm, though not for quantitative measurement of heavy fallout. It is completely portable, with self-contained power supply. Some types of electrometers are actually calibrated electrosopes; in others, specially designed vacuum tubes detect and amplify small currents.

A good example of the calibrated electroscope type electrometer is an instrument used to measure accumulated dosages of radiation acquired by Civil Defense or atomic workers. This pocket dosimeter is illustrated in Fig. 1. A movable quartz fiber, plated to make it conducting and attached at both ends to a fixed wire element, is deflected away from this element by a charging voltage. The voltage is then removed and the fiber remains deflected until radiation ionizes the air surrounding it, allowing the charge to leak off and the quartz fiber to collapse toward the fixed wire element. The ionizing current required to collapse the fiber a given amount is calibrated in units of accumulated radiation.

The pocket dosimeter measures a given quantity of radiation. To measure the intensity of radiation, a vacuum-tube electrometer, coupled to a suitable probe unit (an ion chamber) is used. The ion chamber converts radiation into a minute electric current, which is measured by a vacuum-tube electrometer calibrated in units of radiation intensity.

The ion chamber is adapted to measuring very high intensities of radiation. Typical instruments have ranges of more than 500 roentgens/hour. The familiar Geiger counter, on the other hand, can measure only up to about 50 milliroentgens. (A roentgen is the intensity of radiation emitted by 1 gram of radium at a distance of 1 yard. A Geiger counter would be of little use in measuring the immense radiation intensities of an atom bomb explosion.

Earlier electrometers almost invariably used the deflected quartz fiber or gold leaf. Present day instruments use a specially designed electrometer tube, carefully constructed to minimize grid-current flow and stray leakage currents. One of the better instruments is currently being marketed for about $450.

If you could construct an electrometer of comparable quality for $30 or less, you could probably think of a lot of uses for it. If it were portable, you could use it as a high-sensitivity radiation detector. I used it as a detector of static electricity, to discover the best way to eliminate static charges on phonograph records. It would also be useful as a static detector in industrial machinery. It will measure the output of the negative-ion generators now being combined with air purifiers, and will detect radioactive ores.

Circuit

You can build such an electrometer, and without using any special components. The secret is a rather unique circuit that eliminates one of the bugs—boos of the vacuum-tube electrometer—grid-current flow.

The electron flow between the filament and positively-biased control grid of an ordinary electron tube decreases when one of the elements surrounding the control grid is given a negative charge. The size of the charge is determined by the proximity of the surrounding probe element to the control grid. A very small negative charge on the screen grid repels many electrons emitted by the filament and prevents them from reaching the control grid.

In practice, the electrometer (Fig. 2) consists of a 5Q4 tube, its 3-volt filament operated at close to 1 volt to obtain a control-grid current of 20 µA at a positive grid potential of 3. A known variable negative charge is now placed on the screen grid and the meter is calibrated in volts.

To measure ionizing current, the electrometer is charged and the voltage...
The underchassis view.

As the filament voltage regulation, although alkaline cells might be increased by subtracting the characteristic leakage current of the instrument, let the instrument warm up for about 45 minutes with the FUNCTION switch in the CHARGE position. This warmup period allows filament voltage to stabilize, and the constant charge on the grid and associated circuitry counters "insulator soak-in," or dielectric absorption, which might tend to make instrument leakage current appear rather high.

After the warmup period, place the FUNCTION switch in the READ position, ground the probe and reset the ZERO ADJUST control. Now, charge the instrument by momentarily rotating the FUNCTION switch from READ to CHARGE and back. The meter should stabilize slightly to the left of the higher voltage calibration. If not, recharge the instrument or readjust the CALIBRATE control.

Now, time the meter drop over 2 volts and calculate leakage current with the equation:

\[ I = \frac{V}{C} \]

where:
- \( I \) is the leakage current in amperes
- \( V \) is the voltage drop in volts
- \( C \) is the capacitance of the electrometer, typically millifarads (mF)

As overall probe-to-chassis capacitance of the electrometer is used in making current measurements, dress your leads as shown in the underchassis photo. If you have access to a capacitance bridge, you can measure the capacitance of the instrument when it is completed. In any case use stiff, tinned copper hookup wire for the probe-to-switch-to-socket connection, and dress all other leads well away from it.

The only portion of the circuit which is connected to the aluminum chassis is the positive terminal of the charging battery, BATT 2. The rest of the circuit must be well insulated from chassis.

As the filament voltage regulation is very important, especially for small current measurements, don't attempt to use ordinary dry cells for BATT 1. The mercury cells suggested have very good regulation, although alkaline cells might do the job too, and would be less expensive.

Calibration

The initial portion of the calibration procedure should, by rights, be a part of the construction section—the selection of R1. First, tack in a 75-ohm resistor as indicated in the schematic. Now, assemble the chassis, turn the FUNCTION switch to READ, and set ZERO ADJUST control R2 for a full-scale meter reading (zero volts charge). This should occur with R2 near its center position. If it doesn't the probe may have picked up a charge. Ground this charge by grasping the chassis in one hand and the probe bolt in the other. Now release the probe bolt first, then the chassis. If this doesn't remedy the situation, try other sizes of R1 until the meter reads full scale with the ZERO ADJUST control near midpoint.

Now calibrate the meter in volts by connecting a high-resistance dc voltmeter between probe bolt (negative) and chassis of the electrometer. Switch the FUNCTION switch to READ, ground the probe as described above and set the ZERO ADJUST control for a full-scale meter reading. Next, place the FUNCTION switch in the CHARGE position and adjust the CALIBRATE control for a half-scale meter reading. Note the voltage. Now adjust the CALIBRATE control for readings of 1 volt either side of half-scale and note the voltages.

Mark both the half-scale and the two 1-volt positions on the meter scale. Electrometer readings will be made by timing the meter drop through 2 volts. Finally, disconnect the voltmeter and, with the FUNCTION switch in the CHARGE position, set the CALIBRATE control so the meter rests slightly left of the higher voltage calibration.

Before measuring the characteristic leakage current of the electrometer, let the instrument warm up for about 45 minutes with the FUNCTION switch in the CHARGE position. This warmup period allows filament voltage to stabilize, and the constant charge on the probe and associated circuitry counters "insulator soak-in," or dielectric absorption, which might tend to make instrument leakage current appear rather high.
where \( I \) is the leakage current in amperes, \( C \) is the capacitance of the electrometer in farads, \( V \) is the voltage drop (2 volts) and \( t \) is the time in seconds. If you have a capacitance bridge, measure the probe-to-chassis capacitance of your electrometer and use this value in the equation. If not, use a value of 12\( \mu \)f, which should be very close if you have constructed the instrument as illustrated. In my electrometer, a 40-minute interval is required for a 2-volt loss of charge. This figures out to a minute interval is required for a 2-volt drop (2 volts) and \( t \) the time in seconds.

Using a mid-scale value of 12 volts, the leakage resistance of the instrument is:

\[
R = \frac{E}{I} = \frac{12}{1 \times 10^{-11}} = 12 \times 10^{10} \text{ ohms.}
\]

Leakage current will vary somewhat with humidity, but this figure shows that the instrument is capable of. If your figures show a much higher leakage than this, check to make sure probe wiring is well separated from the chassis and other components and wiring. Also make sure that no solder rosin lodged between switch contacts.

The graph, drawn to expedite current readings (Fig. 3), is laid out on 3 x 3-cycle log log graph paper and plots current against time. Basic leakage current of the electrometer will be a factor at figures of about 10 times this leakage current and below. Above this figure the graph will be a straight line. If you use a meter capacitance of 12 \( \mu \)f, the straight-line portion of your graph will be identical to that illustrated. For other values of electrometer capacitance, plot the graph from the equation:

\[
I = \frac{CV}{t}
\]

Subtract instrument leakage current from the calculated values below about 0.1 \( \mu \)a (0.1 \( \times \) 10\(^{-11}\) amperes).

An additional horizontal scale, calibrated in roentgens per hour (r/hr), may be added to the graph for radiation readings. Unfortunately, in its present form, the electrometer would read about 0.5 r/hr maximum. To increase this maximum reading we must add capacitance between probe and chassis and, while we are about it, we may as well make the radiation scale coincide with the current scale, giving us an instrument range of 0.1 to 10 r/hr.

The added probe-to-chassis capacitance is a 25-280-\( \mu \)f trimmer to which two tinned copper wire leads have been soldered. Terminate one of these leads with a miniature alligator clip, and solder the other to a lug mounted under one of the chassis screws. Theoretically, the total capacitance of the electrometer with trimmer attached should be about 175 \( \mu \)f to make the radiation and current scales coincide. Due to the added probe surface with trimmer attached, this capacitance will be greater.

\[
\text{IONS/cm}\text{ }^2/\text{SECOND} (\times 1000) \quad \text{IONS/cm}\text{ }^2/\text{SECOND} (\times 1000)
\]

The upper scale of the graph is plotted in ions per cubic centimeter per second, which is a standard unit for measuring the output of negative-ion generators. This scale was plotted on the assumption that the volume of air contributing mostly to electrometer discharge was approximately 250 cubic centimeters (based on the size of the instrument). This assumption is fairly accurate and in any case serves as a means of comparison between generators. This scale is also plotted logarithmically and, if you use an electrometer capacitance of 12 \( \mu \)f, will be identical to the graph of Fig. 3. For different values of electrometer capacitance use the equation:

\[
\text{Ions per cm}^2/\text{second} = \frac{CV}{4t \times 10^{-11}}
\]

where \( C \) is the capacitance of the electrometer with trimmer attached; \( V \) the voltage drop (2 volts) and \( t \) the time in seconds. This equation is derived from the fact that the product of \( CV \) is the charge in coulombs, and the charge on one electron (ion) is 1.6 \( \times \) 10\(^{-19}\) coulombs.

**Operation**

The electrometer is extremely sensitive to static charges. About the worst possible set of operating conditions would be an operator clothed in fuzzy wool or flannel, wearing rubber-soled shoes and working on a wool rug. The electrometer can measure radiation intensities from about .001 to 10 r/hr in two ranges. The lower range (trimmer capacitor disconnected) is not calibrated, but an extra logarithmic scale may be added to the graph using a current of 0.58 \( \mu \)a as the equivalent of .50 r/hr. Radioactive ores may be detected and compared by placing the ore near the probe.

While this instrument was not designed to cope with large quantities of radiation, but rather to measure minute currents, it can be a useful alarm for heavy and dangerous radiation. A 1-second discharge period corresponds roughly to 25 roentgens/hour, which means that a person could remain...
in the area safely for about 2 hours (see below). Discharge in half a second or less indicates that the area is definitely dangerous, and, if the needle drops immediately, radiation is probably present in lethal quantities.

Should it ever become necessary to measure fallout radiation, the following dosages, together with their probable effects on the human body, will be of interest:

Less than 50 roentgens (r) — relatively little risk
50–500 r — some injury and radiation sickness.
300–500 r — serious injury or death.
500–1000 r — death almost certain.
Above 1,000 r — death certain.

The figures are total-body dosages. A dosage of 1 roentgen being that acquired by exposure to an intensity of 1 r/hr for a period of 1 hour.

The electrometer can measure the output of a negative-ion generator:

As with all low-current measurements, allow the instrument to warm up for a period of 30–45 minutes. Now, with the generator operating in a closed room to eliminate spurious air currents, place the electrometer about 3 feet away, in the air flow of the generator. Charge the electrometer, note the voltage drop and use the graph to determine the output. Several readings should be taken, and a little practice will demonstrate where the instrument should be placed for the highest reading. I have found that ion generators produce a higher output after operating for 30 minutes or more.

Static charges of electricity may be detected at great distances with the aid of the electrometer. No warm-up period is required for this operation and the instrument should be operated with the probe discharged. As an example of its sensitivity to static electricity, run a hard rubber comb through your hair and bring the charged comb toward the electrometer probe. A sizable meter deflection can be obtained at a distance of up to 1 foot.

All examples to this point have dealt with negatively charged objects. What if a material bearing a positive charge is brought near the electrometer probe? You would expect the meter to indicate an increase in grid current. It does, momentarily. But when the positively-charged object is removed, the instrument acts as if it had acquired a negative charge—the meter is deflected several volts. The reason for this is simple.

When the charged object was held near the probe, electrons from the screen grid were attracted to the probe bolt, leaving the screen grid with a deficiency of electrons, or positive charge. This positive charge attracted electrons from the filament and, when the charged object was removed, the screen grid, probe bolt and associated wiring had a surplus of electrons, or a negative charge.

If you ever have had occasion to use an electrometer but couldn’t locate one, don’t let it happen again. If not, build this one anyhow—you never can tell when it will be a lifesaver!
collector. Operating at a nominal Zener voltage of 6, it insures equal amplification for each pulse. When the output pulse at the collector is positive-going, the Zener prevents it from exceeding 6 volts. This is shown by the flattening of the waveforms at the collector. The lower portion is leveled as the transistor collector reaches saturation. Thus, limits are set and pulses emerge with equal amplitude. This will hold true for input signals that might range between 10- and 500-volt amplitudes.

The Zener diode serves another function too. Any battery rated between 9 and 32 volts may power the circuit. Voltage is automatically reduced to the desired level by the Zener diode. This action also corrects small fluctuations that occur as the vehicle generator changes speed. (D2, a Hoffman RT-6, is a double-anode unit that consists of two Zener diodes back-to-back. This configuration sharply reduces the adverse effects of heating. The temperature coefficient of the pair is just a tiny fraction of that of a single diode.)

Now that pulse amplitude is made equal in all cases, the next section of the circuit can act upon pulse width. C2, D3 and D4 form another shaping network. The short time constant set by C2 produces the waveform shown at the junction of C2 and D4. (The negative-going dip of short duration.) Any positive-going component is shunted to ground by D3 while the desired signal moves on to the meter via D4.

The meter is calibrated directly in rpm. It measures the average voltage of incoming pulses. As pulse repetition rate rises with rpm, higher average voltage is indicated. Calibration control R5 is used to set the instrument for readings on any type ignition system.

Since the tachometer will operate over a wide range of signal input voltages, highly accurate calibration is possible with line voltage as a reference. A simple formula takes into account line frequency, number of engine cylinders and cycles. For example: for an 8-cylinder 4-cycle engine, R5 is used to set the meter to 900 rpm when input is 60-cycle house current.

END

WHAT'S YOUR EQ?

It’s stumper time again. Here are three little beauties that will give you a run for the money. They may look simple, but double-check your answers before you say you’ve solved them. For those that get stuck, or think that it just can’t be done, see the answers next month. If you’ve got an interesting or unusual answer send it to us. We are getting so many letters we can’t answer individual ones, but we’ll print the more interesting solutions (the ones the original authors never thought of). Also, we’re in the market for puzzlers and will pay $10 and up for each one accepted. Write to EQ Editor, Radio-Electronics, 154 West 14th St., New York, N. Y.

For answers to last month’s puzzle see page 58.

Forbidden Current Path

In this hookup, a standard ac ringer is so hooked up that the clapper makes a good contact with a pair of contacts at each end of its swing, putting the lamp across the line. Why doesn’t the lamp light when the bell is ringing and the clapper is making contact?—I. S. Kerstetter

Simple (?) Ac Problem

In the circuit shown two ac generators furnish the two voltages E1 and E2. E1 and E2 are both 100 volts (rms) 60 cycles, but E1 leads E2 by 90°. (In other words, the potential of point A with respect to ground G reaches its maximum or peak value one quarter-cycle earlier than the potential of point B with respect to G does.)

a. What will be the voltage between points A and B, and what will be the voltage between points D and G? b. Will it make any difference, as far as these two voltages are concerned,

Service Stinker No. 3

Look at the picture. What is the trouble? Horizontal phase diode out? Bad horizontal oscillator?—Jack Dorr

FEBRUARY, 1962
CAPTURE NATURE'S SOUNDS ON TAPE

It takes patience and practice to get a bird to sing for your tape recorder

By PETER PAUL KELLOGG*

EVERY YEAR HUNDREDS OF LETTERS COME to Cornell University asking about recording sounds in nature. Many come from people who think it might be interesting, but don't know how to start. Other letters come from those who have tried but are dissatisfied with the results. Many who started recording as a hobby combining their interests in electronics and the out-of-doors become so fascinated by the possibilities of making scientific contributions in the field of bio-acoustics that they have joined organizations or expeditions where their efforts have been very valuable.

This article shows how to get started with the simplest of equipment—perhaps with what you already have. Then we show how to improve and modify home equipment so it will be better suited to this rather special field. Here we are concerned with recording bird sounds. But the same principles also apply to almost every phase of natural history sound recording.

Basics of nature recording

Almost any recorder, even the inexpensive home types, will give pleasing results with a number of bird species. The trick is to get close. To do so, you can take advantage of normal bird behavior. First, try attracting your quarry by playing his voice back to him. You can also use any available recording of the same species. When birds are in the mood to sing, they often respond so well to a recorded song that it can be embarrassing. We have had wrens come right into the house. A semipalmated sandpiper searched between my boots looking for his rival as I stood near the loudspeaker, and a white-crowned sparrow sat on the rim of our parabolic reflector and sang when we played his song back to him on the edge of Hudson Bay.

The best way is to plan your attack a little ahead. As soon as you have evidence that a bird is interested in responding, get ready. Place your recorder in an open window or other hiding place with curtains drawn so you can see what is going on and can operate the recorder without being seen. Arrange the microphone in front of the window at a point close to where you expect the bird to alight. Arrange a convenient perch for the bird close to this point and cover or eliminate all other likely nearby perching places. If you want to be very realistic—and it often pays big dividends—place a small mirror near the perch.

Most home type recorders have only a built-in speaker but, if you have an auxiliary or external speaker, place it in the group with the perch, micro-

*Dr. Kellogg is Professor of Ornithology and Biological Acoustics in the Department of Conservation and assistant director of the Laboratory of Ornithology at Cornell University, Ithaca, N.Y. He began recording sounds in nature in 1929. This article has been amplified and brought up to date by the author from an earlier paper published in the Atlantic Naturalist and is used here with permission.
phone and mirror. Now put on your re-
corder a reel of tape on which you have
recorded three or four of the best avail-
able songs of the species you are after.
They don’t have to be top quality. Most
birds don’t seem to mind if the record-
ings are poor and very noisy by our
standards. Play through the three or
four songs and wait. If the bird flies in,
be prepared to record. If not, rewind the
tape and play it again. Success doesn’t
come every effort like this but it is a
real thrill once in a while.

Another technique worth trying is
to take advantage of song perches. Birds
are creatures of habit and sometimes
it almost seems as though they mark
out the boundaries of territory by flying
from one song perch to another, and
singing from each one. Watch for the

ready to work. Any packing box or a
pile of brush can be placed where you
propose to hide. If you see that these
changes do not bother the bird, then it
is a simple matter to arrange things
the way you want them without much
change in the appearance of things and
the bird will probably never notice you.

Extending your mike cable
You may be very successful with the
methods described above, but opportu-

nities will increase if you can lengthen
your microphone cable. This seems
simple, but it is not just a matter of
buying more cable and attaching it.
Doing this ruins the signal because of
added noise and sometimes introduces
frequency distortion as well. The secret
of using a long line from the micro-

phone is that the microphone and the
line must be low impedance. Most home
recorders are designed to use high-im-
pedance crystal microphones and short
lines. These microphones are usually
of poor quality.

Perhaps the best solution is to buy
a new low-impedance dynamic micro-
phone, a new shielded line of the desired
length and a transformer, to be used
close to the recorder, to match the low-
impedance microphone and line to the
higher impedance of the recorder input.

This may sound complicated to the
uninitiated, and certainly the person
considering it should have either some
familiarity with audio circuits or the
help and advice of an expert. This mod-
ification should cost between $50 and
$200, depending on the quality of mi-
crophone and transformer selected. Several
manufacturers offer special cable trans-
formers for this purpose. They are
spliced into the cable near the tape re-
corder.

Most important are shielding and
proper grounding if hum is to be

avoided. It is best to use 2-conductor
shielded cable between the microphone
and the transformer. Connect the mi-
crophone case to the shield at one end
and the transformer case at the other.
The signal leads from the microphone
run only to the transformer primary,
which is strapped to match the micro-
phone impedance, usually 50 to 200
ohms. It is sometimes tricky to con-
nect the transformer to the recorder
without introducing hum. Often it is
best to ground the shield at the trans-
former only through the ground lead
of the shielded cable. The shield goes
on to the body of the plug which goes
into the recorder (Fig. 1). If the trans-
former is not well shielded magneti-
cally, it may be desirable to orient it
with respect to the recorder to minimize
hum pickup.

Choosing a mike
Microphones are always a compro-
mise between output for a given signal
and the frequency range over which
they give a reasonably flat response.
Crystal units normally supplied with

home type recorders generally have
high output in the mid-range but poor
low- and high-frequency response. Any
effort to broaden the frequency response
usually decreases sensitivity.

Most bird-sound studies are made
with dynamic microphones. These in-
struments have the advantage of rea-
nsonable response over most useful fre-
quencies, fair output, great ruggedness.

Parabolic reflector suspended from tripod by soft rope can be used for following
birds in flight.

The little Water Ouzel sat right on the
microphone and sang within inches of
the diaphragm.
and low impedance which enables them to transmit energy over long lines with relatively little loss.

Ribbon microphones have many of the advantages of the dynamic type, but are usually heavier, not so rugged and very sensitive to wind disturbance. Capacitor (condenser) microphones have excellent frequency response throughout the entire spectrum. Many have useful output even at 100 ke and are used when exploring ultrasonic frequencies such as those encountered in studies of dogs, bats and some other mammals. The low output and extremely high impedance of capacitor microphones, plus the need for a high polarizing voltage, make it mandatory that the preamplifier, and usually the power supply, be located within inches of the microphone head. Until recently, this requirement almost excluded this microphone from the field. Now, with small, efficient transistor amplifiers and power supplies two companies (A.K.G. and Neumann) have offered capacitor microphone systems with battery-operated power supplies suitable for field use. Although these systems are expensive compared to simpler microphones, they are superior and will probably be popular with those who want the best available.

Parabolic reflectors

Parabolic reflectors are almost a necessity for anyone planning on doing much bird-song recording. However, they are expensive and cumbersome and have other limitations. The cost of a suitable unmounded aluminum parabola is about $50, but good ones can sometimes be found on the surplus market. The effectiveness of a parabolic reflector increases with size. A 40-inch parabola will collect about 1,600 times as much sound energy from the direction in which it is pointed as the microphone alone would do from the same point. Unfortunately, as the size of the reflector increases, so does the inconvenience of handling it. The choice of size is always a compromise. At Cornell we use mostly 40-inch reflectors with a 10-inch focal length, but for most bird songs a 36-inch reflector with a 10- or 12-inch focal length will be satisfactory. Smaller reflectors have poor low-frequency response, are less directional and pick up less sound energy from the source. Always mount the microphone at the focal point with its sensitive part facing the parabola, not the bird.

With a good reflector, properly adjusted to the microphone and correctly pointed, excellent recordings have been made of a bird song at distances of over 100 yards. This, however, requires excellent weather and noise conditions. In practice, distances of 25 to 100 feet are more usual. Better recordings should theoretically be possible when the microphone alone is within a couple of feet of the bird, but it is often impossible to tell the difference between recordings made with a parabola and with the microphone close up. Certainly, however, it is much less work to get a desired song when using a good parabola.

Portable recorders

Portable recorders are especially useful in bird-sound recording. According to our definition, a portable recorder is battery-powered and weighs less than 30 pounds. Such recorders, if quality instruments, are rather special and usually cost many times the price of home recorders. They vary from 8 to 20 pounds in weight and are marvels of electrical and mechanical perfection, comparing favorably with the finest professional studio machines. Most recorders in this class are designed for use with high-quality low-impedance microphones, and can readily be used with long or short microphone cables as the occasion demands.

Home type recorders can be used away from commercial power outlets if you use a converter to change the battery current available in a car to 60-cycle ac at 117 volts. This gives a much greater degree of freedom with this type of recorder and, when combined with a long microphone cable, it is possible to record in very remote places. Converters of this type cost between $50 and $100.

Tape speed

Some birds have very high-pitched songs and notes which begin or change with such suddenness that they are very difficult to record, even with the best professional equipment available today. Therefore, it is desirable to record at the highest tape speed available. Good recordings of many bird songs can be made at 7.5 ips, but many warblers and finches have song qualities which make them difficult to record even at 15 ips. We have found many advantages in using 15 ips and have standardized on it. We have modified many recorders to operate at this speed, and strongly recommend it for serious work.

Recording quality

In general, anything that causes a recorded bird song to be different from what is heard in the field should be avoided. This imposes a difficult problem because in the field we have sounds coming from all about us. Our ability to segregate these sounds and to concentrate on those coming from the bird, while disregarding sounds from all other directions, permits us to "hear through the noise" and to disregard it to a great extent. Recorders, unless they record stereophonically, receive sound through one microphone and play it back through one speaker. All sounds,
desired and undesired, come out from the same point and there is no chance for the ears to separate them or distinguish between them.

Noise mixed with the desired sound is perhaps the easiest fault to look for in a recording. However, there are two kinds of noise. One is in the environment when the recording was made. While this type of noise is not the fault of the person doing the recording, careful workers try to choose a time when such noises are lowest and do everything possible to minimize them. Wind sounds often help reduce the blast effect of the wind. One type fits tightly over the microphone and is usually purchased from the microphone manufacturer. The other, equally effective, is made from a tightly woven material, such as organza, cut to fit over the entire parabolic reflector and microphone, and held tight with an elastic hem. Electronic filters can often be used to reduce greatly the low frequencies of traffic and wind noise without affecting the bird songs. Fig. 2 shows a simple 1.5-ke high-pass filter that can be inserted between the recorder’s high-impedance input and a crystal mike or line-to-grid transformer. Especially effective are adjustable bandpass filters such as the Krohn-Hite, model 310-AB (Krohn-Hite, 580 Massachusetts Ave., Cambridge 39, Mass.) These filters permit the removal of objectionable low and high frequencies at the same time, but be sure you avoid cutting into the desired sound frequencies. If you don’t, you’ll get an unpleasant “thin” quality to the sound or may even eliminate important parts of the sound.

The second type of noise comes from the recording equipment itself and may vary from occasional or regular rumbles to steady hiss or hum. Distortion is usually distinguished from noise and defined as tones or frequencies in the recorded version which were not in the original. The ear will tolerate small amounts of distortion much more readily than it will tolerate noise. The more familiar the sound, the easier it is to detect distortion. In general, recorders having less than 2% or 3% distortion are very satisfactory. For analytical work, minimum distortion becomes more important.

Wow and flutter are caused by irregular motion of the tape as it passes over the magnetic heads. They are very objectionable because they can add trills and tremolos to a recorded bird sound. These faults are more likely to occur in low-grade recorders, but they can be caused by dirty parts or poor maintenance in good recorders. Again, these faults are more evident when listening to familiar sounds. Therefore, this type of imperfection is dangerous in bird-sound recording since, if we are not too familiar with the bird, the fault may pass unnoticed and be attributed to the bird.

Dynamic range

No recorder can handle as wide a range of sound intensities as the human ear can perceive. Therefore, there must

This young Golden Eagle came right up to the mike.

always be some compression in recorded sound if it has a wide dynamic range. Intensity is usually limited at the upper end by the same amount of distortion we are willing to tolerate. In modern professional recorders, this is usually set at 1% to 3%. In home recorders it may run much higher. The lower end of the dynamic range is determined by noise introduced by the equipment. With the best equipment, the dynamic range is usually satisfactory if not adequate for recording the total range of a great orchestra.

Frequency response

This characteristic has been left until last because so much emphasis is usually placed upon it. The frequencies to which human beings respond are between 20 and 20,000 cycles for young people. Older people tend to lose their responses to high frequencies first. It is questionable if many people, young or old, can detect the presence or absence of frequencies above 10,000 or 12,000 cycles in human voice—or in bird songs. In advertising, great emphasis is usually placed on uniformity of response throughout the sound spectrum. This may be desirable or even necessary for technical work involving the analysis of bird songs but it is not of great importance for listening to them, since most people are hard pressed to detect the difference in loudness represented by doubling the power of sound or cutting it in half. Such a change in loudness is referred to technically as a change of 3 decibels. Therefore, a system which is uniform throughout the spectrum within this 2-to-1 power range is satisfactory for all but critical measurements.

Care and use of recordings

Some system must be developed if tape recordings are to be of much use. As soon as possible after a recording is made, play it back. Pick out the parts to be saved, splice them together and erase the remainder. The Cornell Library of Natural Sounds has a separate reel for each species and all recordings of that species are given a cut number and added to that reel as soon as possible. Each cut is separated from the next by a foot or two of white, plastic leader tape, and a short announcement is spliced onto the beginning of each cut giving the scientific and common names, the cut number and the name of the person who made the recording. A separate editing sheet (Fig. 3) is prepared for each cut. On this sheet complete notes are kept showing all details of the recording, such as locality, date, time and background sounds, and especially information about the bird, its activities at the time and how it responded to the removal of objectionable low and high frequencies. If you don’t, you’ll get an unpleasant “thin” quality

FEBRUARY, 1962

Professional tape recorder for field recording and the one used by the author is the Nagra-III. Price is over $1,000.

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ing phonograph records with pictures. Some sound studies have indicated relationships of species. Others have related to bird behavior and might be thought of as vocabulary studies. Other studies show how voice changes when members of a species are isolated for long periods, such as has occurred sometimes with insular birds which are also represented on the mainland. Some studies have been made in search of beauty in bird song and the quest has led to every part of the world. Perhaps one of the most rewarding efforts is to select a single species and try to record and catalog all of its songs and calls—throughout the day, the season, the year and throughout the range. This is a big job, but eventually it must be done. Certainly it is fully as important as collecting specimens of the birds themselves and it will probably reveal just as many important facts.

Of the 6,000 species of birds in the world, hardly more than 1,000 have had any record made of their voices. Even in the United States many birds are still to be recorded. One of the most challenging of these has been Townsend's solitaire. It is a beautiful songster, as we found out this year.

I would like to suggest that if you should get seriously interested in the recording and study of bird songs, please consider permitting the Library of Natural Sounds at Cornell University to copy your tapes and include them in their collection, where they will be catalogued, preserved and made available for scientific study to scholars throughout the world and with credit to the contributor.

END

Suggested Reading on Technical Aspects of Recording


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**SHORT WAVE FORECAST**

**Jon. 15-Feb. 15**

By STANLEY LEINWOLL†

During late January and February the ionosphere is affected by three major changes in earth/sun relationships.

First, because of the lengthening hours of daylight in the northern hemisphere, the number of hours during which the higher daytime frequencies can be used for long-distance short-wave communication increases.

Second, as the distance between the earth and the sun increases, the intensity of ultraviolet radiation striking the ionosphere decreases. As a result, daytime MUF's fall from peak mid-winter levels.

Finally, because the sun is headed more directly overhead, its heating effects on the ionosphere increase, and the ionosphere expands.

The combination of an expanded ionosphere and the fact that there are fewer hours of night for recombination of ions and free electrons to take place results in an increase in maximum usable frequencies at night.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, in your local standard time.) The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

For example, a listener in Chicago would use the Central USA table. He would be most likely to hear broadcasts from West Europe in the 6 megacycle band at 8 pm, Central Standard Time.

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†Radio-frequency and propagation manager, RADIO FREE EUROPE.

*Reception may be very poor or impossible on this path at this hour.

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**GHOSTLY BATHTUB**

In the old days of radio, people occasionally heard voices or music coming from kitchen sinicks, metal rain gutters and downspouts or other pieces of metal sometimes miles away from radio stations. Now, in the age of TV, we have found a video counterpart of this phenomenon in an eerie green-glowing bathtub.

Recently, a husband woke up in his Kansas City home to see a greenish-white light coming from the bathroom. Investigation revealed the bathtub was luminescing.

Next night nothing happened. Then a week later it happened again. The next night it was gone. Each Wednesday night it happened. Finally he figured it out. Every Wednesday night his wife took a sun-lamp bath. The cast iron of the tub absorbed enough rays from the sun lamp to cause a long-persistence afterglow!—Walter Inman
There are three main detection systems—switching, matrixing, and envelope

By NORMAN H. CROWHURST

Present reactions to FM stereo vary from surprise to the skeptical whether it will ever be possible to get good quality with it. Actually, as several sensible, nontechnical people have already guessed, FM stereo is having the same kind of troubles stereo once had when it first came in.

It's no use to transmit stereo unless someone can listen to it. On the other hand, the adapter makers cannot field-test their products unless someone transmits. The real neck-sticker-outers of the hi-fi industry have gone ahead and designed the best adapters they knew how, with very little to go on. Initially, only one manufacturer had the advantage of advanced field testing.

So they worked with home-made generators, to simulate the transmitted signal, and made adapters that gave what they felt was acceptable separation, distortion, SCA (Subsidiary Communications Authorization) subcarrier rejection, etc. Mostly they started by trying the G-E or Zenith circuit. In some instances, they satisfied themselves with "optimizing" these circuits—making minor changes that improved performance. But in more cases they felt they could do better by trying for some completely new way of doing it.

This has resulted in a number of claims to having produced "unique" circuits, supposedly quite different from everybody else's. On the assumption that everybody else more or less copied G-E or Zenith, their claim to uniqueness may be supportable. But when one examines the various circuits, it seems they have mostly discovered the same things, independently, so they end up not being the least bit unique! However, it's to the credit of the industry that it has so many engineers who can think up and develop something original—even if they end up finding essentially the same things.

Detection methods

So far there are three main detection methods: switching, following the original Zenith concept; filtering, reinserting subcarrier into the L-R modulation, detecting and matrixing; envelope detection, utilizing the fact that, when the subcarrier is added in correct phase to the composite signal, the top of the envelope is left program waveform, while the bottom is right. Fig. 1 shows these three concepts.

The Zenith circuit used a beam-switching tube to switch from left to right. If a relatively large-amplitude, symmetrical-waveform switching signal (regenerated subcarrier) is used, we get square-wave switching. Close to the zero switching-waveform level, the entire signal is transferred from the "left" plate to the "right" plate, and back again (Fig. 2). Notice that, if left and right momentarily are of the same phase and magnitude, the output at each plate is a half-time sample of the waveform. But, if they are momentarily out of phase (and, say, approximately equal magnitude), the output at each plate is a succession of half-waves of 38 kc, with a peak value on the waveform for that channel (Fig. 3).

During half-cycles of the 38-kc switching waveform, in the case where L and R are identical (Fig. 3, top), each output gives the momentary waveform value for half the time—a complete half and half. When left and right are opposite (bottom), although the 38-kc switching occurs abruptly, a half-cycle of the received 38 kc appears in each output, whose peak touches the momentary waveform value for that side (L or R). The average value of this half wave will be less than the peak—representing some leak from left to right and vice versa. An averaging-type filter will cause the output in one channel to be affected by the output from the other.

The remedy for this is the injection of opposite channel—or composite—in opposite phase, so each channel is itself unaffected by the instantaneous value in the other (Fig. 4). This was shown in the original Zenith circuit.

In the cathode a small replica of L + R appears in opposite phase from the L and R appearing at the respective switching plates. By appropriate adjustment of values (or the slider on the cathode pot), this exactly neutralizes the "leak" from left to right and right to left, with a slight loss of "wanted" channel as well.

Scott and several others use, or have experimented with, essentially the same method, but with semiconductor diodes instead of a beam-switching tube.

Fig. 1—Comparison of the three basic detection methods developed to date.

Fig. 2—Switching method using beam-switching tube. Composite signal goes to control grid, switching frequency to beam-switching electrodes.
values.

The people who worked with filters and matrixing have been having troubles. As our previous article pointed out, it is not feasible to design a phase linear filter including high-pass function, which such a circuit needs. The frequencies above 23 kc have to be separated from those below 15 kc. Consequently, normal linear detection will not retrieve the L-R signal, correct in magnitude and phase at all audio frequencies.

What may be regarded as a slight misadjustment, or compensation, can get complete separation between left and right, after matrixing, at any one audio frequency. Careful adjustment, using the matrixing adjustment to get maximum separation at lower audio frequencies while the subcarrier reinserion phase is adjusted for maximum separation at the higher frequencies, can give acceptable separation throughout the audio range (Fig. 6).

It can never be perfect, however good the circuit design and adjustment. But it can be made fairly good, and it's more tolerant of tuner alignment errors that upset the output linearity than are some other circuits.

The third form of detection is the one most engineers have "discovered" independently. Each of the previously published circuits—Zenith, G-E and Scott—was unique. Although they are by no means identical, they have similarities. But each one has its individuality too. This third form—envelope detection—appears because it requires no filters at all for the stereo function (Fig. 7). More than a cost-saving device, this avoids the problems they bring, in correct alignment or setting values.

This method works on a very simple principle: if the regenerated subcarrier is added to the composite received signal in the correct phase, the left-channel waveform forms the top of the envelope and the right channel the bottom (Fig. 8). Detection is just a matter of having one detection element follow the top (positive) peaks and another the bottom (negative) peaks. As with the switching method, there is some slight interaction, equivalent to leakage, which can be offset by precisely similar methods.

Subcarrier regeneration

Every reception method calls for subcarrier regeneration. Every method also requires that the subcarrier be used in the correct phase. Otherwise separation suffers, and distortion may increase.

The term subcarrier regeneration is used for the whole operation of isolating the 19-ke pilot frequency from everything else and producing a 38-ke signal whose phase is correctly controlled by the 19-ke pilot. The method may simply frequency-double, or it may use a synchronized (locked) oscillator at either frequency—19 or 38 kc. The circuit configuration does not change very much. The difference that will identify which is used is usually in the coils. Where an oscillator is used, the coil either has a regenerative winding or the cathode is tapped up from ground on the grid winding—a cathode-coupled Hartley circuit.

A problem several ran into was...
that of satisfactorily separating the 19-ke pilot from everything above and below it. A high-Q tuned circuit is a big help, but several found this could also be influenced by the second harmonic of 9.5 ke in the program, and possibly the third harmonic of 6.4 ke. The presence of audio frequencies near these values could shift the subcarrier phase enough to cause considerable degradation of separation.

The solution is to use stages with very low distortion (which one would think they needed for high fidelity, anyway) before the pilot is separated from the rest. Some have used a 9.5-ke trap instead, but this seems the wrong way to do it.

Some preferred amplifying and doubling the pilot frequency to produce the subcarrier. They found that phase of the reinserted 38 ke varied less with signal level at the antenna than when they used an oscillator. But, of course, the regenerated subcarrier's magnitude fluctuates.

On simulated signal this may be all right. But field testing showed the magnitude fluctuation proved worse, at least in circuits using matrixing or envelope detection. The amplitude fluctuations in the subcarrier are indistinguishable from those caused by the received sidebands and get detected as noise.

After field tests, practically everyone has gone over to a synchronized oscillator in one form or another. Some use 10 ke, some 38 ke, as the oscillator frequency. Most are content with a curvature type doubler using the plate circuit of a tube that also serves as oscillator in its grid circuit. Fig. 9 shows such an arrangement with a pentode. Triodes have also been used this way.

A very good doubler, needing few parts beside a 12AU7, applies push-pull 19 ke to the 12AU7 grids and gets 38 ke at the common plates (Fig. 10).

Coupling between tuned circuits has been another problem. To get better selectivity or rejection of all but 19 ke, double-tuned circuits may be used. But it was difficult to find a coil or transformer manufacturer who knew how to wind an "undercoupled" coil for 19 ke. The same trouble may also account for some unnecessarily distorted 38-ke outputs.

SCA subcarrier rejection

A number of the circuits work quite well on transmissions without an SCA subcarrier as well as the stereo multiplex. But they run into trouble when tried out on a transmission with SCA subcarrier. Mostly it shows up, not as breakthrough, but as birdies. Several have tried putting in extra filtering to get rid of the 67-ke sidebands as well as the 67 ke itself (Fig. 11).

This works, as far as getting rid of the interference is concerned, but it poses more serious problems in gaining the phase linearity needed in the low-pass filter action, below 83 ke. And considerable rejection is needed, in most receivers, to get rid of the birdies over the whole range from 69 to 75 ke.

The rejection either may have to be so far down that any slope detection, as the frequency modulation shifts the nominal 67 ke through the range between 59 and 75 ke, does not produce enough amplitude-modulated output to be audible. From this viewpoint, it is better not to use any filters, because this avoids any slope detection (Fig. 12).

But to be completely "clean", the response at the output of the tuner needs to be flat out to 75 ke, which is a tough requirement.

Another possible cause of the birdies, and one which is doubtless responsible in many adapter circuits, is the presence of third and fourth harmonics of 19 ke, along with the wanted second—38 ke. These frequencies, 67 and 76 ke, beat with 67 ke to produce 10 and 9 ke, respectively. But when the 67 ke is modulated, the birdies "dip" to much lower frequencies, often to 1,000 cycles or lower.

Where this is the cause, the remedy is a much cleaner regenerated subcarrier, as well as whatever other measure is used to control what happens to the SCA subcarrier itself. Actual adapter circuits seem to have almost run the gamut of possible combinations of the features we have discussed: type of detection, method of subcarrier regeneration and procedure for SCA rejection.

Transmissions

Not to be overlooked among all the problems is the possibility that the transmissions used for reception and field testing may not be perfect. Lack of separation or other problems may not be caused by poor adapter design or alignment. It may be failure of the transmitter to conform to the FCC requirements about subcarrier phasing, or some other feature about the signal.

Although SCA subcarriers may have been overmodulated before stereo was introduced without trouble on monophonic transmission, now they could cause severe trouble unless the modulation is brought in line for stereo. The best solution for the station might be to forego the SCA revenue and concentrate on good stereo. Some adapter makers are hoping this will happen. But there's no guarantee. Meanwhile, if someone hears birdies, the adapter gets the blame.

As with stereo discs, at the beginning we needed both good discs and good pickups, so each could check the other. We got them before too long. Undoubtedly the same thing is happening with FM stereo.
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Spice-Can Audio Mixer

By JAMES A. FRED

THOSE spice cans in your wife's kitchen cabinet make handy containers for housing small electronic gadgets. You will also find other small cans such as bandage cans, 35-mm film cans, food containers around the home and shop.

I had been intending to make a two-input, one-output audio mixer for several years, but never seemed able to find volume controls small enough to fit into the real small spice cans. When I learned that Mallory had introduced a type MLC carbon control that was only \( \frac{3}{2} \) inch in diameter, I knew that it was time to build the audio mixer.

An audio mixer of this type is especially useful with an amplifier that only has one input jack. The mixer described will accept two signals, one from a microphone and a record player. Or one signal from a microphone and one from an electric guitar. For that matter, practically any two signals can be fed into the mixer where individual volume controls allow independent control of their amplitude. Thus you could have a musical background and, when you want to make an announcement, you merely turn up the gain on the microphone input and the microphone will override the music. Used with a tape recorder you dub in your voice with a musical background.

The first thing to do is to assemble the necessary parts. If your wife has saved a spice can for you, you are ready, but if she hasn't look through her stock and find one that is nearly empty. You can buy her a replacement on your next visit to the supermarket. I used phono jacks for the inputs and used a headphone plug for the output. You should use whatever type plugs and jacks fit your particular equipment.

The phone plug needed a modification and a small threaded addition to make it work. The phone plug is a Mallory type 85 miniature plug with an aluminum barrel. Modify it by cutting off \( \frac{5}{16} \) inch from the threaded end of the barrel. Then take a glass jewel assembly from a Dialco pilot-light assembly and cut \( \frac{5}{16} \) inch of the threaded portion off it. Screw this threaded portion into the short piece you cut off the barrel. Insert the threaded part of this assembly through the hole in the spice-can lid and screw on the hex nut that was part of the pilot-light assembly (Fig. 1).

Several circuits can be used. Two are shown that are quite different in action. The first (Fig. 2) is better if your inputs have equal amplitude. The other (Fig. 3) is preferable if you are using a high-output phonograph and a low-output microphone.

Make the holes in the spice can before painting it to cover up the advertising on the can. Mount the parts before the wiring is started. The input jacks and volume controls can be wired through the lid opening. The leads are very short so it won't be necessary to use any shielded wire. Short wires are left sticking out through the lid opening and are soldered to the output plug, and the lid is then pushed on. Now paint, apply decals or other printing and the audio mixer is ready to use. END
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dimensioned. This technique avoids overheating the electrodes and prevents them from becoming welded to the work.

Pulse equalizer: A circuit that produces output pulses of uniform size and shape in response to input pulses which may vary in size and shape. The one-shot multivibrator is often used for this purpose.

Pulse resolution: The minimum time separation between input pulses that will permit a circuit or component to respond properly. Many circuits will not respond to a second input pulse until the circuit has recovered from the effect of the first input pulse. This recovery time (pulse resolution) is usually specified in microseconds (usec) or milliseconds (msec).
plates connected to an rf oscillator. The material to be heated becomes the dielectric of a capacitor, and dielectric losses produce a temperature increase. This technique is used to bond plywood, cure rubber and soften plastics for molding operations.

Radiography: The process of obtaining an X-ray photograph. The object to be examined is placed between the X-ray tube and a sheet of photographic film. After penetrating the specimen in proportion to its density, the X-rays expose the film. When developed, the film shows a shadowlike picture of the internal structure of the specimen. Radiographic inspection is used industrially to inspect welded joints, locate internal flaws and air bubbles in metal castings, check alignment of internal components of complex assemblies, etc. When inspection speed is more important than fine detail and resolution, a fluorescent screen may be used instead of the film. This technique is known as fluoroscopy.

Register: (1) An electromechanical counter consisting of a set of numbered discs similar to those used to indicate automobile mileage. Each input pulse to the register energizes a solenoid which provides the mechanical force to advance the numbered discs. The register is widely used for product counting and packaging. In these applications, a moving part of the machine closes a switch (once for each operation), and the switch completes the circuit to the register solenoid. For counting objects moving along on a conveyor belt or assembly line, a photo-relay circuit activates the register as each object passes through a light beam.

(2) In computer terminology, a register is a circuit used to store a number while that number is being used in a calculation. Since the numbers are usually expressed in binary notation (a succession of ones and zeros), the register commonly consists of a number of flip-flop stages. Some of the stages are on to represent the ones of the binary system, and the other stages are off to represent the zeros.

Register control: A system of circuits and mechanical components used to control the relative position of a strip of material (paper, cloth, metal, etc.) with respect to the active parts of the machine through which the strip is passing. (See Photoelectric register control.)

**Fig. 24**—Rf energy is used for heating metals (a) and nonconductors (b).

The average TV technician has one very useful test instrument in his shop that doesn't get nearly as much wear and tear as it should. It will furnish a lot of very useful information about lots of circuits, if used when it should be. This is the milliammeter section of the shop's vom.

The typical shop vom is a pretty accurate instrument, or ought to be, usually with a 50-µa 250-mv basic meter movement. This gives us a voltmeter with 20,000-ohms-per-volt resistance.

Current ranges, which is what we're interested in, run from 50 µa up to 10 amperes. One typical unit has the following scales: 0 to 50 µa, 1 ma, 10 ma, 100 ma, 1,000 ma, and 10 amperes. This covers any reading you will need.

**Using the milliammeter**

What can we do with one of these? Quite a lot. For instance, one of the most important readings in a TV set is the cathode current of the horizontal output tube. By opening the cathode circuit and connecting the 500-ma vom scale in series with it, we can check the current to see if the new tube we just put in is going to last.

For instance, the 'BQ6 series should never draw more than 110 ma. Normal current should run from 70 to 100 ma. If you find the tube pulling about 120 ma, you can expect a callback at this address within 3 weeks. Correct currents for any other similar tube can be found in the tube manuals.

In stacked-B circuits, a milliammeter can often help locate those obscure defects that drive you mad. If voltages are all off, break the circuit at the audio tube cathode, or any other "source" of the low half, and measure the current there. There are two basic causes for low voltages—low supply voltages and overloads caused by something in the lower half drawing excessive currents. Hanging the milliammeter there will show whether the low voltage is caused by an overload.

To get normal current, pick some resistor in the circuit and calculate the current through it by Ohm's law. There is usually a small dropping or filter resistor somewhere in or around one of these circuits. For example, a cathode resistor in the audio tube's bias circuit. If it is about 500 ohms and has a 10-volt drop across it, current flow is 20 ma.

One item that seems to bug technicians is the little transistor radio. A milliammeter can be a big help when servicing these little monsters. Hook it in series with the battery and check the total current drain. This will give you a lot of helpful information in a hurry. If the current is lower than it ought to be, you've got a weak battery, incorrect bias on an audio transistor, open filter capacitor, etc. Too much current could mean a leaky filter capacitor, shorted transistor, incorrect bias on audio transistors, etc.

Hybrid and all-transistor auto radios are also easier to service with a current meter. If the fuse is blown, connect the 10-ampere scale of the meter in its place and turn the set on. If there's a short, it'll tell you right away. Be ready to turn the radio off in a hurry if that meter pointer seems headed for outer space. If there is something else wrong, such as an open transistor, open audio transformer, burned bias resistor, bias adjustment potentiometer set wrong and the like, current checks will tell you that, too. When replacing a power transistor, use the current meter to set the collector current of the new transistor to the correct value. Wrong operating currents will cause premature failure.

**SERVICE CLINIC**

Conducted by **JACK DARR**

**SERVICE CLINIC**

This column is for your service questions. We answer them free of charge and your name and address will be kept confidential if you wish. The main purpose is to help those working in electronics with their problems.

We've changed our target a little and are no longer restricted to TV. Radio, audio and industrial electronics problems are also grist for the mill. All letters get a prompt individual answer and the more interesting ones will be printed here. So if you have a service problem, send it first. We'll do our very best to help you solve it.
Blown B-plus fuses in TV sets can be checked by connecting the milliammeter in place of the fuse and reading the actual current. This is especially valuable if you suspect some kind of intermittent short in some of the power supply circuits. Set the meter on a scale high enough to prevent meter damage if a sudden short does show up. After you know it’s safe, you can drop down to the 100-ma scale and read the exact value of the current.

After you accustom yourself to the idea of reading currents instead of voltages in certain circuits, you’ll find that new uses for this section of the vom will suggest themselves all the time.

Stacked-B trouble

I have a DuMont RA-165 for repair. The picture is snowy and the sound is distorted on all stations. The contrast control must be fully advanced.

The 135-volt line is too high and the 270-volt line is too low.—J. S., Queens, N. Y.

This could be a voltage distribution problem, quite common in some sets with stacked-B circuits. This set takes the video i.f., part of the tuner and several other voltages from the audio stage (Fig. 1). The 150-volt line begins at the cathode of the 6W6 and supplies a lot of other things in the set. Shorts in the 6W6 can burn up the 220-ohm 2-watt resistor in the 270-volt line, upsetting the voltages. Normal resistor drift can upset the voltage divider in the grid of the 6W6—the 510,000 and 470,000-ohm resistors in series to ground, with the control grid tied to the tap. If the 470,000-ohm resistor to ground opens or if its resistance increases, the plate current flow of the 6W6 (which is the main factor in determining what the cathode voltage shall be) changes accordingly, and all the stages supplied by the 135-volt line are upset.

Snowy picture

A very snowy picture appears on the screen of a Westinghouse V-2313-25 chassis. Tubes are all good, plenty of signal from antenna, but I can’t get it...
AGC CONTROL

Fig. 1—The AGC circuit.

**AGC CONTROL TO VIDEO IF**

Fig. 2—The 18-megohm resistor often increases in value.

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Winegard Transistorized Electronic Powertron TV Antennas. 3 Models to Choose From.
This article describes the operation, construction and calibration of a device designed to improve the reliability of communications on the Citizens band. The system consists of two units—one at the receiving station and one at the transmitting station. The unit used at the called (receiving station) triggers a signaling device to alert the called station when a special signal is received. The system is simple to build and calibrate, noncritical in tuning and has been proved reliable during 6 months of operation.

Conditions on today's Citizens band are becoming more and more crowded and difficult. It is estimated that by the end of 1962 there will be more than 800,000 licensed stations. What this congestion will do to decrease the reliability of contacts is already evident in large metropolitan areas. A strong nearby station operating on an adjacent channel can easily drown out an important call on the monitored channel. If the operator is not listening carefully, the message goes unnoticed. This is especially significant to the many commercial CB users. We will describe a device which will partially solve these problems. It can be built for about $15.

The idea behind the system is very simple. The calling transmitter sends a tone over the air on the channel monitored. This tone is attenuated by a tuned filter system which eliminates the annoyance of having to listen to the conversation of other users. Second, the tone is easier to distinguish than a voice call when buried in noise and other conversations. When coupled to the decoder, a key tone as little as 2 db above the background noise is enough to alert the receiving operator. Third, when used on the radio-control channels, as much as 25 watts input can be used for signaling. This will really get through the 5-watt noise and extend the signaling range. The users can then switch to a clear channel for voice communication.

How the circuit works
The system itself consists of two units. The coder, actually a tone generator, is used at the transmitter. A decoder, actually a filter, demodulator, and relay combination, is used at the receiver. The choice of the triggering tone must be left to the individual constructor. We chose 440 cycles. This frequency was chosen because it is a widely used standard and tests for frequency devi-
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If electronics is the "field of opportunity," how is this possible? No question about it, electronics offers many opportunities, but only to qualified men. In any career field, it is how much you know that counts. This is particularly true in the fast moving field of electronics. The man without thorough technical education doesn't advance. Even men with intensive military technical training find their careers can be limited in civilian electronics.

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The decoder is a simple Colpitts sine-wave oscillator with modifications. Its frequency is determined by tank circuit T, C1 and C2 (Fig. 1). T is a transistor type audio output transformer. When its secondary is open, the frequency of oscillation is

\[
\frac{C_1 + C_2}{C_1 \cdot C_2} \cdot f = \frac{1}{2\pi L}
\]

when L is the inductance of the primary of T. However with the inclusion of R5 the frequency can be varied over a 2-to-1 range and set. This is possible because the resistor loads the transformer, effectively changing the inductance of the primary. R4 controls the output amplitude. The other resistors bias the transistor for proper operation. The battery can be between 1.5 and 9 volts, depending on the output required. Transistor V can be any p-n-p unit which can take 9 volts collector-to-emitter and has a beta (β) of 10 or better. All values shown are for a resonant frequency of 440 cycles. The circuit is quite stable and did not drift more than 1 cycle from 32°F to 120°F (the limits of our test).

The decoder consists of double-pi network filter followed by a half-wave demodulator (rectifier) coupled to a high-impedance relay (Fig. 2). Capacitor C1 blocks the dc from the plate circuit and passes the signal to choke CH, which is the 500-ohm center-tapped primary of a transistor output transformer. It’s secondary is left open. C2, C3 and C4 tune this winding to a resonant frequency (in our case 440 cycles). Diode D and C5 form a half-wave peak rectifier that provides a dc output to drive the sensitive relay—a 10-mw Advance unit with a 4,000-ohm coil. However, any high-impedance relay with 10-mw sensitivity is suitable. The contacts can be used to sound a buzzer or other signaling device.

Alignment and calibration

Alignment is simple if both the coder and decoder are constructed to resonate at approximately the same frequency. Use a dummy load for your transmitter during this procedure. First we must set the resonant frequencies exactly. This is done by tuning the coder to match the decoder. There are two ways to do this. The first requires no instruments other than a voltmeter and can be completed easily and quickly.

Plug the coder into the mike jack of your CB transmitter. Connect the decoder to the plate of the audio power amplifier tube of the receiver as shown in Fig. 3. Set the coder’s output amplitude control at maximum. Key the transmitter on.

Set the coder’s frequency control at maximum resistance. Slowly turn up the sensitivity control of the decoder until the relay trips. If the resonant frequencies are reasonably matched, this should occur at approximately half rotation. Place a dc voltmeter across the relay coil and adjust the frequency control of the coder for maximum voltage. Then turn the decoder’s sensitivity control back to zero and bring it up slowly as before. The relay should trip at a lower setting than before. The frequency controls are now set. Lower the coder’s amplitude control while raising the decoder’s sensitivity control. Adjust for maximum decoder sensitivity.

If a scope and audio generator are handy, a much more exact alignment is possible. Connect the scope’s vertical input across the filter’s output (across the relay coil) and set the signal generator at the frequency that produces maximum deflection on the scope (Fig. 4). This is the resonant frequency of the decoder’s filter. Apply the signal from the coder’s output into the horizontal plates of the scope. Adjust the coder frequency control until a slowly rotating ellipse is observed. The slower the better. Both coder and decoder are now matched.

Even if the circuits are designed perfectly from the standpoint of equations for resonance, one of the preceding methods must be used for optimum matching. This is because the components, particularly the transformers, may vary considerably from unit to unit or brand to brand.

A code frequency between 200 and 2,000 cycles should be used. They are easily passed by the audio circuits of the transceiver and are easily obtainable with standard components. We could have tabulated capacitor values to be used for a certain transformer for a set bandpass, but as mentioned previously component variation makes this futile.

The final model of the decoder was built into a small plastic box and the signal was taken through shielded...
cable from the plate of the audio tube through a switch which chooses either connection to the speaker or to the decoder. We used a loud buzzer for a signaling device.

The coder was first built in a haywire fashion. It was then calibrated as indicated. Pot settings were noted, then replaced with fixed resistors. To reduce size, subminiature high-capacitance ceramic capacitors replaced the usual paper units. The mounting frame was removed from the transformer and the whole unit shrunk enough to fit in a small pill bottle which we terminated on one end in a phone plug and an on-off pushbutton switch on the other.

When you want to call a station equipped with a decoder, plug in the coder into the mike jack, key the transmitter and switch on the coder. The transmitter may be keyed with a signal that indicates what channel to use for voice communication or “Come home—soup’s on.” This reduces air time.

On the receiving side, the decoder’s sensitivity is adjusted so that voice or noise does not trip the relay accidentally while even a weak key frequency tone will trigger the signal. A superhet receiver is needed to insure proper operation. It should also have some sort of squelch.

Either or both units have other uses too. The coder can act as an audio sine-wave generator or as a code-practice oscillator. The decoder could be used in any application where a tone-controlled response is required. END
audio generator fits your tube caddy

Portable 4-transistor unit is excellent for hi-fi work

By STANLEY E. BAMMEL

Here is an all-transistor wide-range sine wave audio generator. It covers 15 to 150,000 cycles in four slightly overlapping ranges. It is portable and just the thing for testing hi-fi equipment and is easily built from non-critical parts. The cost is relatively little.

The circuit is basically a Wien-bridge oscillator. Direct coupling throughout makes its wide frequency range possible, eliminates such problems as motorboating and reduces the cost. The Wien-bridge oscillator (Fig. 1) consists of an amplifier with a phase shift of 0° or 360° and a voltage gain of 3. Feedback is taken through the Wien bridge network which feeds a third of the output voltage back to the input. The oscillator works at the frequency at which the network gives a phase shift of zero.

Transistor V1 provides a high input impedance through the use of an unbypassed emitter resistor (Fig. 2). The input impedance of the stage is approximately R (B + 1) where R is the emitter resistor and B the ac beta of the transistor. All the 2N1265's I have tested have had an ac beta of 50 to 100. Therefore, the input impedance of this stage ranges between about 165,000 and 330,000 ohms. Negative feedback through R11 raises this impedance even higher.

V1 is biased through a network made up of R1, R6, R7, R9, R23 and R4-b. The network also limits the effective range of R4-b.

The signal is direct-coupled from V1's collector to V2's base. Returning V2's emitter to a tap on the battery is a convenient way of providing it with a low impedance at the proper voltage. This arrangement also allows a fairly high-value collector resistor for V1 which makes for high gain.

V2's output impedance is fairly high, so an emitter-follower or common-collector stage (analogous to a cathode follower in a tube circuit) is used at the output. This stage (V3) provides a low output impedance.

V4 in conjunction with the diodes and other components forms an automatic amplitude control. This is what makes the generator possible. Anyone who has tried to build a transistorized variable oscillator has undoubtedly run into the problem of providing a constant amplitude across the whole frequency range. V4 and the diodes take care of this.

V4 is normally biased to cutoff but, when oscillator amplitude goes high enough, it conducts on negative peaks. A pulse proportional to the excess amplitude appears at V4's emitter. This pulse is coupled through C10 to D1 and D2. These diodes rectify the pulse and apply a forward bias to D3 and D4. C11 and C12 filter the rectified current. As the forward bias on a semiconductor diode increases, its resistance decreases. Therefore, the resistances of D3 and D4 decrease and they pass some of the signal at V1's collector to ground through C11 and C12. When this happens, gain decreases. Overall, the circuit regulates output voltage within ±10%.

The extra components in the two high ranges are necessary to get the desired sweep of 10 to 1 per range. Without them, the ratio is only about 9 to 1 on the ×100 range and 4 to 1 on the ×1000 range.

Construction hints

I built my unit in a 3 x 4 x 6-inch chassis box. Anything with enough room on the front panel for the controls should be OK. Keep the leads in V1's base circuit as short and as isolated as possible because this is a high-impedance circuit. Otherwise, layout is not critical.

I mounted most of the small parts on a piece of phenolic board. The parts are mounted on one side and all connections are made on the other.

The oscillator should work with the values shown. It is not especially sensitive to variations in different transistors. In fact, almost any general-purpose transistors should be all right. The only exception may be V1. It should have as high a beta as possible.

If you build this circuit and find that it does not oscillate evenly over the whole range or will not oscillate at all (in the latter case, check for wiring errors first), raise the value of R11. This lowers the negative feedback and raises the overall gain. If you have difficulty getting it to oscillate on the low end of each range, lower the value of R5. If the difficulty is on the high end, lower the value of R29.

On the other hand, if the output is distorted, gain is too high. Lower the

Completed unit is only 2 inches deep.
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FEBRUARY, 1962
value of R11 or raise the value of R22 or R5.

These adjustments are fairly easy to make by adding resistors in parallel or in series. To lower the value, insert a relatively high value parallel resistor. To raise the value, insert a relatively low-value series resistor. Experiment until you have it exactly right.

Other adjustments that might be necessary may be the extra components in the two highest ranges. These values were determined experimentally and must be adjusted the same way.

The unit is easy to calibrate with the aid of an oscilloscope. Set the scope's horizontal sweep for line sweep and hook the generator's output to the vertical input terminals. With the RANGE switch on ×1, set the generator's FREQUENCY VERNIER for a stationary pattern. Now divide the number of vertical peaks on the scope screen by the number of horizontal peaks and multiply by 60 (F = \( \frac{H}{60} \times 60 \)).

The next higher range should be exactly 10 times the frequency of the lower. If the frequency is higher, more capacitance is needed; if lower, less capacitance.

If one range oscillates weakly, there is not enough feedback. If one is distorted, there is too much feedback and it is overpowering. In either case, the two capacitors for that range are not exactly equal, or at least they are not in the same relationship as the capacitors in the other ranges. If the capacitor in one leg (SI-b) is too large or the capacitor in the other leg (SI-a) is too small, there will not be enough feedback. If it is the other way around, there will be too much feedback.

All changes must be made in respect to all variables (frequency and amplitude). For instance, if the frequency is too high and there is not enough feedback, the total capacitance should be increased. To get more feedback, the capacitor selected by SI-a must be increased in value or the capacitor selected by SI-b must be decreased. Since you want to increase the total capacitance, increase the one selected by SI-a. In this way both problems can be solved with one change.

Capacitance can be adjusted in much the same way as resistance. This was

![Fig. 2—Four transistor circuit is straightforward and easy to build.](image-url)
Tape bias test adapter

By HAROLD REED

The little gadget described here will make it easy for the audiophile to check the bias current to the record head of his tape recorder as well as to measure the erase current flowing through the erase head. Also, it is one of those welcome time-savers for the service technician.

These measurements should be made if quality of reproduction from a recorded tape is below par or if erase of the tape is incomplete. The recommended procedure for measuring bias and erase currents is to break the ground side of the connections to the head and insert a 100-ohm resistor in this circuit—usually inconvenient.

Most recorders have standard phono jacks and plugs to connect the electronic section and the tape deck, with the jack mounted on the deck assembly.

The tiny test adapter consists of one of these jacks and plugs. The center conductors of these two items are connected with a short length of No. 14 bus wire. This size wire gives rigidity to the gadget. Spaghetti tubing slipped over the wire prevents shorting to the ground side. Then solder a 100-ohm resistor between the ground sides of the jack and plug, as shown in the photo.

To use the test adapter, remove the plug going to the head jack on the deck and plug it into the adapter jack. Insert the adapter plug into the head jack. Now, connect an audio vtm across the 100-ohm resistor with the high side of the vtm toward the head. Set the recorder in the record mode to place the bias oscillator in operation, and read the voltage drop across the resistor on the meter. The same procedure holds for either record or erase head measurements.

The bias or erase current, whichever is being measured, is determined by

\[ I = \frac{E \times 1000}{R} \]

where \( I \) is the current in milliamperes, \( R \) is the resistor value (100 ohms) and \( E \) is the voltage drop across \( R \).

Bias current will usually range from 0.5 to 1 ma, and erase current will run from 5 to 15 ma. Compare the results with the recommended values given in the service manual of the recorder.

Variations

The generator could be modified in several ways. For example, it could produce only a single fixed frequency. Simply substitute two fixed resistors for R4-a and R4-b and eliminate the range switch.

Another possible modification would replace the continuously variable frequency vernier with a step control. To do this, use a multi-position rotary switch and a group of fixed resistors to replace R4. Fig. 3 shows one possible arrangement. You might want to use different value resistors to get desired frequencies. But keep the resistors within the range of 5,000 to 50,000 ohms.

Fig. 3—This step frequency selector can be used instead of the continuously variable control shown in Fig. 2.
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FEBRUARY, 1962
CLOSED-CIRCUIT TV FOR THE SCHOOL

How an efficient low-cost system can be set up

By JACK BEEVER

CLOSED-CIRCUIT TELEVISION IS A VERY broad term, one that encompasses every use of a television camera and viewer that does not include a broadcast transmitter as part of the system. In complexity, it ranges from a simple camera and monitor connected by coaxial cable all the way to the state-wide educational systems, which include the coaxial cable linking of all schools within a school district, and the linking of school districts by microwave.

Microwave links do not eliminate the closed-circuit concept since a microwave transmission is not broadcast—it is point-to-point, and almost as private as a length of coaxial cable. The applications most interesting to us are in the small-business area. They extend from the simplest surveillance setup of a single camera to the largest in-building multiplex installation. Large building systems may involve a group of buildings on commonly owned ground—such as a college campus or a large hospital. Even prisons are adding complex CCTV systems.

A quick look at the most commonly talked-about application, the industrial camera and monitor setup, should clear the way for the more interesting multiplex automatic-studio systems.

The basic output of an industrial TV camera is composite video that contains currents from dc to as high as 8 mc, depending on the quality and adjustment of the camera. A video monitor accepts such signals and produces TV pictures from them. Therefore, if we connect a camera and monitor with coax cable, as in Fig. 1, we have a basic closed-circuit system. It provides a picture whose quality is limited by the characteristics of either the camera or monitor.

System limitations are:

▷ It provides no sound signal. Audio, if needed, must be provided by a separate system.
▷ It operates in a range of frequencies that includes power-line frequencies, and is subject to hum troubles due to ground loops. On long runs, grounding may become a problem.
▷ The cable can carry only one signal. It cannot be multiplexed.
▷ Due to the wide range of frequencies in use, the cable’s loss varies widely, and compensating amplifiers are needed if long runs are intended. These amplifiers have high gain at the high frequencies, and low or no gain at the lower frequencies.

The camera/monitor system also has advantages—don’t sell it short. Some of them are:

▷ It uses a minimum of apparatus.
▷ Maintenance costs are low.
▷ Installation is generally simple.
▷ Longer runs are possible without amplifiers than with rf systems.

Such systems are most commonly used for surveillance in factories, warehouses, department stores, banks, railroad yards and traffic control.

Educational CCTV

When you enter the educational field, new problems arise—you need flexibility and you can’t afford to get it by hiring a full-time crew of technicians and cameramen. The chances are that the equipment will be operated by instructors and students.

Let’s take a look at the requirements of a high school or preparatory school when the curriculum is aimed toward scientific or academic career building. Keep in mind that the main object is to “spread out” a teacher or an experiment. We might want to be able to place a camera in the physics, chemistry, biology or general science laboratory, gymnasium, assembly hall and any other special service rooms.

It is not necessary that these rooms all have cameras operating simultaneously, and since the camera is the most expensive single piece of equipment in closed-circuit systems, it is likely that the school’s budget cannot afford very many.

We need viewing devices—TV receivers or monitors—in every room where students assemble. We also need provisions to pipe off-the-air educational TV programs to every viewing location.

Take a look at what going video with simple camera and video monitors entails. You need coaxial cables from each camera location to a centrally located patch panel, a kind of telephone switchboard for coaxial cable. From this same point, cables would run to each room where monitors would be located—which means all rooms.

CCTV via rf

Such spiderweb wiring is extremely expensive and requires very large conduits or raceways and pull boxes. There is a less expensive and more flex-

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ible method—going rf—which means that you use self -originated programs modulating vhf carriers, just as is done in a TV broadcast.

Only one exception is made—you do not broadcast. Instead, you feed the vhf into a coaxial cable. And since you can multiplex on vhf, it is practical to run 10 channels on the same cable and, at a higher cost, up to 16 simultaneous channels.

The simplest form of vhf TV transmission is found in cameras such as the Argus (Radio-Electronics, Nov. 1959). It contains a built-in modulator and, when operating, puts out a 0.1-volt signal at any one of the low-band TV channels (2, 3, 4, 5 and 6). Such a signal can be sent over more than 1,000 feet of RG-59/U coaxial cable or 2,000 feet of RG-11/U before it falls below a level of 3,000 µV, and any television set will perform well on 3,000 µV.

However, the big improvement is that we can feed camera signals into the cable simultaneously, one on channel 2, another on 4 and still another on 6. Any standard TV receiver tapped onto that cable can show the picture of any of the cameras at will. A point to remember is that these cameras put out a double-sideband signal, so you can't use channel 3 when using 4, or channel 6 when using 6. If you did, you would be getting mixed up with the lower sidebands of the higher channel.

One big advantage of such systems is economy. Standard television receivers can be used and, thanks to mass production, they cost less than the technically simpler video monitors.

Video monitors, however, are usually of very high quality. They are classed as test instruments, and close tolerances are held in their construction.

Vhf distribution systems

For a school of any size to use off-the-air educational TV properly, it needs a television distribution system so the signals received can be piped into the various classrooms. This system does almost exactly the same job for off-the-air channels as was just described for the vhf-output cameras. As a matter of fact, if one of the off-the-air channel inputs is replaced by a camera with a vhf output, it will distribute this signal to all receivers in the building. The only thing it does not do is provide points of origination within the building itself.

One way of doing this (and the approach used in some early installations) is to install a system of coaxial cables originating in various rooms and terminating at some point convenient to the distribution system's head end (Fig. 2). Note that certain areas have been selected as input points for video signals from a camera so a camera operating in these rooms can feed its signals back to the head end location. At the head end, these cables end in patch-panel plugs, or coaxial connectors. Here they are made convenient to patch panel which allows the input of any camera to be connected to a modulator which produces a vhf carrier with the proper video modulation. This modulator is in actuality a miniature TV station and with a microphone and camera produces a signal.

With the system described, a number of modulators on different channels may be used to run simultaneous programming—the camera outputs going to the patch panel, from patch panel to modulator, and from modulator onto the television distribution system's head end. Signals are now available at any receiver within the building.

Another approach

This system is quite workable, but has limitations. The school planners must determine in advance what rooms are to be used for program origination. If too many rooms are chosen, the cost of coaxial cable becomes astronomical, since each camera input runs all the way to the head end or studio location. The system lacks flexibility and rapidly becomes cumbersome and expensive. Another approach uses only one cable passing from room to room and which can be used to transmit pictures in both directions. These pictures may originate in the building, from any room which has a television outlet.

This new system calls for a new concept in coaxial cable wiring. Basically, coax is a practical transmission line for all frequencies between dc and 300 mc. Above this range, losses of practical
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77
This modulator produces a complete vhf TV carrier. The strength of the rf output signal is 1 volt. Unit is made by Jerrold.

cables becomes too great and we get into trouble with amplifiers. However, in the usable band, coax is our own private broadcasting space, and we can do anything we like. We can broadcast TV on frequencies other than those assigned by the FCC, for instance. And just as channel 4 signals from New York City cross channel 3 signals from Philadelphia at Trenton, N.J., going in opposite directions, we can similarly broadcast two ways in our own private space, the coaxial cable. We must obey the physical laws, however. We cannot, for example, broadcast two channel-3 signals simultaneously. It confuses the TV receivers.

Four "extra" channels

Let's look at the unused spectrum space we have—the space not used by standard TV receivers or FM sets. Since TV uses frequencies between 54 and 88 mc and 174 and 216 mc, we have a good area below 54 mc where losses will be low. We can broadcast (in the cable) at these frequencies (called, in the trade, subchannels). Creating these subchannels is simple: we convert a standard TV channel to a subchannel by a simple heterodyne converter.

TV channels are 6 mc wide, but the job of working with TV is easier if there is a blank, unused channel between each working channel. Therefore, we find that we can easily have four channels below channel 2, which starts at 54 mc. For example, we could have channels which we'll designate 07, 09, 013, 015. Fig. 3 shows the frequencies chosen for these subchannels.

This arrangement has a secondary value since a single broad-band converter can change all these frequencies at one time, with one oscillator, to the high channels—7, 9, 11 and 13—an economy in some applications.

Since we can do these things, we need to look at devices for coupling into a coaxial cable which loops from room to room. This is not too easy if we stick to the concept of using a wall plate outlet which contains the necessary matching and isolation networks. It is likely to make it necessary to take out the plate whenever we wish to change the function in the room. For instance, to change from an rf receiver to a video monitor or camera, we would have to change the outlet circuitry. This is too cumbersome, especially for non-technical operating people.

One approach to this is simply to refrain from putting any works into the wall in the first place. Just bring out the cable ends and plug whatever devices you need between the ends. If the outlet is not to be used, merely

**Fig. 5—Bandpass filters used as splitter-mixers to separate or combine subchannels.**
WEAK SIGNAL?

READY FOR UHF?

TV & FM AMPLIFIERS

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<td>Indoor</td>
<td>24.95</td>
</tr>
<tr>
<td>IT-3</td>
<td>Home VHF/FM booster for up to 4 sets</td>
<td>12 db</td>
<td>Transistor</td>
<td>Indoor or Mast Mounted</td>
<td>33.00</td>
</tr>
<tr>
<td>AB-4</td>
<td>Home VHF/FM booster, battery powered, for up to 4 sets</td>
<td>12 db</td>
<td>Transistor</td>
<td>Indoor or Mast Mounted</td>
<td>29.95</td>
</tr>
<tr>
<td>AB-2</td>
<td>Home VHF mast mounted booster, Remote power supply</td>
<td>10 db</td>
<td>Tube</td>
<td>Mast Mounted</td>
<td>53.95</td>
</tr>
<tr>
<td>UB (70-75)</td>
<td>UHF booster (ch 70 thru 83)</td>
<td>15 db</td>
<td>2 Tubes</td>
<td>Mast Mounted</td>
<td>84.50</td>
</tr>
<tr>
<td>UB (72-76)</td>
<td>UHF booster (ch 72 thru 76)</td>
<td>21 db</td>
<td>2 Tubes</td>
<td>Mast Mounted</td>
<td>103.75</td>
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UHF CONVERTERS

<table>
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<tr>
<th>MODEL</th>
<th>IMPEDANCE</th>
<th>INPUT CHANNELS</th>
<th>OUTPUT CHANNELS</th>
<th>GAIN</th>
<th>LIST PRICE</th>
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<tbody>
<tr>
<td>BTC-99R</td>
<td>300 Ohm</td>
<td>4 thru 83</td>
<td>5 or 6</td>
<td>22.95</td>
<td></td>
</tr>
<tr>
<td>BTU-2S</td>
<td>300 Ohm</td>
<td>14 thru 83</td>
<td>5 or 6</td>
<td>5 to 8 db</td>
<td>39.95</td>
</tr>
<tr>
<td>BT-70</td>
<td>300 Ohm</td>
<td>70 thru 83</td>
<td>5 or 6</td>
<td>5 to 8 db</td>
<td>41.50</td>
</tr>
</tbody>
</table>

Where all other methods fail to bring in UHF channels, use the model UB-UHF amplifier with the BTC-99R, the BTU-25 converter, or any all channel (VHF and UHF) receiver.

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Fig. 6—Typical educational CCTV system layout.

Auxiliary equipment
Before a system can be designed around these concepts, some auxiliary pieces of equipment are necessary. One of these is a crossover network quite similar in function to the familiar crossover networks of the hi-fi fan, but working at an entirely different frequency range.

For reasons which will become clear later, we need a crossover at around 50 mc. Fig. 4 gives the schematic of a unit that matches 75 ohms (for coaxial cable) and splits all frequencies below 50 mc out at one terminal and all those above at the other.

Another requirement is met by a multiple bandpass filter (Fig. 5) designed to separate subchannels found in a cable to individual terminals. Once separated they may be processed separately. It can also be used to combine separate subchannels into a single cable. The usual splitters and pads (attenuators) found in vhf television distribution systems are also needed and we must be sure that these devices do not discriminate against the subchannel frequencies.

With these components we can build a system following the usual rules about distribution system layout. Fig. 6 is the circuit of a simple system we can study for its method of operation. Basically, we have a 7-channel TV distribution system. Each channel is amplified by an amplifier having automatic gain control. Such amplifiers hold their outputs within 1 db of the set level even if input changes as much as 20 db. The amplifiers are bridged in their output circuits so all seven signals appear in the cable leaving the top (channel 13) amplifier. Four are conventional off-the-air television signals—channels 7, 9, 11 and 13. (Don't worry about where you can find such a channel allocation in a given area—if you haven't got a usable setup like this, you can make one by rearranging the channels with vhf-to-vhf converters.)

The other three signals—2, 4 and 5—originate within the building. All signals proceed to the crossover network, entering through the leg that passes frequencies above 50 mc and emerging from the all-pass terminal.

From here, following the solid arrows, they go to the splitter and thus to the four branches of the system. These system branches have the outlets inverted at strategic points—and all outlets have an insert of some sort, either the proper network or a jumper plug.

So far, with the exception of the crossover network, we have a conventional TV distribution system. The difference comes with the cameras and modulators shown connected to outlets in branches B, C and D. These modulators either have subchannel outputs or...
Crystal-controlled converters.

else their outputs are converted to sub-channels.

By using the proper insertion plugs, the subchannel signal from the modulator of each camera is introduced into the system, the energy being sent back toward the amplifier, along the path indicated by dotted arrows. These plugs do not in any way interfere with vhf signals, which pass straight through. Arriving at the crossover network, the subchannel signals are shunted away from the amplifier outputs (which would interfere by acting as a tuned stub) and toward the bandpass filters (illustrated in Fig. 5). The bandpass filter splits them apart and feeds them to the proper converters, where they are converted to vhf channels 2, 4 and 5. From the converters, these vhf signals are sent to the amplifiers and return to the system as vhf signals.

Now, here is what we have. Any camera can be taken, with its modulator, to any outlet and its signal will be seen in every room where the receiver is turned to its channel. All cameras may be operated simultaneously without in any way affecting the others or the off-the-air channels. Note that the head-end equipment does not have to be touched—it is fully automatic.

How to get 16 channels

The system described uses only seven channels—the greatest number possible with ordinary vhf television receivers. This limitation is imposed by the lack of selectivity in the receivers, which cannot satisfactorily separate adjacent channels such as 2 and 3 or 7 and 8. As mentioned earlier, up to 16 channels may be used, but this requires additional apparatus.

Let us explain. The difficulty with adjacent channels is a beat produced in the video amplifier of the receiver between the aural (sound) carrier of the lower channel with the video carrier of the desired channel. This beat (heterodyne) is the difference between these two frequencies, 1.6 mc, and falls right into the video range, producing a herringbone pattern on the screen. The remedy is to lower the power of the audio carrier considerably. This reduces the power of the beat below a visible point since a beat note is always directly related to the weaker of the two signals producing it. This can be done with the audio signal because all TV receivers use an FM sound system, and have much surplus audio gain.

Reducing the audio carrier 10 to 14 db is enough, and is done as shown in Fig. 7. The two devices represented by blocks are an aural amplifier and a sound limiter, both with adjustable output levels. The signal to be regulated is brought into the sound limiter, where the sound carrier is stripped off. The video carrier and its sidebands are passed on to the age amplifier. In the sound limiter, the signal is amplified, limited (clipped) and its level set by an output controlling potentiometer. The video signals are amplified in the age amplifier and their levels set by the level control. The two signals are then mixed, with any ratio desired. The ratio needed is largely a function of the receivers used, and should be set up so that the worst receiver is out of trouble. In this way, the 12 vhf channels (2-13) can be used, and, if we add on the 4 subchannels, we have a 16-channel system.

The kind of system described has other features which greatly extend its use. For example, we could easily isolate any of its branches by removing a jumper plug, terminating the line coming from the direction of the head end, and then do anything we liked in the isolated branch—go video or go on-channel vhf, subchannel vhf, or use the cable for audio, alarm, or ringing a doorbell for that matter. At the splitter, we can interconnect any two branches and make an isolated interconnecting system. The possibilities are limited mostly by the user's imagination.

One of the desirable features from the viewpoint of the user is the freedom from obsolescence—a piece of cable doesn't readily go out of fashion—and that is all there is inside the walls. Anything else is external and can be installed as needed without labor expense.

So there you are, a new, simple concept which gives the system designer immense scope for his imagination. END
Ice formations are a problem on microwave relay, radar, vhf and uhf broadcast and on community TV antenna installations. Ice distorts the beam pattern, increases power losses through leakage and may cause hazardous loadings on the structure.

Several types of detectors have been developed to sound an alarm or turn on heaters after ice forms. The new early-warning ice alarm, developed by Hygrodynamics, Inc., 945 Selim Rd., Silver Spring, Md., monitors air temperature and precipitation and detects conditions—low temperature and precipitation—that favor ice formation. Thus, it actuates an alarm or turns on heaters before ice actually forms. This system is valuable in detecting incipient icing conditions around airports, turnpikes and other sites where advance warning of icing is important.

The circuit of the early-warning ice alarm is shown in Fig. 1. The detection unit, connected between the grid of the control tube and ground, consists of a precipitation detector and a Thermoswitch (Fig. 2) that closes at a critical predetermined temperature—generally around 35° to compensate for evaporative cooling. The two detector elements are in series so the alarm is operative until precipitation and freezing temperatures occur simultaneously.

The precipitation detector consists of two parallel coils of fine nichrome wire wound around the outside of a plastic tube. When the coils are dry, the resistance between the terminals is infinite. A drop of water shorts the coils together and the resistance drops to around 500,000 ohms.

A 2.8-watt 6-volt heater inside the detector coil form melts sleet or snow so the detector responds equally to all types of precipitation. It also keeps the detector warm to hasten drying so that it clears itself when precipitation stops. It is fed 6 volts through the cable shield. When temperature closes the Thermoswitch and precipitation shorts the detector coils, current flows from the upper end of the 6-volt winding through the relay, grid biasing resistor and detection head to ground. The voltage developed across the detection unit upset the bias on the grid and causes the relay to pull in and flash the alarm or operate an auxiliary relay to turn on heaters.

The 5-megohm pot enables the operator to adjust the threshold sensitivity to compensate for accumulation of dirt on the precipitation detector. The momentary switch is for testing the amplifier and alarm circuits.

The complete ice alarm system.

---

Fig. 1—Diagram of the circuit used to detect incipient icing conditions.

Fig. 2—Internal construction of the Fenwal Thermoswitch.
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Tiny silicon diodes, cadmium sulphide photocells and an acorn-size radio-control relay make it possible to construct photoelectric alarms much smaller than comparable units of a few years ago. Using the parts specified, you can construct a photoelectric alarm in the small plastic box in which the relay is shipped and still have room to spare. The alarm operates satisfactorily at 12 feet with a 50-watt lamp and a double convex lens to concentrate the beam. I used a Jewell relay (Lafayette F-260), Lafayette MS-827 photocell, a 1N538 silicon rectifier and a miniature pot and electrolytic.

HANDY TESTER FROM OLD RADIO
By using the circuit modification shown, any transformer type receiver can be used as an audio amplifier for testing tuners, preamplifiers, etc., for signal tracing or troubleshooting, and as a signal source for checking carphones, amplifiers and signal-operated relays.

The two jacks shown in the diagram can be placed anywhere on the chassis, but the closer to the takeoff point the better. If the connection between the grid lead and the AUDIO IN jack is more than a few inches long, the wire should be shielded. Remove the original coupling capacitor from the set and substitute two capacitors, C1 and C2, each having double the value of the capacitor removed. Installing two capacitors, one in series with each jack, eliminates the need for external coupling capacitors to the equipment being tested or used. When both plugs are removed, the two capacitors are connected in series to provide the original coupling capacitor value. (Note: Do not use this arrangement in ac-dc receivers, nor plug ac-dc equipment into the jacks because of the potential shock hazard.) —Louis Maggi

MODIFIED HEADLIGHT REMINDER
Here is my simplified version of the headlight reminder described on page 116 of the September 1961 issue. I've substituted a buzzer, made from a spdt relay, for the transistor oscillator and audio amplifier. Mount the buzzer at some point under the dash that provides a good sounding board. With the lights

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on and the ignition off, the coil circuit is completed through the normally closed contacts and the relay vibrates like a buzzer. When the ignition is turned on, the relay locks in through the normally open contact.

With a little effort, you can connect the buzzer to a separate speaker or to the radio speaker in the car. If you use the radio speaker, be careful to eliminate the possibility of shorting out the audio voltage or feeding high-voltage pulses from the buzzer into the radio's output circuit. —Thomas A. Markland

**NOVEL DC-TO-DC CONVERTER**

You can obtain 24 volts dc for surplus relays and other equipment from a 12-volt vibrator power supply by using the circuit shown. The added diodes form a full-wave rectifier that "adds" 12 volts to the battery voltage. Add a capacitor of a few hundred microfarads to smooth out the voltage on the 24-volt line.

This method of voltage doubling is adaptable to any voltage and current by appropriate choice of vibrator, diodes and transformer. A center-tapped choke can be substituted for the transformer if a B-plus voltage is not needed. —Richard L. Koelker

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Simple Short Locator

A few days ago one of the bench men was servicing a Philco 51-T1602. The filter choke was well cooked. After checking the filters—they tested good—he temporarily replaced them with new filters and a new choke, which was at least twice as big as the original. But when he turned on the set, the choke began to get hot.

Next, he unsoldered all leads from the electrolytic—section A in the sketch—and connected his multimeter (500-ma range) to A and then, one at a time, touched all the leads that had been connected to A with the meter's other lead. Result? Do you know anyone who wants to buy a vom with its needle wrapped around the pin?

Since then, I've developed a little gadget which tests for shorts, but uses pilot lamps rather than a meter—pilot lamps are much less expensive than meter movements. The simple circuit is shown in the diagram. Note that I actually have a four-range milliammeter. Of course, the unit will locate shorts that show up only under operating voltage, a very pleasant point to ponder.—Nate Silverman

Mounting Speakers

The service technician often finds himself confronted with a perplexing speaker replacement problem simply because the bracket, nuts and bolts supplied as mounting accessories will not fit. Usually this happens when the original speaker was held in place with metal screws driven directly into the magnet-shoe assembly.

The logical answer, it seems, is to drill identical holes in the replacement unit and go from there with the metal screws. But this is usually the road to ruin, for nine out of ten magnet shoe assemblies are at least ¼ inch thick. Drilled but untapped, the metal

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screw will go in for only a few turns and snap off.

The easy way out is to drill the mounting holes where they belong, making sure the drill size is just under the diameter of the metal screw to be used. Then countersink the hole with a drill larger than the body of the screw, to a depth, from the bottom of the hole, approximately the thread width of the metal screw. With this thread clearance, the screw will now be able to tap its way into the remaining bottom wall of the hole, cut clean and hold firmly.—George D. Philpott

CLIP INSULATOR IS TUBE PULLER

Need a tube puller to remove a hot or hard to reach tube? A Mueller No. 48 clip insulator makes a good substitute if you've misplaced your regular puller or it's busy elsewhere on the shop bench.—Joe Crane

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SEALING UHF LEAD-IN

Because uhf lead-ins of the oval and round types are hollow, moisture must be prevented from entering the tube. The usual method is to leave both ends of the lead-in open with the end connected to the antenna curved over the top of the mast, keeping rain out. A much surer method is to seal the ends. After the lead-in length has been determined, place the coil of wire in a gas or electric range oven which has been preheated to about 150°F. Allow the lead-in to remain in the shut-off oven for about an hour to dry out any moisture. Then seal both ends of the lead-in with a hot soldering iron. The polyethylene insulation melts readily and an airtight moistureproof seal results.

—Warren J Smith

(Continued from page 87) permanently moist soil means 10-foot units, which in turn means driving from a stage to get them started. Sledg-

ing at that height is a bit tricky and slow, hence we improved the old technique by fabricating a "drive bar-

rel" that can readily be manipulated by two men with a force equal to sledg-

ing.

The D-shape side handles are made of ½-inch cold-rolled stock torch-heated for bending in the blacksmith's vise. They were arc-welded to the barrel. It consists of an 18-inch length of 2-inch pipe into which is welded a 1-foot sec-

tion of 2-inch steel shafting with a 1½-

inch bore extending to within 1 inch of the upper end to form the ram section.

The bottom of the barrel has a skirt welded so the device can stand upright in tool truck or shed. An oval cap welded to the top serves as a hand grip as one man manipulates the ram while the second holds the rod steady in get-

ting it started plumb.

Once the rod is started straight, both men grip the side handles and proceed to alternately lift and slam down the device to penetrate most soils as effect-

ively as with a compressed-air tool.—

Paul C. Ziemke
MAKE COMPLAINTS PAY OFF

New York, N. Y.—Handle customer complaints immediately and you may save the customer. You spend money on advertising to get new customers, so why not spend a little to save one you already have. These words were part of a talk given by Jules W. Rubin, national advertising manager of Allied Radio, at a meeting of the American Management Association.

Another interesting point of the talk was Mr. Rubin’s statement that prompt action on a complaint, in addition to turning the complaining customer into a public relations representative for the firm, probably will convert the customer to one of the firm’s best sources of new business—he will recommend the company to friends.

If the customer has a complaint, real or imagined, and sees it handled quickly to his satisfaction, he will sing your praises.

AL MERRIAM DEAD

Elbert (Al) Merriam, national service manager of Symphonic Electronic Corp., died of a heart attack late in November. Service manager of Sylvania Home Electronics Corp. for years, he was known to numerous radio technicians throughout the country.

FREE ADS FOR TECHS

Aurora, Mo.—The local radio station, KSWM, is going to cooperate with TESA of SW Missouri by giving spot announcements plugging TESA and telling the public how to identify a TESA shop. TESA will boost the station by setting pushbuttons on car radios and home sets that have pushbuttons to the station when they service such sets.

TECHS NEED UPGRAADING

Harrisburg, Pa.—Upgrade your business to survive, was the message given to delegates of the Pennsylvania Federation of Television & Radio Service Associations by Edward Wimmer, vice president of the National Federation of Independent Businesses, to a meeting of the FTRSA in the Hotel Harrisburg.

Mr. Wimmer’s subject was “Unfair, Unjust Competition.” He included suggestions on how to upgrade a business: “Instead of spending your money on trading stamps and other gimmicks, lay a bright new rug on the floor of your store and put up a bright neon sign to let the public know you’ve in business. Paint the walls and ceiling in bright contrasting colors, and up

...and is priced amazingly low... only $39.50

Here is the answer to aggressive-minded technicians who seek a dependable, professional performing tube tester at a minimum cost. Hard-to-find tube defects are a snap for the Model 1100! It will test all the present tube types and all the new tube types... in fact any type you may possibly come across. It is so compact and versatile, the serviceman will want it at his side wherever he goes.

JUST CHECK THESE ADDITIONAL FEATURES

• Also tests battery type tubes, auto radio hybrid tubes, voltage regulators, foreign and hi-fi tubes, thyatrons and most industrial tube types
• Exclusive meter bridge circuit provides accuracy found only in the more expensive tube testers
• Will detect any short in a tube, even where internal pins are tied or heater is tapped
• Checks each section of multi-section tubes separately
• Long lasting phosphor bronze tube sockets
• Handsome too-tone etched aluminum panel
• Built-in 7-pin and 9-pin straighteners on panel
• The most complete tube chart conveniently located in cover
• New tube listings subscription service available
• Housed in handsome black leatherette case with a special lead compartment
• Small compact size: only 10¾ x 8½ x 3¼”.

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We are franchised dealers for most Hi-Fi lines. Most orders shipped promptly from stock. RECORDING TAPE at LOWEST PRICES. FREE 95 page STEREO CATALOG

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_AUDIO unlimited

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• LOWEST POSSIBLE QUOTATIONS
• FAST DELIVERY

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HI-FI RECORDING TAPE

Solder Free Record Supply. Free Catalog. Dept. 20, 30,000 cts., 12 day money-back guarantee.

1200' 7" polyester 9.20 9.17 9.11 9.05 9.02 9.00
1200' 7" acetate 9.20 9.17 9.11 9.05 9.02 9.00
1200' 7" Mylar 1.20 1.19 1.18 1.17 1.16 1.15

FREE 95 page Stereo Catalog. 192R Lex. Ave., Cor. 23 St., New York 16, N. Y. Visit Our Showroom

CARSTON 125-RD East 88 St. New York 28, N. Y.
grade your store to the point where your customers will find it a pleasure to walk in.”

**TEXAN ELECTRONICS**

*Weatherford, Tex.*—State tax on radio and electronic components has been repealed. A general retail sales tax has been replaced. Also repealed was the bond required of the service dealer and the technician.

This word comes from James M. Cotten of the Texas House of Representatives.

**COLOR TV TRAINING**

*Philadelphia, Pa.*—Almost 300 TV service technicians attended the second in a series of six seminars on the intricacies of maintenance and repair of color TV at the Drake Hotel.

A session is being held every three weeks, and every technician who completes the course successfully will be awarded a certificate stating that he is qualified to service and repair color TV sets. The program is being sponsored by Almo Radio Co.

Morris Green, president of Almo, pointed out that service follows sales and service dealers should be prepared to handle every technical problem.

Mr. Green said Almo has arranged for some of the top service engineers in the country to conduct the classes. These factory experts, he explained, would show service technicians every conceivable time-saving shortcut known in the color-TV field today, which in turn will benefit the customer, who will receive finer workmanship at a lower cost.

**TECHS AND TAPE**

*New York, N. Y.*—Service calls on tape recorders can be reduced if the customer is shown how to operate the device, according to Allan E. Bachman, executive vice president of the National Better Business Bureau. Although today’s tape recorder is not difficult to operate, he states, the customer should be shown exactly how to operate it. The Better Business Bureau has found that customer dissatisfaction with electronic and electrical equipment is due largely to lack of knowledge and understand- ing of how it works, rather than an inherent fault of the equipment itself.

**WEST COAST ROUNDUP**

*Oakland, Calif.*—Yellow Page advertising was the topic of a recent Alameda County Television & Radio Association meeting at the Driftwood Restaurant. Guest speaker was Jack Morris, assistant sales manager of Pacific Telephone & Telegraph directory advertising.

*Sacramento, Calif.*—This California State Electronics Association chapter discussed a system that would allow the association to provide service to the public on Sundays and holidays. The objective is to give the public confidence that when they call the association, they know that they will be referred to a firm that is reliable and can be trusted.

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Bench Servicing Made Easy

Bob Middleton’s new and really practical book on troubleshooting techniques. Here is a step-by-step guide to the location of defective components in any TV circuit you’re likely to run across—the kind of help servicemen want but haven’t found until now. Presents brand new material based on the author’s own workbench experience. Eleven big-help chapters. 160 pages; 8½ x 11”. Only $29.50

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Regulation of supply currents and voltages is an extremely important factor in today’s electronic equipment. This valuable book describes dozens of different methods for controlling power supply outputs. Covers circuit operation; discusses variations in design parameters to achieve desired results. Six fact-packed chapters. 192 pages; 8½ x 11”. Only $39.50

Servicing Transistor Radios, Vol. 10

Covers 53 models produced in 1960-61. Includes famous PHOTOFAX® Standard Notation Schematics, chassis photos, alignment instructions, parts lists and replacement data for each model. $29.50

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For TV & Auto Radio Controls

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- Servicing VCRs, Vol. 10 (TVM-10) $39.50
- Replacement Control Guide, Vol. 4 (RGC-4) $10.00

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- (outside U.S.A. priced slightly higher)
WITH SEMICONDUCTORS AT THE REINS WE start with a group of germanium units for FM radios, continue along with a uhf oscillator, break stride on three TV horizontal output tubes and wind up with a group of flat conduction-cooled selenium rectifiers.

2N2089, 2N2090, 2N2091

These three germanium transistors are designed for use as an rf amplifier, oscillator-mixer and if amplifier, respectively, for FM and FM-AM radios. All three are post alloy diffusion transistors (PADT). They feature low collector leakage, high current gain, high $f_{	ext{max}}$ and a high collector-base breakdown voltage. Also, they will work well even when supply voltages are as low as 3 volts.

The 2N2089 is controlled for low noise and high power gain at 100 mc. The 2N2090 features high conversion gain up to 100 mc. The 2N2091 has low output capacitance and conductance at 10.7 mc as well as low noise and good age performance.

Maximum ratings of these Ampex transistors are:

<table>
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<tr>
<th>Transistor</th>
<th>$V_C$</th>
<th>$I_C$</th>
<th>$P_C$</th>
<th>$I_E$</th>
<th>$P_E$</th>
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<tr>
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<td>20</td>
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<td>11</td>
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<td>2N2091</td>
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Characteristics of these transistors are:

<table>
<thead>
<tr>
<th>Transistor</th>
<th>$NF$ (noise figure)</th>
<th>$r_{	ext{oc}}$ (typical $db$)</th>
<th>$f_{	ext{max}}$</th>
<th>$Z_{	ext{in}}$ (Base impedance, ohms)</th>
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<tr>
<td>2N2089</td>
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T2028

Here is a germanium micro-alloy diffused-base transistor (MADT) designed for use as either a vhf or uhf amplifier in communication and radar circuits operating at frequencies up to

---

**For The Independent Serviceman Who Wants To Be Truly Independent**

**The New Lafayette Associate Store Program Offers You A Most Unusual Opportunity To Own Your Own Business**

If you have a basic knowledge of radio, television or electronics, and if you have ambitions for true independence and security, a Lafayette Radio Electronics Associate Store can be the beginning of a profitable and respected career. With the past year, Lafayette Radio Electronics began to explore the possibility of expanding on a nationwide basis. Twenty men such as you (some with established stores, some with little or no business experience) were granted associate store franchises. They have been given the benefit of Lafayette's many years of experience selling stereo kits, citizen band radios, recorders, science and electronics kits, tools, components, hobby supplies, television repair equipment and all the other things that make this the fastest growing industry in the country. Today, every one of these men is the owner of a thriving business and is well on his way to a better way of life. (A list of these successful associates is available on request.) As a result of this success, Lafayette has decided to expand the program. We are now looking for a limited number of men who are willing to invest at least $10,000 to get the things they've always wanted out of life: travel, new home, new car, education for the children, security of their own business. For more information on how you can own a profitable business, fill out and mail the coupon below and find out more about Lafayette's:

**Protected Territory** Yours will be the only franchised Lafayette Radio Electronics Associate Store in your marketing area. This means that when your customers want the advertised and branded merchandise supplied by Lafayette, they'll come to you. **Marketing Direction** With the knowledge gained from past successes, we will help you set up a complete program, from choosing the right location, to designing your store for maximum profits, to setting up your inventory. **Executive Guidance** Our program will help you function effectively in the day to day operations of your store. We'll show you how to deal with customers, how to establish a large, loyal following, how to build public relations. In short, Lafayette will show you how to be the kind of responsible executive who is a success in business, a leader in the community. Advertising Support Millions of dollars have been spent to establish Lafayette Radio Electronics and its franchised dealers as the primary source for electronics, radio and science equipment. The Lafayette sign in front of your store will indicate to everyone that you are associated with a multi-million dollar organization, one of the largest of its kind in the world. Furthermore, all-year round advertising, public relations and promotion campaigns will continue to send customers to your store. Fill out and mail this coupon today. This can be the beginning of a new way of life.

Lafayette Radio Electronics Corporation

165-08 Liberty Avenue, Jamaica 33, New York

Mr. Robert Laub

Please send me full information on how I can own my own profitable business.

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FEBRUARY, 1962
Duotone needles, of course... tipped with genuine diamonds, sapphires or osmium. Most people forget to change their stylus or don't know how to change them. Why not suggest a Duotone diamond needle replacement for every phonograph that comes into your shop? It’s the stylus with the whole diamond tip that’s handset and hand polished. Your customers will appreciate the service and you’ll appreciate the increase in business.

Write for Free 1962 Duotone Needle Wall Chart and see DUOTONE Distributor. DUOTONE COMPANY, INC. KEYPORT, N. J.

800 mc. The high maximum frequency of oscillation (typically 1600 mc) and exceptionally low noise figure assure proper operation in such circuits.

Maximum ratings of the Philco T2028 are:

- $V_{cc}$ = 20
- $V_{es}$ = 20
- $I_{cc}$ = 0.5
- $P_{max}$ (mw) = 60

High-frequency characteristics when $V_{cc}$ = -10.4, $I_{cc}$ = -1.3 ma and $f$ = 200 mc are:

- $P_{G}$ (power gain, typical db) = 18
- 3 db broadband (typical mc) = 9
- $NF$ (noise figure, typical db) = 4.0

6GJ5, 12GJ5, 17GJ5

These three tubes comprise a series of high-pervenance beam power tubes intended for use as the horizontal deflection amplifier in TV receivers. They come in a Novar envelope. All three are identical except for heater ratings:

- 6GJ5: 6.3 volts, 1.2 amps for the 6GJ5; 12.6 volts, 800 ma for the 12GJ5 and 16.8 volts, 450 ma for the 17GJ5.
- 12GJ5 and 17GJ5 have an 11-second controlled warmup for use in series-string heater circuits.

Maximum ratings for these RCA tubes in horizontal deflection amplifier service are:

- $V_{cc}$ (boost plus dc power supply) = 770
- $I_{cc}$ (peak positive-pulse) = 6,500
- $I_{cc}$ (peak negative-pulse) = 1,500
- $V_{ce}$ = 220
- $I_{cc}$ (peak negative-pulse) = 55
- $I_{ce}$ (peak ma) = 330
- $I_{cc}$ (average ma) = 175
- $I_{cc}$ (input watts) = 17.5

Flat selenium rectifiers

New line of flat conduction-cooled selenium rectifiers have been announced by Radio Receptor. Currently available units include half-wave, doubler and bridge arrangements in single- or three-phase circuits for voltages up to 120 rms and current outputs to 10 amps dc. These units are only a quarter the size of equivalent air-cooled units.
DON'T TURN ANOTHER PAGE until you clip out this coupon! It could be the turning point in your life!

Make More Money Soon... with Electronics!

This handy 31-page book tells you all you need to know to pass the 3rd class FCC Radiotelephone examination, qualifying you to operate radio-telephone transmitting stations used by airlines, police, railroads, emergency services, etc.

Central Technical Institute's 64-page book on electronics is packed with free information on amazing career opportunities for you in: Industrial Electronics, Automation, Radio, Color TV, Radio-TV Broadcasting, Electrical Wiring, Appliance Servicing, Communications Electronics, Radar, Missiles, Computers, Nuclear Energy, and many others! This free book tells all about Central Technical Institute's different NEW Home Study Course, "PRACTICAL ELECTRONICS." This Home Study course is so complete, it even contains instructions on how to set up and run your own electronics servicing business. FREE "PROFITS FROM ELECTRONICS" book also contains full information on Central's new Instant Kits, below. All you need to do to get this valuable book is fill in your name and address on the above coupon, and MAIL IT TODAY!

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Study at home in spare time—no High School diploma required!

With a sincere desire to get ahead, make more money and enjoy an interesting career... you can earn while you learn, keep your present job, and set your own pace. Find out how much fun electronics can be! See how you can add to your income! High income, prestige, and security for you and your family can be yours! Don't let a 4c stamp stand in your way. MAIL THE ABOVE COUPON TODAY and GET YOUR 2 FREE BOOKS NOW. The little time you spend mailing this coupon may be one of the best investments you'll ever make!

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Kansas City 8, Mo.
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FEBRUARY, 1962
HOW TO BUILD ELECTRONIC EQUIPMENT by J. Richard Johnson. Whether electronic equipment is your hobby or you are called upon to build it as an engineer or technician, this book will help you do a better, cleaner job and get the most out of the equipment you are building. While it provides complete instructions on how to build electronic equipment starting from the schematic diagram, the kit-layout — not quite ready to build equipment — will also get better results. Presented in the order in which things were done in a typical project, the book starts with an explanation of what typical electronic equipment looks like. It progresses to a coverage of the tools and materials, the selection and working of the chassis, layout, checking, painting, marking and calibrating. #286 hard-cover, $4.95.

ELECTRONIC EQUIPMENT MADE EASY FOR THE BOAT OWNER by John D. Lents. The first book that takes the mystery out of pleasure craft electronics. It provides a working knowledge of what marine electronic equipment is available; what it will do; how it operates; how to install it; how to buy it intelligently and how to use the instruments effectively. An important feature of the book is the recommended equipment chart which includes all types of equipment — tube or transistorized. #287 hard-back, 200 pages, $5.95.

FUNDAMENTALS OF ROCKETS, MISSILES & SPACECRAFT by Marvin Hulst. This book is the entire story of rocketry from its early days. It treats the theory and applications of the basic elements of rockets, missiles and propulsion systems for space vehicles as well as both manned and unmanned spacecraft. The fundamentals of solid and liquid propellents, rocket engine components, basic rocket propulsion concepts. Ideal for those entering the field of space electronics. #278, hardback, $8.95.

TUBES AND ELECTRODES — TUBE SUBSTITUTION GUIDEBOOK — 1962 EDITION by H. A. Middleton. Direct receiving tube substitutions only — plus added new feature, 1960 direct CRT substitutions. The new, 1962 edition of this remarkable "tool", designed for the serviceman's tube caddy, carries a greatly increased number of direct receiving tube replacements. It lists new tubes that replace older tubes, and in turn can be replaced by older tubes. 16-page section of direct CRT substitutions has been added, #279, still only 90c.

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in a hurry
to get ahead

now hear this...
these outstanding features lead a fleet of important articles in Radio-Electronics

next month

nary careers in electronics
It was used to “Join the Navy and See the World” — now you can discover or explore a world of electronics in the new Navy (or other branch of the service). There are so many opportunities for education and advancement. This article outlines them all.

pinpoint color tv faults
Servicing color can be complex—but this pithy article shows you how to track down any trouble faster. From there on—the job is simple.

simplest signal injector
Remember the noise injector? This atomic age version looks like an ordinary probe. Contains its own batteries and two transistors. Tremendously helpful in all forms of servicing.

using the tv check tube
Can you use one check tube for all TV sets? If so—which one? There are at least four on the market now. This story tells you which one and shows you how.

closed circuit tv in the photo studio
How one photographer uses TV to "preview" photos of his portrait subjects and show them instant proofs.

march issue
Radio-Electronics
on sale—feb 20
A new day is dawning in electronics. Transistors are here to stay... they are now being used everywhere; in radio, television, Hi-Fi, intercoms, and in nearly all new electronic equipment...

Why put off transistor circuit servicing any longer... there's gold in them thar hills. But you must be equipped to do the job fast and efficiently. Here are the tools that you will need.

NEW SENCORE TRANSISTOR-MASTER

This Tester will analyze the entire circuit in minutes and test transistors in-circuit or out of circuit. Here is how you can pin point troubles step by step.

First, check the batteries with the 0 to 12 volt meter. If the batteries are O.K., check the current drain with the 0 to 50 milliamp meter. A special probe is provided so that you do not need to break the circuit. Excessive current indicates a short; low current indicates an open stage or cracked board. All PF schematics indicate average current.

If trouble is not located by now, isolate the trouble to a specific stage by touching the output of the harmonic generator to the base of each transistor and note spot where sound from speaker (or scope where no speaker is used) stops or becomes weak. The generator becomes a sine wave generator for audio stages to help find distortion.

If trouble points to a transistor, check it in a jiffy with the exclusive in-circuit power oscillator check provided by the TR110. A special probe is also provided for this.

If the transistor checks bad in-circuit, remove it and give it an out of circuit check with the oscillator check or the more accurate DC check. The DC check is provided for comparison reasons, experimental or engineering work and to match transistors in audio output stages. Beta (current gain) is read direct or on a good-bad scale for service work.

DEALER NET. ONLY $4.95

NEW SENCORE TRANSISTOR AND DIODE CHECKER

Here is a low cost tester that has become America's favorite. The TR115 provides the same DC out of circuit checks as the TR110; leakage and current gain. Beta (current gain) can also be read direct or as good or bad. Open or shorts in the transistor are spotted in a minute. The TR115 checks them all from power transistors to the small hearing aid type. Japanese equivalents are listed also. This famous tester is used by such companies as Sears Roebuck, Bell Telephone and Commonwealth Edison. New circuits enable you to make service checks without set-up charts even though charts are provided for critical checks.

Model TR115 Dealer Net $19.95

SENCORE BATTERY ELIMINATOR AND TROUBLE SHOOTER

For replacing batteries during repair. Many servicemen say that they wouldn't service transistor circuits without this power supply. The tried and proven PS103 is a sure fire answer. It can be used to charge the nickel cadmium batteries as well. Dial the desired output from 0 to 24 volts DC and read on meter. Low ripple ensures no hum or feedback. Total current drawn can also be read on the PS103 by merely flicking the function switch to milliamps. The PS103 is the only supply that will operate radios with tapped battery supplies such as Philco, Sylvania and Motorola. No other supply has a third lead.

Model PS103 Dealer Net $19.95

Now in stock at your Authorized Sencore Distributor
NEW PRODUCTS

EMC advances in Audio and Test Equipment — by far the Best Values obtainable in Wired or Kit form.

EMC Model 801
RC Bridge and In-Circuit Capacity Checker
A new comprehensive resistance and capacity checker, it measures condensers for actual value, leakage, and power factor. It measures condensers while still connected in their original circuits for open, shorts or intermittents. Model 801 Wired ... $38.95 — Model 801 Kit ... $24.95

EMC Model 802
Signal Tracer and Generator
Generates its own audio, RF and HF signal for tracing. Uses both magic eye tube and a speaker for signal detection. Checks noisy components. Checks and compares magnetic, ceramic and crystal cartridges. Supplied with two shielded audio probes and RF crystal-demodulator probe. Model 802 Wired ... $38.95 — Model 802 Kit ... $24.95

EMC Model 107A
Peak x Peak Reading Vacuum Tube Volt-Ohm
6-inch meter cannot burn out — entirely electronic. Measures peak to peak AC voltages to 2600 volts in 6 ranges. Measures capacity in 6 ranges from 50 mmfd to 5000 mmfd. Measures resistance in 6 ranges from ohm to 1000 megohms. Measures DC volts to 1000 volts in 6 ranges. Input resistance 15.5 megohms. Model 107A Wired ... $31.40 — Model 107A Kit ... $26.50

EMC Model 214 Stereo Amplifier
A compact, highly attractive dual 14W amplifier with built-in preamplifiers having 56 watts peak power output. Has rumble filter and contour control switch. Extremely low distortion and noise level. It can be used as a 28 watts (56 watts peak) monaural amplifier or as a monaural amplifier so arranged that one preamplifier is used to drive the internal amplifier while the other preamplifier is used to drive any existing monaural amplifier. Model 214 Wired ... $106.80 — Model 214 Kit ... $68.90

Yes, tell me more, send me FREE a detailed catalog of the Complete EMC Line. Dept. RE-262

EMC Electric Measurements Corp., 625 Broadway, New York 12, N. Y.
Ex. Dept. Pan-Mar Corp., 1770 B'way, New York 1, N. Y.

INDUSTRIAL STAPLES for fastening low-voltage wiring indoors or out. 'Heller-Ply' staples made of steel base, electroplated with copper, for rust, corrosion and salt-water proofing. — Heller Roberts Instruments Corp., 6115 Carnegie Ave., Cleveland 5, Ohio.


—Triplett Electrical Instrument Co., Harmon Rd., Bluffton, Ohio.

TRANSISTOR ANALYZER, model 241. Tests de gain in 3 ranges to 290; gain or leakage on high or low-power transistors; oscillates; in-circuit transistor checks, capacity of diodes and internal battery without removal of instrumen
tment. 50 µa, 5 ma, 500 ma. DC voltage ranges: 5 and 100. Resistance ranges: 1 to 1000 ohms, 10K to 500 kohms, 1 meg to 10 megs. Model 241 Wired ... $30.95 — Model 241 Kit ... $22.95

6-DECcade resistance kit, model 516-11, 12 elements. Switch selection of resistance values from 1 to 999,999 ohms in 1-ohm steps; forty-three 1% 1-watt resistors. Model 516-11 6-decade capacitor kit: capacitance values from 100 µf to 111 µf in 100-µf steps; 1% silver mica capacitors, Ceramic wafers switches. — Heath Co., Benton Harbor, Mich.

600 TRANSISTOR AND CIRCUIT TESTER, model 693. 50-µa, 3¾-in meter movement reads actual transistor parameters plus all volt ranges for servicing transistor equipment. De ranges...
Now you can build a Multiplex Tuner that meets rigid factory standards

Now have the fun of building a genuine H. H. Scott Wide-Band FM Stereo Tuner in just a few hours...and save money, too. Revolutionary Scott-developed kit building techniques assure you of performance equaling Scott factory units.

The new LT-110 Scottkit features a pre-wired and tested multiplex section plus the famous silver-plated factory built and aligned front end. Sensitivity of this magnificent new tuner is 2.2 µv, IHFM. There are special provisions for flawless tape recording right "off-the-air."

Scott Wide-Band multiplex tuners are the standard of the industry. They have been chosen by leading FM stations from Boston to San Francisco. If you want to build a truly professional component choose a Scottkit. All H. H. Scott kits are backed by over 15 years experience in the design and production of superb components. Important features include front panel tape recorder output and precision illuminated tuning meter. All critical parts heavily silver plated. Unique Ez-a-Line system assures factory performance without expensive test equipment. Dimensions: 15½ W x 5¼ H x 13 D in accessory case.

New Scott Amplifier Kits to match the LT-110

**LC-21 Preamplifier Kit**  
Performance so outstanding, this kit is used for laboratory purposes. Hum level —80 dB, distortion less than 0.1%, frequency response 8 to 50,000 cps. $99.95*  
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These exclusive Scottkit Features  
Make Kit Building Foolproof and Fun  
1. All assembly diagrams show parts in exact size and in full color, eliminating mistakes.  
2. All wires cut to exact length and pre-stripped assuring correct lead placement and dress.  
3. Exclusive Part-Charts with parts mounted in order of assembly, eliminating confusion and mistakes. No loose bag of parts.  
4. Handsome appearance makes Scottkits completely professional in looks as well as in performance.

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VTVM, model 44. Balanced vacuum-tube bridge circuit for all voltage and resistance measurements. 7 ac ranges (75% megohm per-volt sensitivity on 1.5-volt range). 7 dc ranges, peak to peak and rms, response ±1 db, 40 cycles to 4 mc (600-ohm source, 5-volt range). 7 db ranges, -4 to +66 db (0 db = 1 mw, 600 ohms). 7 electronic ohmmeter ranges (10 ohms center scale, initial range).-Precision Apparatus Co., 70-11 84th St., Glendale 27, N. Y.


REPLACEMENT FLYBACKS for wide range of models without circuit or chassis alteration. Model 110-250 (illus) replaces Travler part No. TR 28; Model HO-580, Sparta part No. PC-70096.—Stancor Electronics, 3501 Addison St., Chicago, Ill.

CAPACITOR KIT, model K-100, 19 tubular electrolytic capacitors, 14 types, replace more than 50 conventional capacitor types. Ranges:

- 2-500 pf, voltage maximum 50 to 475 volts.-General Electric, Electronic Components Div., Owensboro, Ky.
- 25-VOLT CERAMIC CAPACITOR, type HCC. Available ratings: 01, 02, 05, 10, 22, 47, 100, 150, 470, 1,000, 2,200, 4,700, 10,000, 22,000, 47,000, 100,000 mfd. ±5% tolerance. ±20% and -20%. Minimum leakage resistance at 25°C exceeds 50 megohms at 5 volts and 2 megohms at 5 volts. Maximum power factor 10%.—Cornell-Dubilier Electrodies, Div. Federal Electric Co., New Bedford, Mass.


REMOTE SPEAKER SWITCH, model 674, for switching any of 6 monaural speakers to monaural amplifier. Mounts on wall or cabinet.—Switchcraft, Inc., 5555 N. Elston Ave., Chicago.

MONITOR SPEAKER SYSTEMS employ 12-in coaxial loudspeakers with flat response, High-frequency drivers with diffraction horns extend response to 20,000 cycles. Impedance connections available for 16, 50 and 600 ohms. Sentry I for wall or ceiling mounting, Sentry II floor model.—Electro-Voice, Inc., Buchanan, Mich.

COLUMN SPEAKERS. Vertical stack of six adjusted-range cone speakers, for a fan-shaped beam. Narrow vertical pattern for paging and PA applications. 20-watt Columeir unit measures 5 x 5 x 28 inches, 40-watt unit

8 x 8 x 42 inches. May be rear, side or corner-mounted.—Atlas Sound Corp., Div. American Traduir & Production Corp., 1418-51 59th St., Brooklyn 18, N. Y.

COLUMNAR LOUDSPEAKERS for music and speech. Acoustic tapering reduces effective length of column at high frequencies, maintaining proper vertical dispersion at all frequencies. Uniline model UCS-6 (left), 6-in column: 6 extended-range 8-in speakers. Range 35-17,000 cycles, power capacity 150 watts, impedance 16 ohms, vertical angle 18°, horizontal angle 120°. Model CS-4 (right), 40-in column: 4 extended-range 6-in speakers. Range 45-17,000 cycles, power capacity 90 watts, impedance 4 ohms, vertical angle 22°, horizontal angle 120°.—University Loudspeakers Inc., 39 S. Kenisco Ave., White Plains, N. Y.
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Fix "Tough Dogs" Fast!
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Step Up Your Profit!

B&K NEW MODEL 1076
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for Black & White and Color

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and easy to isolate, pinpoint, and correct TV trouble in
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useful instrument in TV servicing! Its basic technique
has been proved by thousands of successful servicemen
the world over.

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time in half, service more TV sets in less time, really
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FEBRUARY, 1962
**YOU WON'T FIND THIS CONTROL ON ANY OTHER P.A. AMPLIFIER IN THIS PRICE CLASS**

What’s different? The anti-feedback position—which equalizes frequencies most sensitive to generation of feedback “howl” without reducing articulation. This increases sound output under difficult acoustical conditions by at least 100%. And there’s plenty more that makes the new Harman-Kardon COMMANDER Series of public address amplifiers different. Features usually reserved for much costlier equipment are included: 25 & 70 volt & recorder outputs, fader/mixer and master volume controls, magnetic cartridge input, locking covers, etc. Find out why sound men now use the COMMANDER Series for all their needs. Write for detailed catalog. Commercial Sound Division, Harman-Kardon, Plainview, L.I., N.Y.

**BOOKSHELF ENCLOSURES**, with matching Jensen speakers. Tube-vented design avoids bass booming near cone-resonance frequency of woofer, boosts entire bass range. Speakers connected in crossover network to 8-ohm output terminals on back. Model TSE-4S (illus): one 12-in. woofer and two 3½-in. tweeters. Model TSE-2AS: one 8-in. woofer and one 3½-in. tweeter—Argus Products Co., 301 Main St., Goleta, Calif.


**PRERECORDED TAPES**, 4 stereo selections on 3-in reel, 15 minutes playing time. Each Add-A-Tape includes four splicing labels for additions or editing. Compatible for 4- or 2-track stereo playback.—Coleman Electronics, Inc., 133 E. 162nd St., Garden City, Calif.

**COATING FOR PHONOGRAPH PARTS**, Fono-Magic, liquid compound of rubber and carbide particles, applied with brush, eliminates turntable slipping and dragging caused by crystallized rubber drive wheels. Coats metal drive surfaces with nonslipping rubber to increase traction; carbide particles scratch crystallized surface and expose live rubber.—R-Columbia Products Co., Inc., 2008 St. John Ave., Highland Park, Ill.

**AUTOMATIC RECORD CLEANER**, redesigned Dust Bug model. Sweeps record just before playing, using specially designed nylon fiber brush with cylindrical plush pad, both dampened with antistatic fluid. Installs on any tone arm, no vertical stylus loading on cartridge. User-replaceable brush and pad.—Eleetro-Sonic Laboratories, 627 Broadway, New York, N.Y.

**PA TRANSFORMERS**, Outputs 4 and 8 ohms, power steps of 0.8, 1.0 or 2.0 watts. Standard open-channel frame mounting with solder lugs for primary and secondary leads. Model A-8109 (illus), for 70.7-volt line, has taps for primary impedances of 2,500, 5,000 and 10,000 ohms.

**HERE IS A SPEAKER SYSTEM IDEAL FOR THE HOME, OFFICE OR EVEN INDUSTRIAL APPLICATIONS WHERE CLEAR UNDISTORTED SOUND IS REQUIRED.**

By simple connections to your present sound source, such as Hi Fi and stereo components, consoles, TV, radio and public address or intercom systems, the “compact” will produce crystal clear sound with almost no distortion, even at high volume levels. Dimensions of cabinet 6" x 7" x 10".

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FEBRUARY, 1962

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Put volume control; selector; separated. Front-panel controls: 5-position input elements on PC board, ganged tone control; center-channel output. Parts mounted on separate charts: wires present and pretrimmed; me-

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Stereo tape-monitor amplifier, model A-1220. Tapes monitored through headphones during recordings. For tape systems with preamps but not power amplifiers.—Kans.

Stereo to-monitor amplifier, model A-1220. Tapes monitored through headphones during recordings. For tape systems with preamps but not power amplifiers.—Kans.

Stereo-compact tape recorder, model 46. Heterodyne filter for distortion-free re-

Stereo-compact tape recorder, model 46. Heterodyne filter for distortion-free re-

20-20,000 cycles at rated power.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

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SUPERIOR'S NEW MODEL 770-A

VOLT-OHM MILLIAMMETER

FEATURES:
- Compact—measures 3¼" x 5½" x 2½".
- Uses "Full View" 5% accurate 850 Microampere D'Ammelvrat type meter.
- Housed in round-cornered, molded case.

SPECIFICATIONS:
- D.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.
- 2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.
- 3 D.C. CURRENT RANGES: 0-10/100 Ma, 0-1.5 Amps.
- 3 DECIBEL RANGES: -6 db to +18 db, +14 db to +38 db.

Model 770-A comes complete with test leads and operating instructions. Price is $18.85. Terms: $5.00 after 10 day trial then $6.00 monthly for 3 months.

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER

SPECIFICATIONS:
- D.C. VOLTS: 0 to 7.5/15/30/150/300/1500/3000.
- A.C. VOLTS: 0 to 15/30/150/300/1500/3000.
- D.C. CURRENT: 0 to 1.5/15/150 Ma.
- A.C. CURRENT: 0 to 1.5/15/150 Amperes.
- RESISTANCE: 0 to 1,000/100,000 Ohms.
- 0 to 10 Megohms.
- CAPACITY: .01 to 4 Mfd. to 50 Mfd.
- REACTANCE: .06 to 2,000 Ohms. 2,000 Ohms.
- INDUCTANCE: > to > Henrys.
- DECIBELS: -6 to + 18, + 14 to + 38, + 34 to + 58.
- The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

Model 79 comes complete with operating instructions, test leads and carrying case. Price is $38.50. Terms: $5.00 after 10 day trial then $6.00 monthly for 3 months.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price!

SPECIFICATIONS:
- DC VOLTS: 0 to 3/15/150/300/750/1500 volts at 11 megohm input resistance.
- AC VOLTS (RMS): 0 to 3/15/150/300/750/1500 volts.
- AC VOLTS (Peak to Peak): 0 to 8/40/200/400/800/2000 volts.
- ELECTRONIC OHMMETER: 0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- DECIBELS: -6 db to +18 db, +14 db to +38 db.
- All based on 0 db = 100,000 volts (6 mw).
- ZERO CENTER METER—Per discriminator alignment with full scale range of 0 to 3/15/75/750/1500/3000 Volts. 0 to 1,000 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. Price is $44.00. Terms: $5.00 after 15 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

MIRRORED SCALE permits fine accurate measurements where fractional readings are important.

SPECIFICATIONS:
- D.C. VOLTAGE RANGES:
  - All Selenium Rectifiers.
  - All Germanium Diodes.
  - All Silicon Rectifiers.
- 3 DECIBEL RANGES:
  - + 34 to + 58 db.
  - + 34 to + 58 db.
- ZERO CENTER METER—Per discriminator alignment with full scale range of 0 to 3/15/75/750/1500/3000 Volts.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Price is $44.00. Terms: $5.00 after 15 day trial then $6.00 monthly for 5 months.

FOR REPAIRING ALL ELECTRICAL APPLIANCES

MOTORS * AUTOMOBILES

As an electrical trouble shooter the Model 70:
- Will test Transformers, Traps, Resonators, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Phonographs, Switches, Thermostats, etc.
- Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistance, Leakage, etc.
- Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc.
- Luggage detecting circuit will indicate continuity from zero ohms to 3 megohms (3,000,000 ohms).

As an Automotive Tester the Model 70 will test:
- Both 6 Volt and 12 Volt Storage Batteries
- Generators
- Starters
- Distributors
- Ignition Coils
- Regulators
- Relays
- Circuit Breakers
- Cigarette Lighters
- Stop Lights
- Condensers
- Directional Signal Systems
- All Lamps and Bulbs
- Pushes
- Heating Systems
- Horns
- Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. Price is $15.85. Terms: $5.00 after 10 day trial then $6.00 monthly for 3 months.

* Did you ever?

- Order merchandise by mail, including deposit or payment in full, then wait and write...wait and write?
- Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

Obviously prompt shipment and attention to orders is an essential requirement in our business...We ship at our risk!
SUPERIOR'S NEW MODEL 82-A
MULTI-SOCKET TYPE TUBE TESTER

SPECIFICATIONS:
- Tests over 1000 tube types.
- Tests O.S.s and other gas-filled tubes.

Model 82-A comes housed in a handsome portable case. Price is $35.95. Terms: $3.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL TW-11
STANDARD PROFESSIONAL TUBE TESTER

- Uses the new self-clearing Lever Action Switches for individual element testing. Because all elements are simultaneously controlled by the L.A.S. base numbering system, the user can instantly identify any element in any tube.
- Free-moving built-in roll chart provides complete data for all tube types. A.C. and D.C. operating voltages for the older 6.3 types and the newer 8.4 types.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model TW-11 comes housed in a handsome portable case. Price is $7.50. Terms: $1.50 after 10 day trial then $6.00 monthly for 6 months.

SUPERIOR'S NEW MODEL 83-A
C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

Model 83-A comes housed in handsome portable saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 85
TRANS-CONDUCTANCE TYPE TUBE TESTER

- Tests all transistors and transistor radios. An R.F. Signal source, modulated by an audio tone is injected into the R.F. amplifier stage, and the resultant plate current change is measured on a small-signal or transit-time basis, depending on the condition of the tube.

Model 85 comes complete, housed in a handsome portable cabinet, with slip-on cover. Price is $55.95. Terms: $11.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 88
TRANSISTOR RADIOS

Tests all transistors and transistor radios. An R.F. Signal source, modulated by an audio tone is injected into the R.F. amplifier stage, and the resultant plate current change is measured on a small-signal or transit-time basis, depending on the condition of the tube.

The Model 88 comes complete, housed in a handsome portable Texon case, with A.M. Radio, F.M. Radio, Amplifiers for B.B., White TV, Color TV. Price is $21.95. Terms: $5.00 after 10 day trial then $5.00 monthly for 5 months.

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FEBRUARY, 1962
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2 NEW PHONO JAX

- Eliminate rivet mounting.
- Convenient replacement for old style Jacks.

No. 3501FP—Lock Nut back of panel, requires only ¼" hole.

No. 3501FR—For front of panel mounting, where necessary to assemble Jack through the panel from the back due to lack of space.

NEW PHONO PLUG

No. 3502—Removable handle—exposed terminals. Nickel plated brass body and handle, Can be used in multiples even where Jacks are on ½" centers.

NEW PHONO EXTENSION JAX


Send for catalog A-401

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ONLY $4.95

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Eliminates Costly TV Troubles

By absorbing damaging in-rush current so destructive to Television and Hi-Fi tubes, the TV LIFE-SAVER eliminates 3 out of 4 Service calls by more than tripling the life of all tubes...

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A new component easily installed to reduce call-backs by eliminating surge current damage to television and Hi-Fi tubes.

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NAME ___________________________ ADDRESS ________________________________

CITY ___________________ ZONE _______ STATE ________________

(Continued from page 105)

Response 55-20,000 cycles, crossover at 200 and 1,000 cycles, impedance 8 ohms, 90 watts. Model B-3990, bookshelf unit. B-3990 for apartment-sized rooms; B-1990, indoor-outdoor speaker.—R. T. Bozak Sales Co., 697 Connecticut Ave., S. Norwalk, Conn.

WIRELESS INTERCOM KIT, model GD-51.
Power line is transmission medium for low-frequency if signal. No interunit connecting leads, no additional wiring for added units. All-transistor circuit, self-contained 117-vac power supply, squelch circuit, overload diode and 2 indicating lights.—Heath Co., Benton Harbor, Mich.

BUILT-IN CB SPEAKER for HQ-105 TR transceiver, to replace 24-hour clock timer. Full coverage Available factory-wired as HQ-105 TRS.—Hammarland Mfg. Co., Inc., 460 W. 84 St., New York 1, N. Y.

ANTENNA COIL ASSEMBLY, model 1325A, replacement for RCA and Admiral tuners. Balun coil, 5-section if trap eliminate interference between TV sets over if band. Mounted in phenolic board/metal plate assembly.—Coleman Electronic Products, 1017 N.E. 3rd Ave., Amarillo, Tex.

All specifications from manufacturers' data

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NEW LITERATURE

WALL CHART explaining FM stereo for dealer personnel and consumers.—Harman-Kardon, Inc., Plainview, L.I., N. Y.

DIAMOND NEEDLE DISPENSER DR-1. —Duotone Co., Keyport, N. J.

GENUINE DIAMOND NEEDLES

this Fisher Multiplex Adapter works with any brand of FM equipment

Now everyone can enjoy FM Stereo with the only truly universal (and, you might say, impartial) Multiplex Adapter. Only the Fisher MPX-100 will convert to FM Stereo Multiplex operation any FM tuner or receiver ever made, regardless of age, brand or model.

What's more, the Fisher Universal MPX-100 recognizes FM Stereo Multiplex programs automatically with its 'electronic brain,' the exclusive Fisher Stereo Beacon. Whenever the FM station you have selected is broadcasting in stereo, the Stereo Beacon lights a signal and switches the equipment automatically from regular to stereo operation. This ingenious Fisher invention makes Multiplex a pleasure, not a problem. Price, less cabinet, $119.50*.

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"EDU-KIT" $49.95
ALL Guaranteed to Work

WHAT THE "EDU-KIT" OFFERS YOU
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THE KIT FOR EVERYONE
You do not need any previous knowledge of radio or electronics. The kit is complete and easy to understand. You will learn the principles of RF and AF amplifiers, detectors and rectifiers, test equipment.

THE EDU-KIT IS COMPLETE
You receive a "Complete Home Radio Course Kit." All parts and instructions are included. You will learn the art of building radio circuits. All parts and instructions are included. The "EDU-KIT" is the foremost teaching aid ever devised to teach the fundamentals of radio.

TRouble-SHOOTING LESSONS
You will receive complete trouble-shooting and service manual, using the practical, easy-to-understand "EDU-KIT" Teaching Method. You will learn how to repair radio circuits. You will be able to repair and service your own radio circuits.

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You will receive a "Complete Home Radio and Electronics Course Kit." All parts and instructions are included. You will learn the art of building radio circuits. All parts and instructions are included. The "EDU-KIT" is the foremost teaching aid ever devised to teach the fundamentals of radio.

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You receive a "Complete Home Radio Course Kit." All parts and instructions are included. You will learn the art of building radio circuits. All parts and instructions are included. The "EDU-KIT" is the foremost teaching aid ever devised to teach the fundamentals of radio.

TRouble-SHOOTING LESSONS
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FREE EXTRAS

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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
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<tbody>
<tr>
<td>1 - 6&quot; PM SPEAKER</td>
<td>1</td>
<td>$1</td>
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<tr>
<td>1 - 6½&quot; PM SPEAKER</td>
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<td>1 - 8&quot; PM SPEAKER</td>
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<td>3 - 1/2&quot; TWEETER</td>
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<td>5 - SETS SPEAKER PLUGS</td>
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<td>3 - AUDIO OUTPUT TRANSFORMERS</td>
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<td>4 - PRINTED BOARD WIRE FORMERS</td>
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<td>5 - ASSORTED WIRE FORMERS</td>
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<td>5 - TV FOCALIZER</td>
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<td>10 - ASSORTED SELENIUM RECTIFIERS</td>
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RCA 8EY4DJ

A common trouble in these record players is excessive hum. There are two causes. One is heater-cathode leakage in the 12AX7 and is cured by replacing the tube. A more subtle 60-cycle hum can be reduced by adding a length of insulated wire from pin 4 of the 12AX7 to the middle terminal on the tone control. Both of these points are at B-minus, but adding the wire cancels hum pickup caused by circulating currents.—M. L. Leonard

BC-221 FREQUENCY METER

Complaint: At times the frequency on both the low and high band would drift badly. This condition would not improve no matter how long the set was left operating.

Test: The drift was traced to a defective corrector control. It was loose and had a wobbly shaft. However, replacement was almost impossible unless I wanted to rip up the precise oscillator section and take a chance on disturbing the dial calibration.

Cure: After hours of thought, I decided to try to correct the drifting of the spacing of the corrector control capacitor by inserting some pressure between the control knob and the front panel. I placed a fiber washer over the control shaft of the capacitor and cemented it between the shaft and panel to keep the control shaft from wobbling. Then I placed a rubber grommet between the fiber washer and the control knob. By adjusting the control knob to give enough pressure to keep the control rotation stiff and to steady any movement between the rotor and stator plates, once the control has been set, I solved my problem.—George P. Oberto

OLYMPIC 1TB61

Horizontal sync was unstable and, while the picture had straight sides, it was about 4 inches narrower at the bottom. After much checking, we replaced C41 and cleared up the trouble.

The vertical output stage and the horizontal oscillator get B-plus from the same source. When this capacitor opened, the output of the vertical output tube was fed to the horizontal oscillator, causing the symptoms above.—William R. Seabrook
FORD 75BF AUTO RADIOS

Complaints of tuning-dial slipping where the slippage is in the clutch mechanism can be cured by mounting a phonograph or dial-cord spring from the tuning shaft close to the gear drive to the right side of the cabinet to exert more pressure on the clutch mechanism. Don't use too heavy a spring or the pushbuttons won't work properly and will wear excessively.—George P. Oberto

GM PORTABLES

Scattered throughout the United States are some Delco Radio portable radios with a “GM” label. These portables have an anodized aluminum case which gives the radio a gold appearance, and a black front cover. They are complimentary radios and service information is not available. The problem is what to do if one of these radios is brought into your shop.

If you were to look at a 1959 Buick portable radio, you would immediately notice the similarity between this radio and the GM portable. This not only applies to the external appearance but also the circuit. The main difference between the two radios is the lack of a connector in the GM portable. Since it was not designed to be part of a car radio, the connector has been left out.

If one of these GM portables is brought into your shop for repair, dig out the 1959 Buick, Pontiac or Oldsmobile service bulletin and go to work.—Delco Testing Tips

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RADIO-ELECTRONICS wants Industrial Technotes. These should cover equipment (including closed-circuit television) actually used in industrial work, or technotes on counters, controls and other apparatus whose users are largely industrial. Unillustrated Technotes pay $5; circuit diagrams raise the price to $9 and acceptable photos are worth $7 each. Send your technotes from industry to Technotes Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y.
TRANSISTOR-TUBE AMPLIFIER
Patent No. 2,979,664
Wm. J. Palmer, Carlisle, and Geo. Schloess, Watertown, Mass. (Assigned to Sylvana Electric Products, Inc., Wilmington, Del.)

V1 is energized by the dc drop across the cathode resistor. This voltage remains steady in class-A operation. V1 is coupled directly to V2. R sets the transistor bias current. It is also a feedback resistor to stabilize the first stage. For example, if the base input goes positive, less current flows into the cathode resistor, driving the cathode more negative. With 10-mv input, the output is 1 watt and the gain is about 60 db. At 4 watts output, distortion is 10%.

CONTROL CIRCUIT
Patent No. 2,972,116
Charles E. Lowe, Fenton, Mich. (Assigned to General Motors Corp., Detroit)

At frequencies near alpha cutoff, a transistor has negative resistance and will oscillate. If L1-C1 is tuned to a frequency slightly above that of L2-C2 (both being near cutoff), the transistor has negative resistance and will oscillate. The circuit as shown allows oscillation to be stopped by tuning L1-C1 below that of L2-C2. When L1-C1 is very sensitive to slight displacements it is tuned to the frequency of L2-C2—when the core connected to a detector indicates the proper setting.

TRANSISTOR-TUBE AMPLIFIER
Patent No. 2,979,664

HYBRID RADIO
Patent No. 2,970,213
Francis M. Dukat, Waltham, Mass. (Assigned to Raytheon Co.)

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