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Low-Priced Video Recorder Announced by Ampex

A new television tape recorder, weighing less than 130 pounds and costing under $12,000, was described by Ampex, who demonstrated a prototype at a special showing in New York City. The new recorder is one-twentieth the size and one-fourth the cost of the Ampex Videotape recorder, the first practical television recording device.

The new machine—the VR 1500—operates on the principle described in the article “New Video Tape Recorders,” RADIO-ELECTRONICS, December 1962, page 64. The tape is scanned by heads rotating inside a drum around which the tape spirals. The result is a long, diagonal track on the tape. In the Ampex machine, instead of one head scanning 360°, two heads scan 180° each. The tape speed is 5 ips; the tape width 2 inches.

The new recorder is intended for such applications as educational television, where the need for a recorded video program is great, but where the cost of a broadcast type video tape recorder would put it beyond the means of the average institution. Military and industrial training, surgery and other applications were cited by Ampex spokesmen.

FCC Would Improve Citizens-Band Practices

The FCC has proposed rule changes for the Citizens band which, if adopted, may make the band less attractive to the hobbyist, but more useful to the serious operator. The proposed changes are applicable to the class-D category in the 26.96–27.23 band. Under the proposed new rule, only 5 channels of the present 23 would be available for communications between stations of different licensees. (Some legitimate business, such as phoning ahead for reservations at a motel, requires intercommunication between stations of different licensees.)

Licensees on all other channels would be confined to their own units. Hobbyist types of chatter, such as communications to “any station that might be listening” or discussions as to types and excellence of equipment, antennas, etc., would also be illegal.

Bell Labs Announce Electret Microphone and Earphone

A quality condenser microphone and an earphone—also operating on the capacitor principle—that do not need high polarizing voltage, have been announced by Bell Telephone Labs. Instead, the new devices have a permanently polarized piece of dielectric material—an electret, the electrostatic equivalent of a permanent magnet.

Mylar film, coated with aluminum, was used for the dielectric. It was heated to 120°C in a 3,500-volt field and then gradually cooled in the field. The resulting polarization is about the same as would be produced by 200 volts external bias.

The construction of the earphone is somewhat like that of some modern electrostatic speakers, a push-pull principle being used. The earphone is flat within 3 db from 20 to 50,000 cycles, and the microphone from 50 to 15,000.

Are Lamps Devices For Making Light?

Though nearly 3,000,000,000 electric light bulbs are produced for illumination every year, several million lamps yearly are made for uses that have nothing to do with lighting, says Dr. Rolland Zabel, Westinghouse Lamp Div. engineering man-

New Ampex VR-1500, photographed in front of the standard Ampex VR-1000C recorder used in broadcasting. Model Phyllis Moness demonstrates simplicity of new recorder—one push and it’s on, another and it’s off.
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These trays of meat balls were cooked by quartz infrared heat lamps.

ager. These lamps do such jobs as taking toughness out of steak, keeping food fresh, helping capture criminals, and making motion pictures talk.

One common nonilluminating lamp is the ultraviolet radiator, used in crime detection, in prospecting to detect fluorescent minerals, and to destroy germs. Industrial ultraviolet tubes are used in photochemical processes such as the production of fertilizer, the development of colors and dyes, bleaching fabrics and even tenderizing meat.

At the other end of the scale is the infrared, or heat lamp, used for drying, baking paint on automobiles, gluing and even cooking. The cesium lamp is used for invisible signaling by the military, and for developing the sound on motion picture film.

While a third type of lamp produces visible light, it may have special uses, such as a group of fluorescent lamps designed especially to stimulate plant growth, or an artificial sunlight lamp used to produce suntan.

Citizens Band Has Own Show
Citizens-band equipment stole the show at the first International Communications Fair held late in November at the New York Coliseum. The great majority of the more than 75 commercial exhibitors were demonstrating Citizens-band equipment. Other types of communications were in evidence, including a number of ham radio booths and an amateur radio demonstration setup, as well as 25 educational exhibits. Marine communications manufacturers were also present, and one booth—Craftsman Instrument Laboratory—was operated by a manufacturer of a television camera kit.

Telstar Refuses To Take Orders
The Bell Telstar satellite, after four months of successful operation, developed trouble in the system which turns its communications receiver and transmitter on and off, making it impossible to use it as a radio and television relay. The telemetry circuits were at last reports still working perfectly, sending back reports on the amount of radiation in space, the condition of the satellite and its components, temperature readings, effects of radiation on the solar cells and transistors—in fact, almost everything except why the command circuit won't work.

Double Medal of Honor Given by IRE
The IRE (now IEEE) has chosen two recipients for the Medal of Honor, its highest annual technical electronics award. John Hayes Hammond, Jr., president of Hammond Research Corp., Gloucester, Mass., will receive the award for theoretical work in radio control of missiles, and George Clark Southworth, consultant of Chatham, N.J., for achievement in the fields of radio physics, radio astronomy and waveguide transmission. For leadership in scientific research and education, Frederick Emmons Terman, vice president and provost of Stanford University, will receive the Founders Award, a special-occasion honor for outstanding service to the profession. Contributors to the fields of radio art, technical authorship and electronic television are honored by five remaining awards.

Presentations will take place on March 27 at the Waldorf-Astoria Hotel in New York City.

100 Conversations Carried On Single Telephone Path
A new British electronic telephone exchange permits subscribers to carry on perfect telephone conversations, though they are connected to the line only 1% of the time. The principle is called "time division multiplex," and consists of a crystal-controlled switching system operating at 1 mc. Each of 100 telephone lines is gated "on" with a semiconductor diode 10,000 times
New IRC Type 103 Vinyl Electrical Tape has everything a good tape should have... and then some.

- 2 to 18 times better dielectric strength than other tapes.
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Also available in cellophane wrapped rolls:

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Ask for IRC Vinyl Electrical Tape at your Electronic Parts Distributor.

Mr. Muniz will be remembered by older readers of Gernsback's magazines as author, co-author and inspirer of a number of projects at the Brooklyn Technical High School. At the time of his death, he was collaborating on a text "Electronic Instrumentation," to be published this spring.

After the war, he pioneered in TV production as general manager at the A. B. Du Mont Laboratories, and later held executive positions in a number of the larger radio and TV companies.

**FCC Adopts Uhf Rules**

The technical standards for uhf TV receivers recommended by the manufacturers last summer (Radio-Electronics, September, 1962, page 6) have been adopted by the FCC without notable changes. All sets shipped in interstate commerce after April 30, 1964, must be equipped to receive all channels. Sensitivity of the uhf channels is to be not more than 8 db below the average of the sensitivity of the vhf channels.

A request has been made to the FCC for a special ruling to cover equipment used in schools, hospitals, hotels, and similar community antenna type systems, where the signal is received on uhf but converted to vhf for cable distribution to the receivers. In such cases there would be no point in having uhf channels.

**TV Replacements Increase**

Two-thirds of the TV sets sold in 1962 were replacements for sets that were junked, according to Frank W. Mansfield, Sylvania marketing research director. About 4,300,000 TV sets were scrapped in 1962, he believes. This compares with 3,700,000 in 1961. Total TV sets discarded to date number about 26,000,000, out of the roughly 86,000,000 sold in the United States. About 60,200,000 TV sets were in use at the end of 1962, estimates Mr. Mansfield.

**"High Fidelity" Defined?**

The Electronic Industries Association, the audio portion of whose membership generally represents the larger packaged hi-fi manufacturers, has proposed a definition of high fidelity, which has been turned over to the FTC for consideration. The definition classifies any instrument with relatively constant response of 100 to 8,000 cycles and power output of at least 5 watts as high fidelity. [This definition sounds more like infidelity! —Editor] According to EIA's consumer products staff director, L. M. Sandwick, this is to be a "minimum definition," which "may well change as the art improves."
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FEBRUARY, 1963
To judge from the record, the art of commercial definitions for high fidelity is improving rather slowly. In 1934, the Engineering Div of RMA (predecessor of EIA) interpreted, tentatively, high fidelity as applying only to a receiver having an af range of at least 50 to 7,500 cycles, with variations not to exceed 10 db, and with a total output of at least 10 watts, total distortion not exceeding 5% (Radio-Craft, Sept. 1934, page 151).

**Skip-Puter?**

With a computer for a skipper and a crew consisting of automatic machines, Soviet diesel ship Labora- toria has completed an experimental voyage on the Dnieper River. Depth finders registered soundings and the electronically controlled ship's log kept dutiful records. A cable on the river bottom sets up a magnetic field that the shipboard instruments use to set the course. The ship, a floating laboratory, collects data for Kiev scientists who are studying ship auto- mation—and does it all, say the Soviets, without human personnel.

**TV Campus Grows**

Florida's ETV network is showing the nation that TV can cope with teacher shortages. In 1961, TV was a part of the curriculum for more than a third of the state's pupils—and the system is still growing. Within the next 12 years, the 6-station network should expand to 12 stations. The sys- tem, a low-budget operation, is run and programmed by the state Edu- cational TV commission. Stations are owned by local school boards, state universities and nonprofit community groups. Each station has its own video-tape recorder to help dis- tribute lessons throughout the state. Next on the list for an ETV installa- tion is Orlando, channel 24.

**R-E Author Passes**

Ralph W. Hallows, who between the years 1946 and 1950 wrote the column "European Report" in this magazine, has died in England at the age of 77. Major Hallows also, under the penname "Diallist," conducted the feature "Random Radiations" in the British magazine Wireless World for over 25 years. He was the author of articles in this magazine and other magazines, and author or co-author of several books on radio and radar.

**Too Much Soap in Your Ears?**

It's not just your imagination—TV commercials often are louder than the programs. H. H. Scott, Inc., after electronically testing three Bos- ton TV stations, stated these find- ings: On 65% of the monitored pro- grams, commercials were louder—

(Continued on page 16)
THE NEW ELECTRO-VOICE
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General Electric Co. has announced prices on research samples of gallium arsenide lasers—the new semiconductors that emit light when stimulated with a current of electricity. The new light-emitting diodes are priced at $130 for the noncoherent type, and $1,300 for the coherent laser. Very heavy currents are applied to the diodes, causing them to emit a beam of infrared light—with a wavelength of about 8,400 angstroms—from the junction plane edges.

Underwater Doppler Radar Guides Surface Vessels

An underwater Doppler navigator, similar in action to the radar for planes described in the May 1962 issue of Radio-Electronics, page 8, has been developed by Janus Products, Inc., of Syosset, N. Y. The device, like its airborne counterpart, will provide the surface vessel or submarine with information on its true velocity and distance as well as its drift angle. Used with a standard marine compass, it informs the navigator instantly of his true heading and position. The radar uses an ultrasonic sonar wave instead of radio waves, to produce the echos from the bottom that give the information as to its rate and direction of travel.

Niels Bohr Dies

Prof. Niels Bohr, world-renowned atomic physicist, died Nov. 18. In 1913, Prof. Bohr discovered the role of the quantum in the structure of the atom, launching a life...
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long study that paved the way for present-day knowledge of the atomic nucleus.

In 1922, Professor Bohr received the Nobel Prize in physics for "studies on the structure of atoms and the radiation emanating from them." He is responsible for the founding of the Institute of Theoretical Physics in Copenhagen.

R-E Readers Invited

The French Fédération National des Industries Electroniques invites readers of RADIO-ELECTRONICS to visit the Sixth International Exhibition of Electronic Components in Paris, one of the world's largest, at the Parc des Expositions, Porte de Versailles, Feb. 8-12, 1963. Show a copy of this issue of RADIO-ELECTRONICS to a hostess at the visitors' desk (Service d'Accueil du Salon) and she will give you a complimentary ticket to the exhibition.

CALENDAR OF EVENTS

9th National Symposium on Reliability and Quality Control, Jan. 21-24; Sheraton Palace Hotel, San Francisco, Calif.
12th Southwestern Electronic Conference (SWELCON), Jan. 27-31; Baker Hotel, Dallas, Tex.
4th Winter Convention on Military Electronics, Jan. 30-Feb. 1; Ambassador Hotel, Los Angeles, Calif.
Pacific Electronic Trade Show; Conference, Feb. 4-10; Starclo Hilton Hotel, Show, Feb. 7-10; Shrine Exposition Hall, Los Angeles, Calif.
Washington High Fidelity Music Show, Feb. 8-10; Shoreham Hotel, Washington, D.C.
6th International Exhibition of Electronic Components, Feb. 8-12; Paris (Porte de Versailles), France
3rd Quantum Electronics Congress, Feb. 11-22; Unesco House and Parc de Exposition, Paris France.
International Sound Equipment Exhibition, Mar. 7-12; Palais d'Oiray, Paris, France.
Symposium on European Markets for Electronic Products, Electronic Industries Association, Mar. 19; Starclo Hilton Hotel, Washington, D.C.
Electronics Industries Assoc. Spring Conference, Mar. 20-22; Starclo Hilton Hotel, Washington, D.C.

90° Color Tube Delayed

RCA, in a telegram to manufacturing customers, reported that, due to technical difficulties encountered during pilot production, the new 90° color tubes expected about the beginning of the year would be held up for approximately 9 to 15 months. While RCA did not specify, rumors were that the difficulties were with color registration and convergence at the edges of the tube.

RCA Spokesmen expect that sales of color TV will run to more than 400,000 sets in 1963.

Some manufacturers were speculating on the possibility that, when RCA gets ready to deliver the tube, it may come out in rectangular rather than in round form.
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For men with Radio-TV experience who want to operate or service transmitting equipment used in broadcasting, aviation, marine, microwave, facsimile or mobile communications. A Service Technician is required by law to have an FCC License to work on C-Band, other transmitting equipment. From Simple Circuits to Broadcast Operation, this new NRI course trains you quickly for your Government FCC examinations.

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Letter from the Editor

Dear Readers:
Your Service Editor wishes to apologize for the error in the article “Use Your Scope” on pages 68–73 of the December issue. During one of his occasional flashes of stupidity, he gave the figures for peak voltage when what he actually meant was peak-to-peak voltage: 1.414 instead of 2.828, which is correct. The correct formula for this is, as he very definitely knows now, peak-to-peak voltages = rms voltage multiplied by 2.828. He has promised to watch out for this in the future. (Only the fact that another writer, in the same issue of another leading electronics magazine, made exactly the same error, saved him from some very drastic action by the Editor!)

Jack Darr
Radio-Electronics

We Were Hypnotized

Dear Editor:
The article in December 1962 (page 48) on an electronic switch for automobile starting illustrates part of the difficulty of our modern age, where complexity for the sake of complexity has become almost a rule. The sole purpose of three transistors, sundry resistors, capacitors and a heat sink is to switch the ignition coil from the regular battery to an auxiliary battery when the starting motor is actuated. This could be done much more simply by using a single-pole double-throw electromechanical relay.
The relay would be less expensive; a separate quick-start switch would not be necessary; problems of insulation, space, mounting and motor heat would be reduced, and the system could be used for 6-volt or 12-volt cars with either positive or negative grounds.
A more general use of Occam’s razor is indicated. Paul L. Esmay Custer, S.D.

[Apparently we were hypnotized by the glamour of electronics. The idea of a relay did not even occur to our Associate Editor, who installed it and tested it for a week, and even went to extra trouble to modify his negative-ground circuitry to work with the equipment. An engineer friend, just after World War II, complained that the glamour of electronics was so great that he had extreme difficulty persuading manufacturers that honest iron and copper were still useful. Possibly the transistor is introducing a new semiconductor glamour age.—Editor]

Another Solution

Dear Editor:
Reading in the December issue the description of a device under the title “Start Your Car Fast” (page 48), I was fascinated by the simple, yet so efficient, scheme. In fact, after analyzing the circuit I came to the conclusion that similar results can be achieved with a circuit even more simple. How about this one?

Atlanta, Ga.
S. Lifshitz

[Some seven letters were received—one of them from Commander Smihey, author of our first transistorized auto ignition article—supporting the position of Mr. Lifshitz and Mr. Esmay, above. Some showed diagrams, and others would have been happy with a simple manual switch. —Editor]

What Kind of License?

Dear Editor:
Several years ago, when I was an officer of ESFETA (Empire State Federation of Electronic Technician Associations), I supported the ESFETA license bill, as I was led to believe that the State Education Department was to participate in the program. Later, I found this was not to be so, and resigned from organized service so that I could alert independent service technicians.

I am definitely in favor of a good license law that will raise the standards of the industry and protect the consumer. But when the law is so written that a man obtaining his license under the grandfather clause (without examination) can become an administrator of the law and even participate in the drawing up of examinations, you have a very inferior law.

I am not against people already in TV service getting a license under the grandfather clause, as I know this is the necessary requirement, but I am against the law being so written that such a man can also serve on the board of administration.

Another point that should be included in any good license legislation is several grades of licenses. This will provide an incentive for practicing technicians to keep abreast of new developments in their field. Melvin Cohen
Hudson Falls, N.Y.

END

February, 1963

THORENS TD-121
Convertible 4-Speed Turntable combined with
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The TD-121 gives you all the main features you'll find in the famous Thorens TD-124 at a big saving to you! TD-121's smooth-running, nonmagnetic table—a rugged, man-sized table that none of the lightweight can touch—assures rumble-free, wow-free performance. You get Thorens double drive—belt plus idler—for complete motor isolation. And many, many more features.

Factory mounted on a Thorens arm board, the BTD-12S tone-arm is an outstanding example of Swiss precision craftsmanship. Thorens engineers came up with an exclusive cueing device that saves records, protects costly high-compliance cartridges. And, although compact, the BTD-12S gives you less than 0.5"/inch tracking error—better than many 16" arms!

Why settle for less than the best? Go to your franchised Thorens dealer. See, hear, and compare this combination with any others. We're sure you'll end up with a far better music system and have the proud knowledge you own the best—Thorens.

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IN-CIRCUIT CAPACITOR TESTER #955
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HUMAN ELECTRONIC TRANSMITTERS

...Doctors Will Soon Treat Patients by Remote Control...

In the early 30's, Dr. K. Ogino and Prof. Dr. Hermann Knaus published their epoch-making discoveries on what is now known as the "rhythm of sterility and fertility in women." Before 1930, it was widely held that fertilization can occur at any time. Not so, stated the Ogino-Knaus team. Only if intercourse took place shortly before, shortly after or during ovulation—the monthly release of the female egg—a period of at most three days, could conception occur. As a rule, women would remain sterile at all other times during the menstrual cycle.

It was also found that at the exact time of ovulation the woman's temperature increases slightly, about 0.4°F. Most women, however, are not aware of this, nor do they feel the onset of ovulation. Last November a new and very practical electronic feature of ovulation detection was announced by the Human Factors Society in New York, a professional organization of engineers, psychologists, researchers and other scientists. They work on various systems and equipment that people can operate most effectively.

Dr. Alvin Singer, of the American Electronic Laboratories of Colmar, Pa., reported a new device to the society: an improved electronic temperature recorder. It is a miniature transmitter mounted on the rim of a pessary (a pessary is a device worn in the woman's vagina, usually as a support for a weak or displaced womb). It does not interfere with ovulation or menstruation. Because of recent miniaturization, the electronic transmitter, with its temperature device and a tiny battery that last a year, is in fact much smaller than the pessary itself. They cause no discomfort to the woman wearer.

As Dr. Singer described it, the woman's internal temperature is broadcast continuously on a short-wave frequency. The signal is picked up by a nearby receiver. Then a steady recording of the basic temperature is made. When ovulation occurs, the temperature rises slightly. The recorder can then automatically sound an aural signal or alarm, notifying the woman of the exact time when ovulation occurred.

Dr. Singer also stated that in cases of difficulty in fertilization, a couple could be advised to have intercourse at the moment of ovulation, the best time to achieve pregnancy.

He also reported that if intercourse takes place immediately after ovulation, the chances for creating a male child increase by a factor of 3. On the other hand, intercourse 12 to 24 hours before ovulation will greatly increase the chances of begetting a female child.

Some scientists, however, have some reservations on this method of sex determination.

The Electronic Patient

In our present economy, there is a serious shortage of doctors. It is an almost impossible problem for doctors to visit all bedridden patients in person. It takes no great imagination to project this situation into the year 2000. If doctors were to continue in their present routine, it is patent that they could not possibly visit one in ten patients. The result: an increase in deaths due to the impossibility of treating patients in time.

What then is the solution? Last July the present writer published this account of his opinion:

Long before the end of this century, electronic techniques will have changed doctors' routines; they will have completely revolutionized our present concept of doctor-patient relations.

This is the way we foresee the great change. The coming revolution is based on two important recent electronic developments and breakthroughs: microminiaturization and millimeter waves.

In the future, doctors will equip their patients with a medical wrist band that looks somewhat like a present-day wrist watch. Completely transistorized. It is in reality a radio transmitter which automatically sends out impulses every half hour. These are then recorded on a microtape at the doctor's office or his laboratory.

This is what the mediwristrecorder does: Every 30 minutes, it gives the patient's heartbeat. On the hour or half hour, the patient places his hand with the recorder over his chest, to transmit the rate of respiration, too. If breathing is labored, or if there is coughing, these facts are faithfully recorded. Temperature is recorded at the same time. Before 2000 a.d., it will be possible for a patient to transmit a good electrocardiogram, as well as an electroencephalogram, via the mediwristrecorder, too, simply by placing it in various positions on the body. Without going into too many medical-electronic technicalities, there will be many other tests, such as blood tests, blood pressure and allergy tests that can be made for various illnesses by using special wristrecorders.

You may ask, "How can such a small wristrecorder make such a multiplicity of tests and transmit them at a distance?"

The answer lies in one word: microminiaturization. It is possible right now to make transistors and other electronic components so small you need a microscope to see them. Hence we will soon have an incredible array of instrumentation in a cubic inch of space.

With the fully microminiaturized mediwristrecorder, the doctor can treat dozens of patients, often without leaving his office. He will make his rounds of calls not in person, but over the phone. After looking at a patient's radio-transmitted record, he will know exactly how to treat and prescribe for him. Of course, if the patient becomes seriously ill, the doctor will go to his bedside in person. But the point is that rarely will too many patients urgently require a personal visit at the same time.

Using millimeter waves, it is possible to have various frequencies, one for each patient. If that proves impractical, each wrist transmitter can be equipped with a timing device so that it transmits its signals only on certain periods of each hour. Thus if a doctor has, say, ten electronic patients, each

(Continued on page 114)
Imagination plus

Plus what? Specialized service on auto radios, fixed-price policy, accessible location, low rent—these add up to success in servicing.

By Jack L. Brayton

There has been no really new method of selling radio-TV service since the fad of service contracts ended with public disgust. But a short time ago I did run across a really new idea—a small concern called United Radio. Doug Smith, the owner of United Radio, is a young man full of imagination, foresight and a desire to get ahead.

Instead of merely flinging his doors open to the public and waiting for customers to rush to him, Doug investigated, sought advice and constantly poured fresh ideas into his business. Now he can complete effectively with shops several times his size. Doug puts it: “I offer something no one else does. That means that I reap bigger dividends and my customers receive better service.”

What’s so unusual about Doug’s business? Top on the list is specialization. He repairs only American car radios. Second, he repairs any American car radio, regardless of the trouble, for $7.95. Cadillac is the one exception. Third, he issues a written, 30-day unconditional guarantee with each repair job. This means that any trouble that develops within the 30-day period will be fixed at absolutely no cost to the customer.

Read on and you will see that this is not the crazy harebrained scheme it sounds, but rather a well planned and successful method of conducting a service business without the usual harassments of not having standard pricing, of dealing with people who can’t understand why the service bill is $20, of dealing with people who have no concept of what overhead is, and last, but far from least, of dealing with people who want something for nothing.

Imagination first

His reply to the question of how he got started: “When I first got the idea, I didn’t have any information to back me up and, of course, no reference material. All I had was an idea which I thought to be good.”

Having only the idea and some inexpensive equipment as assets, Doug rented what used to be the office of a construction firm well off the main streets in East Lansing, Mich. A very poor location in every respect, but the rent was only $10 a month and, since Doug only intended to deal with car lots in his first experiment, the poor location didn’t matter very much.

After setting up shop and establishing an arbitrary price of $5.75 for the complete repair of any American car radio, Doug solicited the local used-car lots. With 48 in the immediate area, he had no trouble getting a small volume of radios. The next 90 days Doug spent collecting data on the cost of parts per radio, number of radios serviced under the guarantee and the time consumed in the repairs.

“From a profit point of view,” Doug says, “these 90 days were fruitless. But I learned a great deal from the data I collected. Also, I learned what tools and inventory were needed.

“At this point, I teamed up with another guy, John Leavitt. John was good on promotion and making personal con-
tacts with the car lots. Together we laid out our plans in detail. Now a good location became important. Our problems in selecting the location were:

1. To get it as close to as many car lots as possible.
2. To make it a place easily found by the general public.
3. To get near a heavy flow of traffic.
4. To get a place that could be driven into so that bad weather would not hamper servicing.
5. To pay a minimum rent.

As stiff as these requirements were, Doug and John found a place that met them, this time in Lansing, Mich. Hence, United Radio is presently located within a pleasant-looking and progressive service station. "This is the only place that met our requirements," Doug says, "and gave us these advantages:"

1. It's located on a busy thoroughfare—four-lane, one-way traffic.
2. The car to be serviced can be driven into the garage in bad weather.
3. An air hoist is available for lifting the cars to facilitate servicing antennas.
4. Rent is still at an absolute minimum.
5. Business is picked up from the station, of course, vice versa."

After finding a suitable location, Doug proceeded to set up the shop and John began the advertising campaign. The advertising consisted of a display ad once a week in the State News and the State Journal. Posters were put up in almost every place that had anything at all to do with automobiles. Postcards were mailed. A week of radio advertisements and an attractive sign, and they were in business.

After the initial promotion, John left the business and Doug took complete charge. That was the beginning, but only the beginning. The real work of making it go still lay ahead.

And now the plus

"Successful operation depends on four things," according to Doug.

1. Top speed and accuracy in servicing.
2. Top-quality servicing to reduce to a minimum the number of callbacks.
3. A volume of radios.
4. Public acceptance of the idea.

Let us take these things one at a time and see how he handles them. First of all, his servicing methods are very thorough and very exact. For instance, he knows that the rear mounting nuts of a radio are either 3/8 or 5/8 inch. Both sizes being on the same wrench, he carries only the open-end wrench with him. Also, Doug knows that there are only four main sizes of front mounting nuts and, therefore, he carries only the 3/4-, 1 1/2, 5/8- and 9/16-inch deep sockets.

Also carried is a 1/2-inch deep socket, but it is rarely used. A set of nut drivers, two sizes of stubby Phillips, one stubby clutch-head, one stubby flat blade, and, of course, pliers and side cutters complete the removal and reinstallation kit. "By specialization I've reduced to a minimum the tools and inventory required," Doug points out. "This, of course, increases efficiency while reducing the overhead."

How he does it

Doug explains his service procedure: "After listening to the customer's complaint, only a few brief tests are needed to tell me whether the radio needs to be removed or may be serviced in the car."

"Of course, I check the fuse first. If it's good, I check for power at the hot side of the lead coming to the fuse. If there is power at this point, I pull the set. If the power is not there, then I continue to check the wiring in the car.

"If the fuse is bad and the set is a vibrator type, then it's pulled. The buffer capacitor and vibrator being the most common causes, these will be changed while the customer waits. I never change one without the other. At first I did, but found that I had too many callbacks. If it is something other than the buffer capacitor and vibrator, the bench procedure will disclose this very quickly.

"If the set has a blown fuse and is not a vibrator type, I simply replace the fuse. The fuse in a transistor-powered radio is overloaded by as much as twice its value when the set is first turned on and for this reason it blows, in many models, every 5 or 6 months. However, I always ask the customer to bring it back if it blows again within a short period. Incorrect transistor bias can also cause the fuse to blow in too short a period. Of course, there is no charge when only the fuse is blown.

"If the new fuse blows immediately, the set is transferred to the bench.

No sound, tubes light

"For this problem, I pull the tubes in succession, starting at the output, and listen for a click in the speaker. When I come to a dead stage, I replace the suspected tube. If sound is not restored, I remove the radio.

FEBRUARY, 1963
"With a transistor-powered radio, you can tell a good deal about it simply by turning it on. When you turn it on, listen for a pop in the speaker. If the pop is there, the speaker is good and is connected. Also the set is receiving power and the output transformer is good. On the other hand, if the pop is not heard, the set is not receiving power, or the speaker is disconnected, or the windings on the output transformer are defective.

Weak or distorted

"The radio is always removed for this fault, with only two exceptions:

1. If the distortion is caused by a warped or loose speaker cone.
2. If the set is weak because of a poor antenna connection. When this happens, a loud rushing noise is heard, even on local stations."

"The reason I pull it," Doug states, "is that even though it may be caused by a single weak tube, too often a weak or distorted radio has a combination of faults that show up only through a careful stage-to-stage check of the entire set.

Cutting in and out

"With this complaint I check the power, antenna and the speaker leads. If this doesn't reveal the fault, the radio is removed for a thorough check.

Automatic tuning defective

"In the automobile, I replace only the relay control tube (12AT7, 12AL8, etc.). If this does not cure the trouble, the radio goes to the bench."

"Certainly, these rules are not infallible," Doug comments, "but they are the ones I have found most effective and time-saving. Nor do they cover every situation. There are not and cannot be any completely cut-and-dried rules for something as flexible and changing as the service business. But a sound servicing procedure and policy applied with judgment will, in the long run, save time and money. I also feel that the customer is never impressed by a technician who spends more than a few minutes checking the radio before he determines if it has to be removed."

On the bench

When the set goes to the bench for further troubleshooting, Doug removes both covers and lays out the schematic for it. After hooking the battery eliminator, antenna and speaker, if required, to the radio, Doug quickly checks each stage with the scope. He always uses the scope for bench checks. "Although the scope I own is extremely inexpensive, I would be at a loss without it," Doug states. "By constantly using the oscilloscope a person becomes so proficient with it that very few troubles will elude him. A majority of the so-called 'dogs' become routine with the scope and a thorough knowledge of its traces. The vibrator, buffer, transformer and filter can all be checked accurately.

"A vibrator with burnt contacts or a high-resistance short in the buffer capacitor will show on the scope long before any voltage or current reading will indicate these faults. With an iron-clad guarantee such as ours, we have to spot these possible troubles before they become actual complaints."

In most cases, Doug checks the radio in this way while the customer waits, thus allowing him either to repair it on the spot or to give his client a definite and fairly accurate estimate of when it will be ready. Even if transformers are replaced while the customer waits, provided Doug has them in stock. He gives three reasons for doing it this way: First, the customer appreciates this kind of service. Second, the customer has the required $7.95 with him when he brings the radio in, but tomorrow he may decide that he has a better use for it elsewhere and the radio is left in the shop for a long while. Last, but far from least, space at United Radio is limited and it is not possible to store a large number of radios. "And besides," Doug says, "the radios under the bench don't do either the customer or myself any good."

So now you say, "OK, Doug has a good deal and has solved a lot of the problems of servicing such as free estimate, credit, customer relations, etc. But now let's have some statistics. Let's see how he is really doing." Here goes.

I took a hundred of Doug's invoices numbered 2101 through 2200 and analyzed them to find the cost of parts per radio, type of work done, and the number of these radios returned under the guarantee.

The cost was figured at the straight wholesale price, although Doug receives several discounts by buying parts in the right quantities and shopping around before he buys, and the normal discount for cash. However, they vary from time to time so were not taken into consideration here.

The cost for parts per radio averaged $1.82, which Doug says is about normal. However, it has been as low as $1.31 and as high as $2.85.

The percentage of radios returned for further service under the guarantee ran about 5%. The average cost of those serviced under the guarantee was $76, and fell sharply into five categories.

1. The printed circuit developed a bad connection.
2. A tube had failed.
3. The new part put in the first time had failed. (A small percentage of f.i. transformers failed)
4. A dial light had burned out.
5. Miscellaneous; turn-signal noise on weak stations, dial cord broken, etc.

Public acceptance of the idea has been steady and rapid. "At first," Doug said, "I got only the dogs that had been circulated from shop to shop. But when I proved myself on the tough ones, word-of-mouth advertising did wonders. Actually, getting the tough ones at first helped me to formulate a very thorough service procedure. Of course, some radios still give me the run-around, but they are getting fewer."

Now let's look at it from the customer's viewpoint. First of all, it's worth $7.95 to most people to have their radios repaired when the technician repairs, not only the main trouble, but puts the set into excellent condition.

Second, they know the price before they come in and need not worry whether they can afford it. Last of all, we come to Doug's main selling point, the 30-day guarantee, not only on his parts and his labor, but on the entire radio. This guarantee eliminates dissatisfied customers. If they are not satisfied in every respect, Doug will continue to repair the radio, at no additional charge, until no faults are to be found.

There may still be some who will say that it cannot work. But it is working, and very well for Doug Smith. His average earnings have been over $100 a week. For a little one-man shop, not working at its full capacity, this sounds, to me, like good business."
A NEW SYSTEM OF TAPE RECORDING and playback, introduced by Minnesota Mining & Manufacturing and Revere Camera Co., may do for tape recording what the long-playing record did for discs. The parallel is not accidental—the new system was developed by Dr. Peter Goldmark, head of CBS Laboratories, father of the long-playing record. (He described and demonstrated the prototype at the IRE convention in 1960.)

The most interesting feature of the new system is the tape cartridge. It is 3¾ inches square, less than ½ inch thick and, unlike earlier tape cartridges, contains only one reel. Columbia Records has prepared a library of 48 stereo recordings as a start, and, of course, the user can buy blank tape to make his own recordings. Unlike conventional stereo tapes, the new ones have but two tracks. Playing time is 48 minutes per cartridge at 1⅞ ips.

The tapes are stacked in a well, little pins on the top of each cartridge locking into the one above it to prevent displacement. As soon as each cartridge is played, it is rewound in roughly 1 minute and slid out to the side, permitting the next cartridge to fall into place. As many as 20 cartridges can be stacked, giving the listener 15 hours of uninterrupted music.

The second most important feature is the changer mechanism, which threads, plays, rewinds and changes cartridges automatically. When the PLAY button is depressed, the cartridge on the top is pulled down and the other cartridge rises up. A roller then presses against the tape leader through a slot on the edge of the cartridge. This leader is a heavy stiff length of polyester film. Pushed out through a slot in the cartridge, it travels across the playback head and into the takeup reel. At this point, the capstan grips the tape and it starts playing.

The rewind mechanism is triggered as the selection ends, and the tape is zipped back into the cartridge. The cartridge then slides into the bottom of an adjacent well and pushes up the stack of used cartridges.

A third important component of the system is the special tape that provides high-quality reproduction at a playing speed of 1⅞ inches per second. To get quality equivalent to that on conventional tapes at 7⅛ inches, the signal-to-noise ratio was improved 6 db over that of earlier tapes and high-frequency response bettered. This was done with a new oxide and binder. The tape is about ½ inch wide, with an oxide coating of about ¼ mil thick, bonded onto a special 1-mil-thick, prestretched polyester base. It is said to be the first tape ever produced with a noise level lower than record hiss.

Another factor in quality recording is the head, which has a gap only ⅙½ microns wide. Extremely high precision was necessary to design it for such a narrow gap, and for good separation between the two tracks on the narrow (⅛-inch) tape.

Since this system depends on a number of interdependent factors, it is, of course, incompatible with any cartridge or open-reel system on the market. In appearance, however, it is simply another recording—playback machine, weighing about 32 pounds, containing dual record and playback preamps, main amplifiers and speakers, as well as jacks for extension speakers. It can record either monophonically or in stereo from the speaker terminals of radios, phonos or TV sets, or from the tape outputs of hi-fi amplifiers and tuners.

The new unit is not cheap, carrying a suggested list price in the order of $450. Prerecorded tapes would run between $8 and $10 depending on the types of program. Raw tapes for recording will be sold in 450-foot cartridges at a list price of $4.75. A limited quantity of the new tape material will also be sold in regular ¼-inch widths on conventional reels for professional use in making tape masters and similar applications.

NEW AUTOMATIC TAPE CHANGER
Plays 15 hours

How the tape is threaded. Feedout (and rewind) roller pushes leader out into takeup reel, where it is gripped by pressure flanges. The capstan then pulls tape as tapesensing pin brings it up against playback-recording head.
add STEREO to your FM with this simple ADAPTER

By DAVID A. WILLIAMS

This all-transistor adapter uses synchronous switching to separate the multiplex signal into left- and right-channel components. The detection system does not require any phase distorting filters, and the 38-kc subcarrier is a low-amplitude signal easy to keep out of the adapter's output.

Another advantage is this circuit's ability to drive a set of stereo headphones without additional amplification. This makes it an economical, high-quality source of stereo for someone who does not already own a stereo system. The low output impedance also permits long connecting cables between the adapter output and a preamp or headphone input.

While the circuit appears complex, it is quite simple in most respects (Fig. 1). Q1, an emitter follower, provides the current gain to drive the adapter circuits without loading the tuner. Resulting input impedance is about 100,000 ohms. A LEVEL control permits adjusting volume of both channels without changing the level of the pilot carrier.

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Fig. 1—Circuit of the 8-transistor unit. The author reports that he has had better results with 18,000 ohms for R40 than with 33,000.
A considerable portion of the circuit is devoted to generating a stable, distortion-free, 38-kc subcarrier. Q6, a sync amplifier with a tuned base circuit, separates the 19-kc pilot from the composite signal. The tuned circuit helps prevent the 19-kc oscillator from synchronizing with anything but the pilot carrier.

A 1N756 Zener diode stabilizes the voltage on oscillator Q7 and doubler Q8. The 003-µf capacitor shunting Q7 reduces the effect of internal capacitance variations caused by changes in ambient temperature. The two coils and transformer in the tuned circuits are standard J. W. Miller components which were designed for multiplex adapter circuits although not for this specific use.

The diode switching circuit is the most important part of the adapter in that it alone is responsible for separating the composite signal into its left and right components. As the 38-kc subcarrier alternately grounds points A and B, the voltage of the ungrounded point will follow the composite signal.

The type of diode used is not critical and 1N34's or equivalents will work well. The 330,000-ohm resistors compensate for differences in the back resistance of the diodes. With no input applied to the adapter the subcarrier at points A and B should be zero. Pad the 330,000-ohm resistors until this holds true. Since the amplitude of the subcarrier never exceeds that of the audio, it is almost completely removed by the de-emphasis network and no additional filtering is needed.

Following each output of the switching circuit is a de-emphasis network, an amplifier (Q2 and Q3) and an emitter follower (Q4 and Q5). The deemphasis filters consist of the 0015-µf capacitor and 47,000-ohm resistor in the amplifier base circuits and the 1-megohm and 75-µf networks between collector and base. This provides a de-emphasis curve that is within 2 db of the standard over the useful audio ranges but is much sharper at 38 kc for better subcarrier attenuation.

The separation control is in the emitter circuits of Q2 and Q3. When it is set at minimum resistance there is no coupling between the emitters and the separation, while not zero, is greatly reduced. Increasing the resistance increases maximum. Separation is obtained with 300-400 ohms in the circuit. The exact setting depends on the adapter adjustments and other factors.

The emitter-follower output circuits have enough power to drive low-impedance headphones as well as conventional high-impedance amplifier inputs. The 120-ohm resistors limit loading when headphones are used.

The power supply voltage is not critical, but an upper limit is imposed by the rating of the transistors and a lower limit by the voltage regulator circuit. A good working range would be 15 to 22.5 volts. The current drain is 22 ma at 18 volts. A battery will last for a considerable period of time but an ac power supply is more desirable in the long run. Voltages on the schematic were measured with a vtm. They are intended as a guide and may vary somewhat. Set the adapter's controls fully counterclockwise while measuring.

Construction is not especially critical, but you must protect the diodes and transistors from heat. My unit is laid out on a 5 x 8-inch piece of perforated circuit board which was later mounted inside a 5 x 10-inch chassis. The photos show the parts layout on the board.

The only alignment required is to adjust the tuned circuits to their resonant...

**BENCH TESTED**

This unit was carefully tested by Leonard Feldman, formerly of Crosby Teletronics. His report shows that separation and de-emphasis are satisfactory. The adapter will lock in on a stereo signal until the input to the unit drops to 0.2 volt. Since the average FM tuner recovers about 1 volt or so of composite signal for full limiting and full modulation, the adapter will lock in on a pilot carrier even if reception is 14 db below full limiting — Editor
frequency. A signal generator and scope are helpful, but not necessary. Tune to a station transmitting stereo. If the oscillator is detuned, a beat tone will be heard. As the slug on the oscillator coil is tuned, the beat will disappear and separation will be heard. If the other two coils are peaked there should be three settings of the oscillator slug which give maximum separation. Leave the slug tuned to the one in the center. This adjustment is easiest when earphones are used.

The doubler may be tuned for maximum voltage at its output. If a scope or ac vtvm is available, sync amplifier Q6 may be tuned for maximum signal at its base. The voltage is too low at this point for an ordinary vtvm. If no instruments are available, align the sync amplifier by listening for the point where the separation is affected as L1 is tuned. As the coil is tuned through resonance the separation will decrease or change sides. Leave the slug at this point and then go back to the oscillator and tune for maximum separation, making sure that it is still on the center maximum. Many stereo stations make their announcements on one channel only to aid in the adjustment of multiplex receivers.

One subject not mentioned so far is the suppression of SCA subcarriers. Theoretically, no filters are needed if the adaptor is linear; however, several other factors affect this including the bandwidth of the tuner, the level of modulation and the linearity of the transmitter. I was unable to find a station broadcasting both stereo and SCA programs. Some stations broadcasting SCA alone caused audible interference and some did not. Since there are few if any stations using both modes of transmission, no filter was included in this unit. An SCA filter circuit is provided (Fig. 3), should it be necessary. It is advisable that the filter be switched out when not needed to avoid any possible phase distortion.

One of the problems associated with most transistor circuits is the tendency for transistor characteristics to change with temperature. This circuit has been stabilized to the point where it will operate from room temperature to above 120°F without loss of separation.

[To simplify construction, a labeled and drilled printed circuit board may be obtained for $4.80 from David Williams, 26 N. Burgess Ave., Columbus 4, Ohio.]
By DICK BARRETT

All the items shown are exhibits at the Cavalcade of Electronics, a collection of electronic equipment housed in one wing of the Perham Foundation's exhibit at New Almaden, Calif. A number of other exhibits appeared on page 35 of the August 1962 issue.

(Left) A collection of many early mercury rectifiers. In top row, partially hidden by cabinet upright, is a three-part rectifier patented by Steinmetz in 1915.

This original de Forest triode was made in 1906. De Forest wrote in a letter in 1959: "Among the really rare relics you will see there [Perham Foundation exhibit] is one of the original three-electrode cylindrical-shaped tubes with a screw base."

This exhibit was built by Ralph Heintz in 1928. It was to be used as evidence in a patent suit to show that the Heintz-Kaufman circuit was not the same as de Forest's and that at least four other researchers had produced oscillations with a three-element tube before de Forest.

Douglas Perham holds early Farnsworth CRT. It was fabricated from a chemist's flask, the fluorescent screen being painted on the bottom and the electron gun welded into the neck.
Try building this 3-transistor unit

**audio voltmeter doubles as preamp**

*By DAVE STONE*

V1 and V2 are 2N140 if transistors noted for their sensitivity and low-noise operation. V3, a 2N331 audio transistor, feeds the amplified signal to the IN70 diode for rectification. The diode load consists of R22, CALIBRATION pot R23, and the 200-µA meter. Switch S2 connects the amplified signal output to the diode-meter combination, or to AMPLIFIER OUTPUT jacks J3 and J4 for use as a straight voltage amplifier. It also switches the battery power on when turned to METER of AMP.

**Construction hints**

Except for the voltage-divider resistances, mount all components on a 3 x 2 1/2-inch perforated board. Mount R2 through R11 directly on S1. The photos show the amplifier board mount-

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**Battery-powered unit needs no line cord.**

The Trans-Audio voltmeter is an extremely useful piece of test equipment for the serious audio or hi-fi constructor, service technician or engineer. It is a portable, transistorized rms ac voltmeter that can measure signal levels from below 1 mV to 20 volts, over the audio-frequency spectrum. It can also be used as a general-purpose low-level preamp with a voltage gain of 10 into a high-impedance load, and a frequency response flat within 3 db between 20 and 20,000 cycles. The voltmeter has a minimum input impedance of approximately 50,000 ohms, and the amplifier section puts a maximum undistorted signal output of 1.5 volts peak into 50,000 ohms.

The test set is powered by a 6.5-volt mercury cell. Total current drain is only 4 ma, so long battery life is assured.

The Trans-Audio voltmeter is a three-stage, common-emitter transistor amplifier driving a detector diode which feeds the indicating meter. R1 sets the minimum input impedance of the voltmeter for relatively light loading of the circuit to be measured. Resistors R2 through R11 form the voltage divider input for the voltage ranges selected by S1, the RMS VOLTS range switch.

The three stages are ordinary voltage amplifiers with each base biased with a resistor from base to ground and base to supply voltage. R24 and the voltage divider chain are V1's base bias resistors, R13 and R14 for V2, and R18 and 19 for V3.

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*NOTE:* ALL ODD VALUE RESISTORS ARE SELECTED 10% UNITS. IF DESIRED USE 1% OR 5% TYPES

- R1 - 47,000 ohms
- R2 - 16,000 ohms (selected 15,000-ohm 10% resistor)
- R3 - 3,000 ohms (selected 2,700-ohm 10% resistor)
- R4 - 400 ohms (two 200-ohm units in series)
- R5 - 220 ohms (two 100-ohm units in series)
- R6 - 100 ohms (selected 120-ohm 10% resistor)
- R7 - 50 ohms (selected 56-ohm 10% resistor)
- R8 - 30 ohms (selected 27-ohm 10% resistor)
- R9 - 6 ohms (three 18-ohm units in parallel)
- R10, R11 - 2 ohms, 1%,
- R12 - 5,000 ohms (selected 6,800-ohm 10% resistor)
- R13 - 5,000 ohms
- R14 - 18,000 ohms
- R15, R16 - 2,200 ohms
- R17 - 4,700 ohms
- R18 - 68,000 ohms
- R19 - 5,600 ohms
- R20 - 2,700 ohms
- R21 - 180 ohms
- R22 - 6,800 ohms

R23 - pot, 2,500 ohms, wirewound, linear
R24 - 51,000 ohms, 5%  
*NOTE: All resistors are 1/2-watt 10% units. Those used in the voltage divider are selected to be close to the indicated values. For greater accuracy, use 1% resistors in the divider.

C1, C3, C5, C7 - 15 µf, tantalum (Mallory TAJ515-10 or equivalent)
C2, C4, C6 - 250 µf, 6 volts, miniature electrolytics (Sprague 161105 or equivalent)  
BATT - 6.75 volts, mercury (Mallory 1R135R)
D - IN70
J1, J2, J3, J4 - 3-way binding posts
M - Meter, 200 µA, dc
S1 - single-pole 11-position rotary switch
S2 - double-pole 3-position rotary switch
V1, V2 - 2N140
V3 - 2N331
Case, to suit
Miscellaneous hardware
ned above the input jacks and alongside S1. If another layout is used, keep J1, J2, C1, R1, S1 and V1 as close to each other as possible to minimize hum pickup. Also, wire all grounds to one common chassis connection.

Placement of S2, J3, J4, the meter and battery is not critical. In this unit, the panel components were mounted and interconnected, the amplifier board wired, and final assembly completed by mounting the amplifier board and wiring the few remaining connections. My meter is housed in a 7 x 5 x 2-inch aluminum chassis. An aluminum cover forms the back. It is absolutely necessary to enclose the instrument completely in a metal case to keep stray hum fields from the input stage.

C2, C4 and C6 are miniature tantalum capacitors. They can be replaced with conventional electrolys if you wish. Since the electrolytics will be larger, arrange the layout to keep the capacitors close to their respective stages for the shortest connections to the emitter. On the other hand, C3, C5 and C7 must be good-quality tantalum units.

The accuracy of the Trans-Audio voltmeter depends upon the accuracy of the range voltage-divider resistances. The range resistors in this unit were selected from 10% units measured on a resistance bridge and provide an over-all instrument accuracy of 5%. If 1% resistors are used, accuracy increases to 3% or better.

Calibration and use

After completing the unit, temporarily connect a milliammeter in series with the negative battery lead and turn S2 to the METER position. If the wiring is correct, the meter will indicate about 4-ma drain. If the current is appreciably higher, check the wiring for mistakes, wrong placement of the transistors in their sockets or defective transistors. When the correct current is obtained, rotate S1 to the .002-volt position and touch the hot side input jack (J1) with a finger or screwdriver. This will cause the meter to deflect full scale and indicate that all is well with the amplifier.

Obtain an audio signal generator and a standard accurate vtvm for calibration. Set the generator for 1,000 cycles, connect the vtvm to the generator's output jacks and adjust the output level for exactly 1 volt rms on the vtvm. Rotate the Trans-Audio RMS VOLTS selector to the 1-volt setting, turn S2 to METER and connect it across the generator's output jack. Adjust R23 for a full-scale reading, then check the other ranges by adjusting the output level of the generator. The 1-volt calibration will suffice for all ranges if resistance tolerances are close.

Applications

The Trans-Audio voltmeter can be used wherever low-level audio signals are to be measured. It will measure the output of most cartridges and microphones, voltages across speaker voice coils, the levels across audio transmission lines, voltage gain per stage of audio amplifiers and many other similar values. If the voltmeter is used to measure an audio voltage in a circuit that also carries more than 100 volts dc, insert a 1-μf 400-volt paper blocking capacitor in series with the input lead. For example, the blocking capacitor is needed when the voltmeter is used to measure an audio signal at the plate of a tube voltage amplifier fed by a 250-volt dc supply. It causes only a slight decrease in accuracy.

Use the unit as a low-level preamp by rotating S2 to the AMPulse position. The amplifier output at J3, J4 can be used to extend the sensitivity of an oscilloscope or drive a power amplifier, headphones or other similar units. The

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**BENCH**

This handy little ac vtvm measures all ac signals from below 1 mV to 20 volts. While not precisely flat over the entire audio range, errors are not large enough to cause trouble and are more than made up for by the portability of the unit. The unit is accurate within 5%. This is not the best possible accuracy, but only the best possible accuracy.

**TESTED**

RMS VOLTS range selector acts as an input attenuator in this application and sets the level of the input signal to provide an undistorted amplified output signal.

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**FEBRUARY, 1963**

Look inside case shows where components are mounted.

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33
CB REPAIRS YOU CAN MAKE WITHOUT A LICENSE

By JACK DARR SERVICE EDITOR

Fig. 1—Setup for aligning CB receivers with AM signal generator and vtvm. Set signal generator to i.f., vtvm to low negative dc volts scale. Tune i.f. transformers for maximum negative swing. Keep generator output down to make avc voltage read about 1 volt. Couple generator as loosely as possible to mixer grid.

Fig. 2—Setup for i.f. sweep alignment of CB receiver. After finishing AM alignment, hook up equipment as shown. You may have to remove crystal to avoid beats in the curve. Sweep rf stages by setting generator to carrier frequency. Feed signal to antenna terminal, keeping coupling loose. Best bet is to hook up regular antenna to receiver and radiate signal into it from piece of unshielded wire connected to signal generator output.

IT IS A VIOLATION OF THE FCC RULES FOR unlicensed persons to make “any adjustments which would affect the frequency or emission” of a Citizens-band transmitter. But there are a lot of service jobs that can be done. You can do anything necessary to the receiver and you can test the transmitter for rf output and modulation.

The receivers are simply AM superhets. (In the better sets, that is. Some of the smaller jobs use superregenerative and other circuits.) Incidentally, Sams Photofacts now has service data for many of the more popular brands. The largest percentage of receivers are crystal-controlled. Some have conventional variable tuning and a switch for selecting adjustable tuning trimmers or crystals.

Receiver alignment

With low-power transmitters, receivers must be at maximum sensitivity at all times to provide good service. The i.f.’s are given in the service data. Use your standard signal generator and the vtvm on the avc for i.f. alignment, as in Fig. 1.

Most i.f. strips are pretty broadband, and sweep alignment isn’t too necessary. However, if you want, it can be done. Fig. 2 shows the setup and a typical i.f. response curve. You’ll probably have to pull the crystal, and perhaps the rf amplifier tube, to get the curve to settle down.

Rf alignment

Rf alignment is a bit more critical, since it must be done at the carrier frequency, around 27 mc. To be sure that the system will work at maximum efficiency, all receivers and transmitters must be on exactly the same frequency. This is called “netting”. So we need a signal on the right carrier frequency. A communications receiver covering the 27-mc band is handy here, but a fixed- or variable-tuned CB receiver can be used. Get a signal from the base station or other mobile station in the same system. Tune the signal generator to approximately this frequency, and couple it to the antenna of the test receiver.

While the signal is on the air, quickly zero-beat the signal generator against it. (Suggestion: with a dummy load hooked up, transmit an unmodulated carrier.) This makes it easier to

RADIO-ELECTRONICS
The average third-overtone crystal will give a reading of 2–3 volts, with a signal generator at full output. If you can’t get any reading, no matter how carefully you tune, the crystal is probably cracked or dead.

By using the crystal from the transmitter, you can use this same test to set the signal generator to the exact rf carrier frequency. Tune the generator very carefully for maximum meter reading through the crystal. When you find this point, the generator is set on exactly the right rf carrier frequency. Don’t use receiver crystals; they are not on the carrier frequency, but on the tube. When a signal comes in, the “ave” circuit develops a positive voltage in direct proportion to the rf carrier strength. (We call this ave for the sake of analogy. Actually, it’s the same thing except for polarity. A separate squelch rectifier delivers the needed positive voltage.) This bias voltage is fed to the grid, where it cancels the blocking bias applied by the cathode resistor. The tube conducts and the audio signal can flow through. When there is no rf carrier, no voltage is developed, and the squelch tube is blocked, cutting off the audio.

As the final step in aligning a mobile receiver, replace it in the car. After warmup, have the base station give you a short call. While listening to the call, tune the receiver’s antenna trimmer for maximum signal.

You can trim a whip antenna, of any type, to be resonant at the transmitter frequency by tuning it to resonance when used for receiving. The Rayleigh-Carson reciprocity theorem says that an antenna has identical characteristics whether it is used for transmitting or receiving. So, if you want to replace an antenna whip or trim an existing whip to a new channel, trim it until it will resonate when receiving, and it will also be resonant for transmitting.

Check the antenna to see that it
The transmitters are supposed to be able to modulate the carrier at least 85%, which means about a 20% increase in peak rf power. To test for modulation, press the mike button and whistle sharply into the mike. The lamp should glow perceptibly brighter as long as the modulation continues.

The second method, and one which can be used without any physical contact with the transmitter at all, uses a pickup rod, diode and a meter of some kind. We use the 0–50-µa scale of our shop vom. A piece of wire or a discarded auto antenna is used to pick up rf from the CB antenna. It is connected through a diode to the vom. (The diode may be connected in series with the pickup wire or simply shunted across the meter terminals.) It rectifies the rf signal and turns it into a minute direct current (Fig. 6).

This type indicator reads nothing but radiated rf, making it about as efficient as you'd want. Maximum reading on the meter means maximum radiation from the antenna.

If the reading is not high enough, use a longer pickup wire or move closer to the transmitter antenna. However, don't get too close. If you place the pickup wire within a quarter wavelength of the antenna, you will distort the field pattern and actually reduce the total radiation. Increase the pickup rod length, or use a more sensitive meter. For maximum sensitivity, make up a tuned circuit which resonates within the 27-mc band, and connect the diode in series with it. If you whistle into the mike while this test is being made, you'll see the increase in power caused by the modulation. If there is no increase in the meter reading with modulation, check the speech amplifier tubes, which are usually the audio output tubes in the receiver. The microphone itself may also be defective.

**Keying**

Some of the smaller sets use a simple selector switch to change from receive to transmit. If the equipment is mobile, it is usually controlled by a keying relay, which acts as a remote switch. This relay in turn is controlled by the pushbutton switch on the microphone.

You may find some peculiar circuits in some sets, on this keying relay. This is especially true in those designed for both 117-volt ac or 12-volt battery operation. In the ac position, the relay is energized by 12 volts dc developed through a silicon rectifier, from the power transformer (Fig. 7). If the diode shorts, as can happen if the output is accidentally grounded, replace it with a 750-ma TV rectifier.

Some trouble has been found while working these sets on batteries. When battery voltage drops to about 10, the radio will still work but the relay won't close. To cure this, replace the relay with one that will close with 10 volts through its coil. Or you may be able to adjust the relay so it will operate at a lower voltage.

So there you are. You can do a lot of things with a CB set, even if you're not a licensed technician. Of course, if you take my advice, you'll get a second-class Radiotelephone license, which isn't too difficult with a little study. You can get all the dope from the Superintendent of Documents, Washington 25, D.C., in the Study Guide. In the meantime you can pick up a lot of extra business by getting into the CB repair end of our industry. There are thousands of these units running around now, and more being licensed every day.

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**Fig. 5**—Pilot light socket, pilot light and antenna connector used for dummy antenna.

**Fig. 6**—Simple radiation indicator for CB transmitters. Maximum reading indicates maximum output.

**Fig. 7**—Partial circuit of power transformer, rectifier and relay circuit as used in one popular CB set.

**750-ma top-hat type silicon rectifier used to replace rectifier for keying relay voltage.**
MODELS WG-5277B, 5377B, 5278B, 5378B, 5279B, 5379B

TRIM HERE AFTER FOLDING

MODELS GT-3313A, 4133A, 3233A, 4933A, 5333A

CUT HERE

CUT HERE

TUBE LAYOUTS IN TV SETS

Compiled by Larry Steckler,

AIRLINE 1961-1962
Montgomery Ward
Chicago Ave. & Larrabee St.
Chicago 7, Ill.

HOW TO FOLD
Fold the top down and back, keeping the cover facing you. Then trim the right and left edges. Now staple the booklet along the vertical center fold, about ¾ inch from the top and bottom. Now fold from left to right, keeping the cover facing you. Trim a fraction of an inch off the top and trim the bottom to size and you're finished. You now have another useful piece of service data, exclusive with RADIO-ELECTRONICS.
this lab’s whole job is Service Research

TO THE AVERAGE TECHNICIAN, “LABORATORY” means a research institution. Secondly, it might be a design lab. The idea of a laboratory for TV and electronics servicing might come as a new one to many. Just what does a service laboratory do?

The chief function of the one shown in part on our cover (the RCA Service Co. lab at Cherry Hill, N. J.) is to investigate service problems and their causes in RCA TV receivers. Any new or unexplained problem in a set, particularly one which appears cropping up in a large number of receivers, which centers around a given component or portion of a set or—as sometimes happens—troubles isolated in a given geographical area, become immediate problems of the laboratory.

Suggestions are worked out for servicing methods or production and design changes. Service notes are also worked out and sent out to the field, as are instructions which sometimes result from production changes. (A change in the tuner, for example, may make it desirable to change the values of components in other parts of the set.) The service company also prepares all the manuals for RCA receivers.

One of the most interesting sights in the lab was a number of picture tubes rigged up in plain frames with yokes and associated components. There were enough of these jigs so that any model brought in could find a tube, yoke, focus and other components matched to it. (These jigs are used as time and effort-savers in all branches of the RCA Service Co. Sets can be serviced without bringing the tube to the shop, even though they may be older and less common models.)

Designs test gear, too

The service company is proud of its work in pioneering test equipment. Actually a very old organization, with its roots back in the '20's or earlier, the greater part of its business is commercial and government work. Servicing motion-picture equipment, computers, broadcast transmitters, marine communications equipment and missile launching, guiding and tracking systems, constitute its main activities. Television, and later color television, was what drew the service company into the consumer products field. No test gear was available for much of the equipment on which the service engineers had to work.

For example, when the first all-electronic pre-war TV's were tested, the lab was asked to send six of its best engineers to install and maintain receivers. Since there was no portable test equipment worth speaking of at the time, the engineers had to develop their own, some of which became the standard dot and color bar generators now sold under the RCA trademark.

This work is still going on, and service engineers in the lab were checking TV remote controls with a piece of test equipment that bore a service company model number, and which had not (at least as yet) been put on the commercial market.

The laboratory also points out that many of its discoveries are now standard throughout the service industry, though they may not be embodied in the form of test instruments. For example, the cathode-emission rise-time method of predicting the life of a kinescope was developed by an engineer in the service company's quality laboratory, during the period when it was handling quality control for the manufacturing division of RCA. John Meagher’s dynamic demonstrator, the first of a large group of electronic trainers now used, was constructed while he was an engineer for RCA Service Co.

One of the jigs used in checking TV receivers.
contact load multipliers

By RONALD L. IVES

At many industrial installations, as well as most research and development establishments, small contacting instruments such as thermostats, flowmeters, anemometers, pressure switches and limit indicators need an inordinate amount of servicing, largely because of contact troubles.

These instruments were originally designed to operate low to medium-current lamp and indicator loads, which are substantially resistive. Many are now controlling relays, recorders, electromechanical counters and positioning motors, often in addition to multiple lamp loads. This "adding on" leads to contact overloading, with sticking contacts dominant if the loads are resistive, and to "cone and crater" or "smallpox" contact erosion if they are inductive.

More than three decades ago, heavy loads were controlled by small contacting instruments with an intermediate medium-sensitivity relay. Coil flybacks were minimized by capacitative, capacitative-resistive or unilaterally conductive "spark absorbers". More recently, vacuum-tube switching has been widely used, and will continue to be at many installations where filament current needs, heat and sensitivity of vacuum tubes to shock and vibration are not important.

Early in 1954, when the first power transistors were made available for experimental use, a number of circuits were developed for controlling relatively large power with small contacts, such as those on mercury thermostats. At that time, transistor prices were high ($90.00 each), uniformity was nonexistent and transistors were extremely sensitive to temperature and humidity changes. These factors limited the usefulness of transistors in any ordinary control work, despite the excellent performance of some of the circuits.

A transistor circuit

Today medium-power transistors with uniform characteristics are available over the counter at less than $2.50 each. Improvements in packaging and circuitry have made them insensitive to ordinary changes in temperature and humidity. Such transistors are used in many load controls.

The circuit of a transistorized working contact load multiplier is shown in Fig. 1. It can be used with a wide variety of transistors, loads and power supplies. With the values shown, the control will operate directly any resistive or inductive device requiring up to 5 watts at 6 volts dc, while imposing a load of less than 100 mw (about 8 ma at 12 volts) at the instrument contacts. If the controlled device is a small industrial relay (as shown), its contacts can control loads up to 1 kw. At somewhat higher cost, the load can control a high-power transistor (to 20 or more amperes at 40 or more volts), which will directly actuate a very heavy load.

The contact load multiplier shown uses a 2N307 transistor. When its base is at approximately the same voltage as the emitter, collector-emitter conduction is minimum. If, however, the base is at approximately the same voltage as the collector, collector-emitter conduction is maximum.

As applied in Fig. 1, transistor base bias, when the instruments are open, is supplied through voltage divider R1, R2. This holds the transistor base about 1v5 volts negative with respect to the emitter, and current through the load is about 14 ma, far too little to energize the relay.

When the instrument contacts are closed, the transistor base is connected to the collector load supply line, the base is negative with respect to the emitter by the full supply voltage, and the relay coil in the collector circuit carries about 350 ma, more than enough to energize the relay.

Providing base bias through a voltage divider makes the control circuit...
substantially immune to temperature changes within wide limits. Several simpler circuits, with a series leak, can be used, at a saving of about 20 cents. They can be made to work with a specific transistor within a narrow range of temperatures only, but not with every transistor of this type nor at all temperatures within the operating range.

Shunted across the relay coil (Fig. 1), is a reversed diode. It absorbs flyback pulses from the coil. These have an amplitude many times greater than the supply voltage and a reversed polarity. If consistent performance and long equipment life are desired, this rectifier is essential, as flyback pulses have a devastating effect on most transistors.

A working model of a contact load multiplier, made for use with contacting anemometers and equipped with its own power supply, is shown in the photos. Parts are arranged for convenience during construction and operation. As no high voltages or frequencies are involved, parts placement and lead dress are not critical. In the control portion, however, there is one very critical item—the transistor heat sink. Minimum safe dimensions are 3 x 3 x 3/8-inch copper, or 5 x 5 x 3/8-inch aluminum. It must be electrically insulated from the chassis in this circuit and should be mounted so air circulation around it is not impeded. If the heat sink is omitted, the life of the transistor will be short, and circuit performance may become erratic after only a few hundred cycles of operation. Adequate heat sinks are much cheaper than replacement power transistors.

The ac input to the power supply is mounted on the rear chassis skirt. The power rectifier—a bridge of four 500-ma silicon diodes—is also in the rear. They are mounted in a four-gang clip on a vertical bracket for easy access and cooling.

Resistors and most connections are under the chassis. The resistors are mounted on terminal strips to provide firm support and easy cooling. Wiring can be done with any good grade of hookup wire, and careful workmanship here will preclude a lot of shadownos to hunt for trouble later.

Whatever parts arrangement is used, never box in the rectifiers or the transistor heat sink, and allow for easy access to the relay contacts (if a relay load is used), to permit inspection and cleaning.

Power requirements of this contact load multiplier depend in part upon the load. For the circuit in Fig. 1, 10 volts is the minimum for dependable operation and maximum voltage tolerated by the transistor is 25. Slow voltage shifts between these limits will have no important effect on operation and will not damage components.

If batteries are used alone, 12 volts is recommended. When terminal voltage under load falls to 10, it’s time for new batteries. Shunt the batteries with a 10,000-uF capacitor to extend operating life. Now the throw-away point is reached when the contacts-open voltage falls to 10. The shunt capacitor is particularly useful in cold environments, where the internal resistance of dry cells increases rapidly, reducing the terminal voltage under load.

Where line power is available, a small power supply consisting of a step-down transformer (Stancor P-8130 or equivalent), rectifier and filter is recommended. The one shown in Fig. 2 is ideal for moderate power requirements. Output, with the values shown, is about 17 volts no load. Because of the capacitative filter, very short-term pulse loads of several amperes can be handled. If larger current capacity is desired, use a larger power transformer and higher power rectifiers, with adequate heat sinks.

Although designed to operate from a set of make-and-break contacts, the contact load multiplier will also respond to changes in resistance across the input terminals. With the values shown in Fig. 1, the load will operate promptly with 2,700 ohms across the input, and will drop out positively when the resistance across the input rises to 12,000 ohms. This is within the range of dark and light resistances of a number of commercial photoconductive cells and wide differential operation from these cells is entirely practicable (do not exceed current limits of cells). Close differential operation from photoconductive cells is not recommended.

With the circuit and constants shown, operation is satisfactory between 40°F and 160°F. Substituting a silicon transistor in the circuit (at about 20 times the cost) extends the satisfactory operating range approximately 100°F in each direction.

With the relay shown, operation at up to 22 counts a second was reached in the laboratory. The maximum speed for sustained industrial use is about 15 counts a second. For higher operating speeds, use special relays such as the Stevens-Arnold Millsec which permits speeds considerably higher than 100 counts a second with this circuit. If a 6-volt 5-watt electromechanical counter is used as the load in this circuit, 10 counts a second is reached easily.

Exposure to mixed beta-gamma radiation, at intensities up to 50,000 counts a minute, had no detectable effect on operation, and rf pickup by the device itself seems of no importance. In extreme cases, some filtering of a long input line, between contacts and control, may be needed.

Actual service life of this contact load multiplier can only be guessed at with present knowledge. Continuous operation at 10 counts per second for 10,000,000 counts produced no signs of wear or changed characteristics of any components.

This transistor contact load multiplier appears to be a satisfactory and relatively inexpensive solution to many industrial problems of instrument contact overloading.

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Rectifier bridge is mounted on rear of chassis. It and transistor must not be enclosed to allow for proper ventilation.

Fig. 2—Use this power supply with contact load multiplier of Fig. 1.
Multipath Distortion

Menace to FM Stereo?

Multipath distortion occurs "when an FM signal reaches the receiving antenna by two or more separate transmission paths. This is usually caused by reflection from an obstruction near either the transmitting or the receiving antenna. The signal reflector could be a large building or hill, or a moving object such as an airplane." The phenomenon is well known to television viewers as "ghosts."

Multipath distortion has been noted since the beginning of FM, but has not given most listeners much trouble. With stereo, things may be different. A much wider bandwidth is required, and multipath "ghosting" may even—under certain circumstances—put the left channel on top of the right one, confusing the stereo effect completely.

Multipath Signals Cause Both Audible Distortion and Impairment of Separation in FM Stereo Reception. The audible distortion usually shows up as mushy middle tones, and raspy and harsh high tones; the impairment of separation is normally indicated by the loss of stereo effect of the subcarrier "second channel" and the presence of background noise or hiss in this "second channel". A classic example of the latter can sometimes be heard as "airplane flutter."

The degree or seriousness of multipath distortion definitely varies with locality, but our experience indicates that it is widespread and causes some distortion in a large percentage of all locations, if a top-quality directional antenna is not used.

Many other causes of poor reception and distortion, ranging from poor recordings and faulty station operation to tuners, amplifiers and speakers, of course exist. However, these are frequently blamed when the true cause is multipath distortion. And such multipath audible distortion is found in monophonic FM, as well as stereo FM, apparently to nearly the same degree and frequency. Monophonic FM is not faced with the problem of separation of the subcarrier second channel that aggravates the stereo FM reception problem.

The FM receiver, whether monophonic or stereo and regardless of its quality, sees its receiving antenna as its source of signal, and the fidelity of its reproduction is limited to the purity and sufficiency of this signal. Receiving antenna gain is of real importance in more remote locations, and rotators may be required if directions vary greatly. High front-to-back ratio, excellence of impedance match, narrow directivity pattern front lobe and elimination of multiple side lobes are the prime factors in most locations if multipath distortions are to be eliminated, and real high fidelity realized.

We have carried on a veritable avalanche of correspondence with the field (individual consumers as well as service personnel), which verifies the conclusions from our own engineering test work that high front-to-back ratio on the receiving antenna is probably the most important item in the elimination of multipath distortion, which has shown up in a surprisingly large percentage of stereo FM receiving locations. A narrow directivity pattern front lobe and elimination of multiple side lobes seem to run a good second in curing these problems, along with excellent impedance-match characteristics. Impedance-match characteristics seem to become more important as the installation becomes more remote, since installation is made on a higher mast requiring longer transmission line, thus making line reflections from impedance mismatch more important.

The fact that FM receivers have greater sensitivity than TV receivers and that FM enthusiasts are more critical and discerning seem to have combined to make the elimination of multipath reflections more critical and demanded in high-quality FM reception than in most TV reception. We also find that the FM enthusiast is more apt to study and intelligently compare FM components and antennas than the vast majority of TV viewers.
THE MOST IMPORTANT EFFECT OF MULTIPATH DISTORTION UPON STEREO RECEPTION, BEYOND THAT UPON MONOPHONIC RECEPTION, IS THAT IT INTRODUCES NOISE AND PHASE-SHIFT EFFECTS IN THE RANGE BETWEEN 23,000 AND 53,000 CYCLES—THAT PART OF THE TRANSMISSION CHANNEL CARRYING THE STEREO INFORMATION.

This is heard as whistling, rushing or warbling noises in the background, accompanied by a rasping distortion, which is partly or totally eliminated when the listener’s system is switched to monophonic reception.

Few localities are immune to multipath problems, although heavily populated urban areas, with concentrations of structures that reflect radio waves, undoubtedly present more of a problem than suburban or rural locations.

Distortion caused by multipath reception can easily be mistaken for poor alignment or low signal strength, and vice versa. The simplest test is to try another station in a different direction. If a rotatable antenna is being used, it is sufficiently directional, turning it will usually establish whether the distortion is due to reflected signals.

In monophonic FM listening, the result of multipath interference is not as likely to be heard. It most often consists of ultrasonic noise, which, even if passed by the audio circuitry associated with the tuner, is not likely to be audible. It is the much greater audio bandwidth required by stereo transmission that has enlarged the problem, since the ultrasonic noise is now converted to audible frequencies by the multiplex demodulating circuitry. Moreover, the phase disturbances associated with multipath reception can severely confuse the multiplex circuit, which depends on exact phase information to sort out the left and right channels properly in a stereo program.

So, assuming that no more actual interference exists now than did before multiplexing became common, the stereo listener is more likely to have his listening disturbed. Since multipath reception causes distortion of phase, frequency and amplitude, tuners that exaggerate these effects will be especially susceptible to multipath problems; this is particularly true where limiting is poor, bandwidth narrow, or capture ratio (the rejection of co-channel interference) is inadequate.

While no simple method of designing tuners presents itself that would totally eliminate such interference, or, rather, its effects, the theory of FM reception supports the hope that this may someday be possible. In the meantime, rotatable directional antenna systems would appear to offer the home listener the best hope of improving reception now disturbed by multipath distortion.

FOR MONOPHONIC FM RECEPTION MULTIPATH DISTORTION HAS NEVER BEEN A MAJOR PROBLEM. FM LIMITERS HAVE BEEN ABLE TO ELIMINATE THE VARIATIONS IN SIGNAL INTENSITY DUE TO CANCELLATION AND REINFORCEMENT OF MULTIPATH TRANSMISSION. A SLIGHT PHASE SHIFT IN THE HIGHER END OF THE AUDIBLE SPECTRUM IS CAUSED BY MULTIPATH TRANSMISSION ONLY NOTICEABLE TO THE EAR. AS A RESULT OF THIS, MULTIPATH RECEPTION IS TROUBLESOME ONLY IN FRINGE AREAS, WHERE TRANSMISSION CANCELLATIONS CAUSED THE SIGNAL AT THE RECEIVING ANTEENA TO DROP BELOW THE LIMITING CAPABILITIES OF THE RECEIVER.

WITH FM STEREO RECEPTION, THE SITUATION CHANGED. SINCE THE FAITHFUL REPRODUCTION OF THE STEREO FM PROGRAM REQUIRES THE MAINTENANCE OF VERY CAREFULLY CONTROLLED PHASE RELATIONSHIPS OF THE MAIN AND SUBCARRIERS, ANY PHASE DISTORTION CAUSED BY MULTIPATH INTERFERENCE WILL BE NOTICEABLE TO THE LISTENER. IT MANIFESTS ITSELF IN LOSS OF STEREO SEPARATION AND, IN SEVERE CASES, MAY GIVE RISE TO HARMONIC DISTORTION.

DURING THIS LAST YEAR, WE HAVE HAD THE OPPORTUNITY TO INTRODUCE MANY THOUSANDS OF FM TUNERS AND RECEIVERS TO THE MARKET, AND HAVE BEEN ABLE TO STUDY, ON A NATION-WIDE BASIS, THE DIFFICULTIES CAUSED BY FM MULTIPATH DISTORTION. FORTUNATELY, IT APPEARS THAT A VERY SMALL PERCENTAGE OF LISTENERS HAVE BEEN PLAGUED BY THIS DIFFICULTY. IN ALMOST ALL OF THESE CASES, A CHANGE IN THE ANTENNA SYSTEM ELIMINATED THE PROBLEM. AS A REMEDY, WE HAVE RECOMMENDED THE INSTALLATION OF AN ANTENNA WITH STRONG DIRECTIONAL CHARACTERISTICS, SUCH AS A YAGI AND A CAREFULLY INSTALLED ANTENNA TRANSMISSION LINE TO LINK THE RECEIVER WITH THE ANTENNA WITHOUT THE INTRODUCTION OF STANDING WAVES.

QUITE OFTEN THE DIFFICULTIES ATTRIBUTED TO MULTIPATH INTERFERENCE ARE ACTUALLY CAUSED BY IMPROPER ADJUSTMENT OF EITHER THE STEREO BROADCAST EQUIPMENT OR THE MULTIPLEX CIRCUITRY WITHIN THE TUNER. THE AUDIBLE RESULTS ARE SIMILAR, USUALLY AGAIN LACK OF STEREO SEPARATION, AND AUDIO DISTORTION.


VISUAL INDICATORS HAVE BEEN INVENTED TO TRACK THE NOISE LEVEL AS CHANGES OCCUR. THEY WILL SHOW A WARNING SIGN TO THE USER WHEN EXCESSIVE NOISE LEVELS ARE DETECTED. THIS CAN HELP TO PREVENT THE USER FROM BEING SURPRISED BY AN OUT-OF-TUNE TRANSMISSION.

IN FM STEREO RECEPTION, THE MOST IMPORTANT EFFECT OF MULTIPATH PROPAGATION IS AUDIBLE DISTORTION, SOMETIMES CaUSING COMPLETE LOSS OF INTELLIGIBILITY. MULTIPATH DISTORTION IS ACCENTUATED DURING STEREO BROADCASTS BECAUSE THE METHOD USED TO TRANSMIT STEREO INFORMATION REQUIRES, NOT ONLY A MUCH WIDER FREQUENCY SPECTRUM THAN MONOPHONIC FM, BUT DEPENDS TO AN EVEN GREATER EXTENT ON AMPLITUDE AND PHASE RELATIONSHIPS. IN ADDITION, MULTIPATH PROPAGATION CAN CAUSE AN IMBALANCE IN THE TWO SIDEBANDS PRODUCED BY MODULATION OF THE 38-KC SUPPRESSED SUBCARRIER, THUS INCREASING DISTORTION. ALTHOUGH MULTIPATH ALSO DECREASES CHANNEL SEPARATION, THIS LOSS IS NOT NEARLY AS OBJECTIONABLE, BECAUSE THE ACCOMPANYING DISTORTION IS MUCH MORE DISTURBING.

MULTIPATH DISTORTION IS NORMALLY

OUR PANEL

L. H. Finneburgh  
President, Finney Co., manufacturers of FM and TV antennas.

John Frank  
Director of Research, Dynaco, Inc., manufacturers of the Dyna-Kit amplifier and Dynamater.

Robert E. Furst  
Vice president, Engineering, Harris-Kardon, Inc., manufacturers of Citation amplifiers and tuners.

F. L. Mergner  
Director of Engineering, Fisher Radio Corp., pioneer manufacturer of audio and FM field equipment.

Richard Sequeria  
Assistant Chief Engineer, Marantz Co., Inc., makers of Marantz amplifier and tuner.

Daniel von Recklinghausen  
Chief Research Engineer, H. H. Scott, Inc., makers of audio and FM equipment.
more prominent in large cities due to the greater number of reflecting surfaces, such as tall buildings, especially those with large metal surfaces. However, it can occur in outlying areas as well. Tests using monophonic transmissions show that distortion becomes more serious as the difference in path lengths and the amplitude ratio between reflected and direct signals increases.

Loose connections, especially at one of the antenna terminals, can cause mismatch between the antenna and the input circuit, a condition which will reflect and delay a portion of the signal and cause distortion which could easily be mistaken for multipath. A drifting 38-ke generator in the multiplex section, poor synchronization due to marginal gain of the 19-ke amplifying circuits, especially during weak signal periods, can also cause phase distortion in addition to loss of separation.

In some locations there can be a problem with multipath reception even on monophonic programs. Investigations have shown that for path differences less than about 1/4 mile, delayed signals at relatively large amplitude can be tolerated as long as the FM receiver maintains adequate AM suppression. As the path difference increases from 1/4 mile, the spectrum of distortion extends to higher order harmonics. Since the ear is very sensitive to such harmonics, the tolerable amplitude of the delayed (reflected) signal falls off very rapidly over the range of path difference from 5 to 12 miles.

For path differences of 18 miles and more, the harmonics spectrum extends beyond the audible range, and the distortion is heard as a hissing noise.

Tuners which maintain a minimum AM suppression of 35 to 40 db under all receiving conditions are able to reduce multipath distortion during monophonic reception to acceptable levels. Therefore, I do not feel that this problem is too serious in most areas at the present time.

I would estimate that in urban areas one out of two installations using an antenna that proved sufficient for monophonic reception could have trouble with multipath distortion during stereo transmissions.

Antennas, highly directional in the vertical as well as horizontal plane, and rotators solve most of the problems. However, good tuner design can also help. For example, having the proper match between antenna and input circuit of the FM tuner will eliminate the possibility of reflections in the lead-in. Well designed tuners with a good capture ratio (low numerical figure in db), as well as a high order of AM suppression, will generally provide much more satisfactory monophonic and stereophonic reception than others under conditions of multipath propagation.

Multipath distortion of FM stereo reception may cause more or less severe high-frequency distortion, inability to recover the 19-ke pilot, phase shift of the upper sideband of L — R signal, reversal of the left and right, and a further decrease in the signal-to-noise ratio. How can the listener recognize it? The only practicable solution we know is our oscilloscope tuning indicator, which presents dynamically the instantaneous deviation plotted against the produced AM components of a multipath signal passing through a nonphase-linear network.

Multipath distortion quite obviously affects FM monaural reception. This can be heard as high-frequency distortion. For a long while, all of us have been guilty of blaming radio stations for the poor quality transmissions, especially at the high frequencies.

As we increase the bandwidth of the transmitted signal for stereo reception, the problems created by multipath distortion rise at an astronomical rate. We feel that most listeners are likely to have multipath distortion of FM stereo.

Frequently, antennas and rotators with the proper lead-in wire such as a 300-ohm balanced shielded cable can make significant improvements in many locations. However, there must be some tuning device which will display the amount of multipath reduction when the antenna is turned. The receiver that has the most phase-linear response will be least subject to multipath distortion in all cases.

Unfortunately, little serious theoretical work has been done on multipath phenomena. We are all quite ignorant of the specific quantities and qualities. This is what we at the Marantz Co. think:

The long time delay between wanted and unwanted signals is the characteristic that produces the most severe multipath distortion, unlike the shortpath delay that produces the most significant ghosts on television.

If the field strength of the unwanted signal or signals can be made sufficiently low relative to the wanted signal, we will have very low distortion. With the use of the antenna, rotator, proper balanced lead-in and a linear phase i.f. system, we can achieve in almost all cases a very significant improvement in the sound and insure the maximum of stereo separation for a given receiving situation.

Multipath distortion is the result of multipath interference. The transmitted signal reaches the antenna simultaneously over direct and reflected paths. These signals add in phase and in amplitude, and cause undesired phase and amplitude modulation.

The most obvious result of multipath interference is audible distortion that is more noticeable with the tuner in the stereo than in the monophonic mode. The amount of phase modulation is approximately proportional to modulating frequencies, and therefore the higher frequencies show more distortion than the lower ones. With an ideal tuner, only phase modulation will be noticed. The tuner's amount of amplitude rejection is a measure of its performance—at least 40 db is required for good performance.

If the tuner has poor AM rejection, distortion will be greater. The more multipath interference is present the more stringent is the job the tuner has to perform. A directional antenna will always reduce multipath distortion, but this may be difficult to do in cities where landlords may not permit outdoor antennas, or in areas where multiple reflections are too numerous to be eliminated by antenna directivity.

Distortion in the tuner is frequently blamed on multipath interference, but often may actually be a distorted signal produced by the station. The station permits distortion values between 2.5 and 3.5%, not including the amount of distortion in the original recorded material. Therefore any added distortion due to multipath may be unnoticeable because it is relatively small. For best results, a tuner engineered for multiplex operation should always be used. Some earlier tuners were not engineered for that, and show a fair amount of high-frequency distortion.

Separation may be affected to some slight degree by multipath distortion but generally the amount of distortion is considerably higher in the audible degradation of separation.

Summary

It would appear, then, that while agreement on many of the phases of multipath distortion is not complete, there is a general tendency to agree that the remedy lies in an excellent directional and well matched antenna, and that there may be possibilities of further improving the situation by attention to a number of other factors. Especially, excellence in tuner design may have an important effect.
Two transistors and thermistor probes give you an accurate electronic thermometer

Here is an electronic thermometer equivalent to a pair of high-quality glass thermometers without any of their disadvantages. The unit is compact and rugged enough to withstand very rough handling. Its indicating meter can be located remotely in a position where it can be viewed in comfort.

Temp-All can be used to check the operating temperatures of components in tube and transistor circuits. It will measure the temperature inside an enclosure containing the circuits, the case temperature of the transistors or tubes, the case temperatures of the various components—transformers, power resistors, etc. It will also measure inside-outside air temperature for checking the effectiveness of an air-conditioner, for example. Other possibilities are limited only by the inventiveness of the builder.

Six selected ranges cover -15 to +125°C, or +5 to +257°F. A panel switch selects either of two probes which can be mounted in two locations. The meter indicates the temperature at the two locations, so the difference between them can be readily figured. Only one probe is used for spot temperature measurements at one location. The instrument is battery-operated, completely portable and can be held in one hand while the other hand directs the probe.

How it works

The temperature-sensing probes are thermistors, semiconductors whose resistance varies with temperature. The simplified schematic of the Temp-All (Fig. 1) shows the thermistor mounted in one leg of a bridge circuit fed by a constant-voltage battery. As the thermistor’s resistance varies with temperature the currents in the bridge arms vary accordingly. The voltage difference between points A and B changes in direct proportion to the current flow. This voltage change is amplified with a transistor dc bridge amplifier to drive an indicating meter.

Range resistor values in Fig. 2 are selected to allow the bridge to balance at the lower end of each range. When the temperature increases, the thermometer’s resistance decreases and the amplified voltage change causes the meter to deflect upward.

The bridge voltage is fed to the transistor bases through isolating resistors R15 and R16. This transistor bridge amplifier is similar to those found in vtm circuits and amplifies very small voltage differences. The voltages fed to the bases are opposite in polarity, causing one transistor’s collector current to decrease and the other to increase. The microammeter is connected across collector load resistors R21 and R23 in conjunction with R22, the zero adjust potentiometer.

S4, when pressed, shorts the bridge and places an equal potential at each transistor base. Then R22 is adjusted to allow equal current flow through both transistors, so the meter reads zero. When S4 is released, the circuit is balanced and ready to accept the bridge voltage. Resistors R17 through R20 are the transistor base-biasing networks, and R9 through R14 form meter shunts for each range.

The amplifier is powered by a 6.5-volt mercury battery with a nominal drain of 1 milliampere.
Construction and checkout

Try to use transistors whose dc current gains are very nearly equal. Close matching is a must-use a good transistor checker. This is important. It will be impossible to zero the Temp-All with very unbalanced transistors. All other components are standard and easily obtainable, and layout and wiring placement are definitely not critical.

The amplifier and bridge circuit including all resistors and transistor sockets is mounted on a perforated board, which in turn is mounted on the meter's terminal posts. To simplify construction, mount all resistors and the two sockets to the board and complete as much wiring as possible. Then, install the switches, jacks, meter and battery mount, and connect these parts. Finally, fasten the board to the meter terminals and complete the few remaining connections between board and switches.

The thermistor probes consist of a thermistor mounted by its leads to a two-prong mating plug installed in the cap of an ordinary plastic pill vial. The body of the vial has holes drilled into its sides to allow the thermistors to sense the temperature of the surrounding air. Make several long shielded twisted-pair cables with mating connectors to connect the probes to the main unit when it is desired to place the probes at a remote location.

When construction is complete, carefully observe the correct polarity of BATT 2 and insert it into its mount. Do not insert BATT 1 at this time. Disconnect the negative battery lead and temporarily insert a milliammeter in series with the lead and circuit. Rotate S3 to ON and observe the milliammeter reading. If it is appreciably higher than 1 mA, disconnect the power immediately and check circuit wiring, and transistors if necessary, for a defective connection or component.

If the milliammeter reading is normal, switch power off and reconnect the battery lead. Throw S3 back to ON, press the PUSH-TO-ZERO switch and rotate the ZERO ADJUST control in both directions. This will swing the needle of the meter above and below the zero mark on the meter. Then, switch power off, observe the proper polarity of BATT 1 and place it in its mount.

Plug a thermistor probe into J1, rotate the PROBE SELECTOR switch to position 1 and turn the RANGE control (S1) to position 2. Throw S3 to ON, press S4 and zero the meter, then release S4. If the air around the workbench is about normal room temperature (70°F), the meter needle will be indicating between half and full scale. You can now proceed with the calibration.

Calibration is easy

There are two ways to calibrate the Temp-All. The first is fairly simple and requires only the use of a precision resistor decade box. The thermistor manufacturer plots an average curve of resistance vs temperature for the thermistor used in this test unit. If a number of fixed resistors are substituted for the thermistor in the bridge arm, the meter deflects to a reading which represents the temperature indicated by the manufacturer's curve. Simply substitute the decade box set at the resistances shown in the table, note the meter reading and mark it as the indicated temperature. When this reading occurs again with the thermistor probe plugged into place, the temperature of the thermistor will be the same as the resistor-calibrated temperature reading.

The ranges overlap, allowing a particular temperature point at the high end of one range to appear again at the low end of the next range. The thermistor manufacturer specifies a maximum of 10% tolerance between individual thermistor units, but I have yet to find any which has exceeded 5%. It is reasonable, then, to expect about 5% to 10% accuracy in temperature readings using this method of calibration.

Accuracy on the order of 2% can be obtained by hand-calibrating the thermistor probes. This requires the use of a precision decade box, a mercury thermometer, and a precision milliammeter.
of good glass thermometers to cover the entire range. The probe and thermometer are heated and cooled together, and the temperature readings of the glass type are noted vs the meter reading. Although this is a long process, the end result is an accurate scale comparable to the accuracy of the glass thermometer. I submerged a glass type and thermistor probe into a small can of light machine oil which was heated on a stove and cooled in a freezer to obtain the temperature ranges.

**How to use it**

Air temperature measurements at one or two locations are simple. One probe is usually plugged into J1 on top of the main unit in one location and the other probe is located at some remote spot. Switching the PROBE SELECTOR back and forth gives the readings at both locations. If the RANGE SWITCH is on an incorrect range, the meter will indicate below zero or above 200. Merely rotate the range switch until the reading is on scale, press the PUSH-TO-ZERO switch and zero the meter, release and note the reading. Look it up on the calibration chart and obtain the temperature reading.

A measurement at one location is obtained with one probe at the end of a short cable held in the area to be checked. Case temperatures are obtained by removing the plastic vial body and touching the tip of the thermistor to the component. The limiting maximum temperature for the probe's soldered leads is 125°C. If the components to be measured are very hot, locate the probe nearby, but not touching the component, to determine whether the nearby temperature is near the limit. If not, touch the probe to the part, but keep observing the meter! In all measurements, allow the probes to remain in place for a minute or two to obtain an accurate reading.

My Temp-All has been used constantly for electronic and general scientific measurements of heat and cold. It is constantly used to check whether transistor circuitry is operating in a safe temperature environment. Its cost is nominal, and the unit has paid for itself by saving a number of power transistors which were mounted on inadequate heat sinks and several electrolytics mounted too close to a power transformer. You'll soon wonder how you got along without the Temp-All.

---

**Efficient Measurement**

A dealer receives five boxes full of carbon resistors. Each resistor is marked with three red bands and one gold. The factory sends notice that one of the boxes should have had orange rather than red for the second band. The dealer tells his assistant to locate the defective box with four ohmmeter measurements. The assistant does it with only one measurement. How?—Albert S. Lombard

**Open Circuit**

Here we have a two-terminal black box which apparently has some kind of internal power supply. Shorting the terminals gives us a circuit carrying 5 amperes (Fig. 1). The researcher picks up a convenient resistor and places it across the terminals (Fig. 2). Now 3 amperes flow, and the voltage drop across the resistor is 32. What will the terminal voltage be if no current is drawn?—Charles S. Bryant.

**Lights and Chicken Farmer**

A chicken farmer has four chicken houses and his home arranged as shown. He uses one powerful lamp in the center to illuminate the whole area so he can see to go from one house to another. When he arrives at any building, he wants to turn the lamp off. When night catches him indoors, he wants to turn the light on before going out. This can be done with only two hot wires from house to house and, of course, the lamp will have to be connected. (Hint: one lamp wire from the farmer's home, and one from one of the chicken houses.) Use only three dpdt switches and two spst switches.—Ray McQueen

Answers on page 63
No longer a creature of the wild-eyed theorist or artist, it has practical applications both for the professional and amateur musician.

By James W. Essex

As far back as 1944, David Raksin, Hollywood film music composer, used electronic music to get the film "Laura" off the ground. Full of melodrama, the picture somehow failed until he hit upon the idea of adding to the music, at a moment of particular emotional buildup, a weird, spine-chilling sound, like a wind mounting in loudness, wave upon wave.

To manufacture it, he chose the sound of a multitude of piano strings, which, when struck, gave a peculiar "whine". To sustain the sound thus made, he amplified it progressively to offset the natural decay of the piano string once struck.

The initial hammer "blow" also had to be deleted. How it was done is illustrated here. Fig. 1-a shows a piano note—a highly damped oscillation. Raksin arranged that, immediately after the hammers struck, amplification of the ensuing "hum" would begin—not before. Then, as the natural wave train decayed, the amplifier would be gradually "turned up" (Fig. 1-b), compensating for the drop in volume and securing a continuous sound of uniform volume (Fig. 1-c).

Of course, there was a limit to this. Happily, recording on film allowed the process to be duplicated endlessly by merely "photographing" the sound waves over and over again. The desired "weird" sound was then dubbed in over the music.

My own acquaintance with electronic music began almost by accident, as an amateur violist in the Stratford Civic Orchestra. I needed suitable accompaniment for practicing difficult passages at home. Such selections as Schubert's Unfinished Symphony, for example, with its long bass violin introduction, presented real problems. If I could simulate a bass violin with my own instrument, I could practice coming in at the difficult point where the bass violins left off and the violins commenced. Timing was important, and it would help to have that introduction played! But the bass violin cannot be effectively simulated on an ordinary violin.

I had heard something of the new art called "electronic music" at the Stratford Composers Conference. To me, it was a parade of weird noises, but they did produce some interesting effects.

I have a tape recorder and other

Fig. 1—How the "rising wind" effect was produced from a combination of piano notes.

Top-flight equipment here at the University of Waterloo (Ontario, Canada). With the recorder, any sound phenomena can be readily investigated. In addition, the Scott noise generator and the Hewlett-Packard signal generator gave me sound sources to draw upon.

The tape recorder was the obvious answer. The one I used has two speeds—7.5 and 15 ips. If I played the violin at its lowest register but recorded at twice the playback speed, I could get a frequency division of 2. A note played at 246.94 cycles, for example, would be heard from the tape recorder at 123.47 cycles (Fig. 2).

Even so, the violin wasn't able to get low F, but it did not alter the basic idea, which was good and served me well. In playing the passage, the normal time was shortened by half. On playback (the tape was now going at 7.5 ips) the notes were held twice as long, and timing was correct.

Author using violin to produce near-sawtooth waves on tape and scope. University of Waterloo
From here, I went on to discover what the simple change in one parameter of a tone can do. For example, any tone, continued at constant speed with judicious use of the volume control, can be altered to resemble an entirely different instrument. A recording of a sustained violin tone can be played back with an initial "burst" of volume and thus simulate the plucked string of the Hawaiian guitar (Fig. 3)! Amplitude as well as tone can be varied to produce effects not originally there.

My 202A Function Generator has a range of 1,200 cycles down to .008 cycle. In addition, it has three kinds of outputs—sinusoidal, square and triangular. Why not, I thought, use this generator to simulate the bass violin experiment? I could then do it entirely by electronics. Its range could more than adequately cover the very lowest reaches of the bass as well as rise to 120 cycles and above. But which type of wave would give me a tone closest to the bass violin?

I knew, from RCA’s Dr. H. F. Olson’s studies of stringed instruments, the violin gave off waves closely resembling the sawtooth (Fig. 4). Thus, it would appear that the triangular wave, resembling more closely the sawtooth, should give the result I looked for. To "play" the signal generator, I scaled off the bass violin's notes with comparative signal generator dial settings.

The square wave is richer in harmonics than the triangular. This fact, in view of what's been said about stringed instruments, would make it seem that for a bass violin imitation, the square wave would be it (Fig. 5)! Not so! I found the triangular output more pleasing and more realistic. And the reason, after it was all figured out, was simpler than it first appeared. The triangular wave more nearly resembles the sine wave than does the square (Fig. 6). Except for the sharp peak, it is virtually a sine wave. Yet, the sine wave—lacking harmonics or “color”—could not be passed off as anything resembling a bass violin.

Why then can the triangular? The only reason I can give is that it more closely achieved or “matched” the basic frequencies of the bass violin. Thus, at a frequency setting of 50 cycles, for example, my ear hears 50 cycles. Switched to the square wave, the tone had such a preponderance of harmonics I couldn’t tell if I was hearing 50, 100 or 150 cycles. And the ear’s natural lack of response at the lower frequencies, especially below 75 cycles, made me think I was hearing a fundamental of 150 cycles. This was very confusing and gave the impression I couldn’t reach 50 cycles or, by corollary, I couldn’t “play” the low notes of the bass.

Because it’s the relative amplitude of the harmonics to the fundamental that determines the kind of instrument heard, duplicating this pattern results in a reasonable facsimile, electronically, of the instrument desired. The violin is a case in point. The stringed musical instruments emit facsimile waves. I learned that this is due to the method in which tones are produced in the violin, for example. In crossing the strings on a bowed instrument, there’s an initial pull exerted by the bow, followed by a vibration of diminishing strength.

Frequency spectrum analysis, or the study of harmonic relationships to a fundamental, tells us some interesting things about musical instruments. For example, the violin sounds different from the flute because it’s far richer in harmonics! Compare Figs. 7-a and 7-b, showing response for the two instruments playing a comparative note. While the flute is practically without harmonics, the violin displays many harmonics with much strength.

END
unsuspected cause of TV color failure

The bad capacitor can lurk everywhere

A surprisingly large number of color TV failures are due to capacitors. The technician expects to find these in circuits which operate at B-plus or screen-grid voltages. Leaky or shorted capacitors in cathode circuits are less common because working voltages are comparatively low. The few pulsed circuits in color receivers are another story. Capacitors in these circuits have the poorest life expectancy. This results from the strenuous "working" of the dielectric by pulse voltages. Capacitor failure in a keyed-age circuit, for example, would not be unusual. On the other hand, a capacitor failure in a tuned signal circuit with zero dc voltage is quite unexpected. A complaint of very weak color (Fig. 1) is generally pinpointed by changing tubes first, and next by measuring dc voltages and resistances in the chroma section. As a leaky or shorted capacitor usually shows up on dc voltage and resistance tests, capacitor trouble did not appear likely because all dc voltages and resistances were normal.

There was a trace of color in the pattern when the intensity control was turned all the way up. Black-and-white reception was normal. As a last resort, a wide-band scope with a low-capacitance probe was set up. An open capacitor often stops (or greatly weakens) an ac signal without causing a significant change in dc voltages. In such cases a scope will show whether the signal can be traced to one end of a coupling capacitor, only to disappear at the other end. A scope likewise shows whether the output from the subcarrier oscillator is weak or absent.

I checked the oscillator output and found the pattern of Fig. 2, which showed normal injection levels. With the oscillator cleared, I traced the chroma signal next. A color bar generator was used to drive the receiver, instead of an antenna signal. It has the advantage of supplying a steady and standardized signal, which can be adjusted for level or various chroma components as may appear desirable.

The color bar generator was set for I and Q output since the trouble was in the chroma section. With the low-capacitance probe at the bandpass amplifier input, a normal waveform was displayed (Fig. 3). The burst signal, followed by the I and Q signals, appeared normal. The burst is somewhat distorted by the blanker characteristics, but this is of no significance. The horizontal sync pulse is absent, being rejected by the chroma-bandpass input circuit (not shown in Fig. 3). This also is normal.

However, when the probe was applied at the color intensity control, it was an entirely different story. Here, the chroma signal appeared weak and contained integrative distortion (integration of pulses, Fig. 4-a). Now the trouble was pinpointed to the bandpass output circuit. The transformer appeared OK on a continuity test, but might have had some shorted turns. This could account for the integrative distortion as well as the weak output. However, the same symptom would result from a defective 330-µµf tuning capacitor. One end of the capacitor was disconnected, and an ohmmeter test made. The meter read 40 ohms!
With a replacement capacitor wired in, receiver operation snapped back to normal (Fig. 4-b). This rather unusual color TV service case ended up on the profit side of the ledger thanks to prompt use of a scope when meter readings offered no clues.

**Another capacitor kick**

This general approach brings to mind an earlier job on a somewhat similar chassis which also had an unusual capacitor trouble. The complaint was distorted color, with noticeable absence of green hues, and the defect did not show up on dc voltage and resistance tests. There was plenty of color, such as it was. Black-and-white reception was normal. The hue control was operative, but greens were not reproduced if the red and blue bars were properly phased in.

Picture analysis accordingly threw suspicion on the G-Y section. Dc voltages and resistances were well within tolerance, and a wide-band scope was brought in to conduct a cross-examination. The input (cathode) waveform was normal, but the second test (Fig. 5) showed an abnormally large and distorted waveform at the grid bypass capacitor. The most likely cause would be an open capacitor. This was quickly confirmed by bridging the suspect (the .01-µf unit in the grid circuit) with a replacement. The green, cyan and yellow bars reappeared.

To understand why the greens disappear from the picture when the .01-µf capacitor is open, note that the cathode of the G-Y amplifier is driven from the cathodes of the R-Y and B-Y amplifiers. The G-Y stage operates as a grounded-grid amplifier. Because of interelectrode capacitance between grid and cathode, the grid "follows" the cathode unless the grid is returned to ac ground. So, when the .01-µf capacitor opens, the amplifier action substantially disappears.

The dc distribution in Fig. 5 is not entirely obvious, and may appear unusual. Although the grid is returned to the 13.7-volt cathode, it measures only 6.5 volts. The reason is based on signal-developed bias. Although there is no signal as such specified while making dc voltage measurements, the noise level is fairly high, because the G-Y amplifier is preceded by numerous stages, and the age line is not clamped. The noise voltages drive the cathode of the tube and, although the grid is grounded for ac, grid current is drawn on negative peaks of drive. A negative drive to the cathode is the same as a positive drive to the grid.

The grid would rest at 13.7 volts were it not for grid-current flow which cancels about half of the cathode bias voltage. As would be expected, if you shunt a large capacitor across the 560-

---

**fig. 5—Normal waveform found at point X in G-Y amplifier circuit.**

Ohm cathode resistor, the dc voltages at grid and cathode become the same, except for a small contact-potential shift. The ac ground return in Fig. 5 is made from grid to B-plus instead of chassis ground because the R-Y and B-Y amplifiers have their grids coupled to preceding plate circuits energized from the same B-plus line. The scope shows a small ripple on the supply line, which varies with the changing chroma signal. Thus, this method of returning the G-Y grid to ground prevents the chroma amplifiers from seesawing the B-plus ripple.

**Noise on video waveforms**

The noise voltages which produce the perhaps unexpected dc distribution in the G-Y amplifier also appear superimposed on video waveforms whenever i.f. bias is low. Fig. 6 shows noise on a video amplifier signal. To avoid noise disturbance in waveform checks, set the color bar generator output for a desirable signal-to-noise ratio. If there are signs of overloading, adjust the age level control or clamp the age lines.

Unless this is done, the beginner may have unusual difficulty in evaluating waveforms. Most noise voltages are generated in the mixer, although the rf amplifier also make noticeable contributions. The amount of noise interference in video waveforms is determined almost entirely by the signal level at the mixer. If the generator output is increased, the signal-to-noise ratio at the mixer is also increased. The noise level itself is not significantly affected. Thus, a tenfold increase in generator output reduces the apparent noise to about one-tenth of its initial value.

Of course, this tenfold increase in signal level will overload various signal circuits following the mixer if age bias has been set for weak-signal reception. Overload shows up as compression or clipping of the signal waveforms, and is highly misleading if it goes unrecognized. If a signal waveform appears distorted, reduce generator output while watching the waveshape. If the waveform remains the same, but merely becomes noisier, the trouble is actually in the receiver circuits. On the other hand, if the waveform changes in shape and becomes more nearly normal, the trouble is due to overload in one or more of the stages.

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**Fig. 6—This color bar waveform shows blurring caused by noise.**

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MR. WELCH PARTICIPATES in a technical discussion with Charles P. Browning, Contract Manager, and Earl W. Bowman, Electrical Calibration and Repair Supervisor, in the Laboratory where Phibs Corp. operates under contract to the Air Force.

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SERVICE CLINIC

By Jack Darr
Service Editor

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 personal answer and the more interesting ones will be printed here. So if you have a service problem, send it here. We'll do our best to help you solve it.

There is one quality which the electronics technician must have at all times - impartiality while trying to diagnose trouble in an electronic circuit. Let's take an actual case where partiality hurt. Fig. 1 shows a popular vertical oscillator output circuit. The complaint is vertical instability, roll and a revolving tendency to lock the blanking bar firmly in the center of the picture. From your knowledge of this circuit, you ought to start looking for a leaky capacitor.

One run of chassis using this circuit had a poor .015-f capacitor in the feedback loop. It failed in many sets of this series. So, using the law of most likely suspect, we always checked that one first. We were partial to it. I walked into a shop one day and there was one of these chassis on the bench. The technician was looking at it with a sort of hurt look. He said plaintively, "I've replaced that .015, and it still won't work!"

After some conversation, we located the real culprit, a bad resistor in the vertical hold circuit. (The 150,000-ohm unit from the vertical linearity control to ground.) Now you can see the evil effects of partiality. It can slow up your diagnoses tremendously! Simply because this man was partial to that one capacitor as the cause of trouble, he refused to admit that there was any other cause. Sitting here reading and talking about it, we can easily see that practically any part in that circuit could be at fault (20/20 hindsight). But when we get to the bench, unless we maintain that cool impartial attitude, progress is going to be a lot slower than it should.

Here's another good example. I was operating on an ancient Stewart-Warner, a beautifully built 9126 chassis which I've had for many years. Old Faithful developed horizontal hold trouble. When I turned the hold control, which was the core of the ringing coil, clockwise, the picture refused to lock in at all, but flipped out of sync in the other direction. Backward and counterclockwise, I could get a pretty unstable picture or a split-picture with a blanking bar in the middle. The circuit is in Fig. 2. It's a conventional stabilized multivibrator, with a 6AL5 phase detector.

I rapidly diagnosed this as afc trouble. Only one small difficulty — all parts, pulse waveforms, etc., in the afc, checked out perfect! So, away we go. Strip out the ringing coil, raise the value of the plate resistor to about 10,000 ohms and the oscillator works pretty well. (Sync shorted out for this test, as usual.) Now back to the afc. Despite all the time I have spent saying, "Once you check a circuit and find it OK, go..."
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Fig. 2 — Partial circuit of horizontal oscillator-afc circuit of Stewart-Warner 9126. This too has a number of possible trouble spots.

on to another.” I went back and rechecked the afc! I was partial to my original theory (spelled g-u-e-s-s):

After a couple of days, I looked at the stubborn thing and said, “Well, there’s only one resistor I haven’t checked out (the 3,900-ohm unit between the ringing coil and plate). Now, everyone knows that the size won’t affect the operating frequency of the oscillator. I’ve changed this in many sets without trouble. But, I’m going to check you anyhow, since you’re the only part in the circuit that I haven’t checked!” It was about 8,000 ohms, so I replaced it. You know what happened. The set worked beautifully.

The point I want to make is that I was so partial to the idea that the trouble was in the afc that I couldn’t see the slightest possibility of it being anywhere else. This cost me roughly a day and a half of work. If I had been impartial enough to give up the idea of afc trouble as soon as I’d checked out that circuit and gone on from there, the total job time would have been about 2 hours instead of 2 days.

The original diagnosis was good. From the symptoms, it was afc trouble. Where I erred was in being so partial to this theory that I couldn’t let go.

The conclusion to draw from these experiences is: “Always keep that mind open!” Make your first tests based on the probability of the cause, from the symptoms. But always remember that they can mislead you. With a completely open mind you can realize that your first diagnosis is not right, no matter how good it seems, and go on to make impartial tests of other circuit components.

One final example, and I’ll stop. A small TV set came in with very bad sound. The ratio detector transformer was replaced with a high-quality standard replacement transformer, not a factory duplicate. Still, poor sound.

Signals traced out fine up to the transformer input. It would not adjust properly. No crossover in the secondary, just a positive voltage, very small. Still, because the transformer was new, correctly installed and high-grade, I thought it was OK. I was very partial to this make of transformer.

Fig. 3 shows the real trouble. The original circuit used a ratio-detector transformer with the resonating capacitor (C2) for the secondary outside, on the printed-circuit board. This capacitor (C1) was inside the replacement transformer. Being blinded by partiality, I couldn’t see the possibility of any trouble in or around that transformer, so I didn’t look. When I had exhausted all other alternatives, I looked, and there it was. Disconnecting the external capacitor (C2) restored normal sound.

Wasted time on this job, several hours. So watch out for partiality. It’s fine in politics, football games and love, but it doesn’t go in electronics service.

Replacement flyback

I’ve been working on a Bendix TM-21CS TV, and I need a new flyback transformer, part 265086-1. Various manufacturers list replacements, but they’re all autotransformers, while the original is a transformer type. Can you suggest a good replacement or give me a hand in redesigning the set?

R. A. C., Jr., West Point, N. Y.

A Triad D-114 flyback seems to be about your best bet here. It is a transformer type and is listed as an exact replacement. I don’t think you will have to redesign the set.

Three-inch picture

The RCA KCS-47 on my bench has a picture that is about 3 inches wide. I can adjust it to about 4 inches in width. I have checked all the voltages and they are ok. Changing tubes doesn’t affect the trouble.—R. McA., Long Beach, Calif.

This defect means trouble in the horizontal yoke. I ran into the same thing on a couple of other sets with
the same chassis. There is no keystoning and the brightness is good. However, the fact that there is high voltage, and the picture can (usually) be locked in, indicates that the flyback, oscillator, etc., are ok and that the whole trouble lies in just a plain lack of horizontal sweep. This does not seem to show up as a bad capacitor or resistor in the damping network but rather as a peculiar short in the windings. The yoke will test bad on a flyback-yoke tester. Replace it and see if this doesn’t cure the trouble.

**Retrace lines**

There are thin white lines running from upper right to lower left on a Philco 52T1802 (Code 124). I can almost get rid of them by adjusting contrast and brightness.—F. K., Millington, Tenn.

They are vertical retrace lines. You can get rid of them by blanking the picture tube during vertical retrace time. Do this by feeding a spike or voltage into the CRT to cut it off during this period.

Connect a .022-μf capacitor between pin 11 of the chassis interconnecting plug, which is the top of the vertical deflection coil, and the CRT cathode (Fig. 4). This will feed in a suitable blanking spike.

**Silicon for selenium**

Can I replace the selenium rectifiers in a typical TV power supply with silicon rectifiers? If so, will the original surge resistor be adequate? What problems would I encounter?—C. W. F., San Diego, Calif.

There are a few things to watch out for but in general, yes. First thing is the condition of the input electrolytic filter. You’ll get a slightly higher B-plus with silicon, because of their lower forward resistance. In some cases you can compensate for this by increasing the surge resistor slightly. Best way is to add a surge resistor or one of the small time-delay relays, as used by RCA and others, in the B+. It prevents the amplifier from going off the rails and protecting the amplifier.

(Continued on page 62)

---

**NEW! WINEGARD NUKevinor Antenna Amplifier**

**ENGINEERED FOR TROUBLE-FREE, LONG LIFE OPERATION...**

**NO CALL BACKS!**

**INSTALL IT AND FORGET IT...USES 2 NUKEvIs THAT WILL LAST FOR YEARS...COMPLETELY WEATHER-SEALED, WON'T CORRODE...RESPONSRES TO WEAKESt SIGNALS BUT STRONG SIGNALS WON'T OVERLOAD IT (TAKES UP TO 400,000 MICROVOLTS INPUT)...NOT AFFECTED BY HEAT OR COLD...DESIGNED FOR COLOR TV...FITS ANY ANTENNA...FULLY PROTECTED FROM LIGHTNING FLASHES, PRECIPITATION STATIC AND LINE SURGES ON 110 VOLT LINES.**

Uppermost in the minds of Winegard engineers in developing the new Colortron amplifier were two things—1. A new high in performance. 2. Long life and trouble-free operation. For example, a special “lifesaver” circuit gives the two nuvistors an expected life of 5 to 8 years at top performance. This is possible because of a heat sink to control operating temperature and an automatic voltage control.

Winegard’s revolutionary new circuit enables the Colortron to overcome the service problems and limitations of other antenna amplifiers. Colortron will not oscillate, overload or cross modulate because it takes up to 400,000 microvolts of signal input. This is 20 times better than any single transistor amplifier.

The Colortron amplifier will deliver clean, clear, color pictures or black and white, sharp and bright without smear. It can be used with any good TV antenna but will deliver unsurpassed reception when used with a Colortron antenna.

It has an ultra low noise circuit... high amplification... flat frequency response... accurate impedance match (VSWR 1.5 to 1 or better, input and output)... and no phase distortion. Can drive 6 sets or more easily.

Nothing on the amplifier is exposed to the elements—even the terminals are protected. A rubber boot over the twin-lead keeps moisture out. Colortron comes complete with an AC power supply with built-in 2-set coupler. Colortron (model No. AP-220N) lists at $39.95. Twin transistor model AP-220T also available. Input 80,000 microvolts without overload—$39.95. For FM model, AP320 twin Nuvistor, 200,000 microvolts input—$39.95.

Colortrons will be heavily promoted this fall with big ads in Life, Family Weekly, Parade and other consumer publications. Order now—ask your distributor or write for technical bulletin.

You get an extra bonus of quality and performance in all Winegard products.
AS OF OCTOBER 22, 1962—THE

(*it ended the day JFD introduced the Log-Periodic TV antenna)

Wave goodbye to all the Rube Goldberg contraptions with their "Chinese puzzle" combinations of collectors, directors, reflectors.

Now you can solve any reception problem with one compact, precisely engineered antenna—the first TV antenna based on the geometrically-derived logarithmic-periodic scale developed by the Antenna Research Laboratories of the University of Illinois for the U.S. Air Force.

Because it is inherently frequency-independent, the JFD Log-Periodic LPV delivers the same superb performance on every VHF channel—performance comparable to that of a single channel Yagi. And delivers it not only in black-and-white, but in color, and you get FM stereo too!

FOR THE FIRST TIME ONE SCIENTIFICALLY FORMULATED ANTENNA CONFIGURATION SATISFIES ANY LOCATION DEMAND:

Harmonically resonant V-elements operate on the Log-Periodic Cellular Principle in the Fundamental and Third Harmonic Modes for unprecedented performance—in color—in black and white—in FM STEREO

developed by the Famous Antenna Research Laboratories

LPV-17: 15 Active Cells and Director System—up to 175 miles

LPV-14: 13 Active Cells and Director System—up to 150 miles

LPV-11: 9 Active Cells and Director System—up to 125 miles

LPV-8: 7 Active Cells and Director System—up to 100 miles

LPV-6: 6 Active Cells—up to 75 miles

LPV-4: 4 Active Cells—up to 50 miles

Adapted to TV and FM Stereo by JFD

√ ELIMINATES THE NEED FOR AREA-DESIGNED ANTENNAS
√ 100% PREASSEMBLED "FLIP-QUIK" ASSEMBLY
√ MASSIVE TANK TURRET BRACKETS THAT DOUBLE-LOCK ELEMENTS
√ AAA† GOLD BOND ALODIZED TO KEEP THAT BRAND NEW LOOK
√ EXTRA-RUGGED, DOUBLE-REINFORCED IN EVERY DETAIL
√ LIGHTEST IN WEIGHT PER DB GAIN
√ WIND-TUNNEL TESTED CONSTRUCTION
√ LEAST SNOW AND ICE LOADING

†Attractive, Anti-corrosive Armor
'ERA OF COMPROMISE' IS OVER!

of the University of Illinois Proved in Space Satellite Telemetry

HOW THE LOG-PERIODIC LPV MAKES ALL OTHER ANTENNAS OBSOLETE

The JFD LPV antenna is a direct descendant of the logarithmic conical spiral antenna used on the Transit satellite. This basic design is FREQUENCY INDEPENDENT—it works like a conical waveguide to yield almost constant gain, matched impedance and a unidirectional polar pattern across an extremely wide band of frequencies.

Dipole version of spiral antenna has elements whose length and spacing is determined by formulas derived from conical spiral geometry, so that antenna acts like a spiral with geometric progression. A logarithmic scaling multiplier ties the dipoles together into active multi-element cells for each frequency. Crossed phasing harness inserts a 180 degree phase shift between dipoles that cancels signals from rear, reinforces signals from front.

LPV's LPV antenna for TV and FM goes one step further—increases gain and front-to-back ratio while maintaining frequency independence. Forward V-ling of elements shrinks total radiation pattern, narrow V-forward beam for sharp directivity, helps to eliminate ghosts and adjacent channel interference. Forward V also permits low band dipoles to contribute to high band gain by operating on the third harmonic mode.

For example: Operation of the JFD LPV-11 on the low band: The larger dipole cells resonate to the low band TV frequencies at their fundamental wavelength. Within each cell, one dipole absorbs the greatest amount of signal for any particular channel; adjacent dipoles pull in 60% more and the next two dipoles add 30% more signal. Many active dipoles working on each channel with constant impedance guarantee high gain.

On the high band: The third harmonic cell forms at the rear of the antenna for channel 7 and as the frequency increases toward channel 13, the active region moves toward the apex of the antenna. It is this third harmonic operation which guarantees as much as 3 1/2 db. additional gain. Continuous and co-linear directors sharpen forward pattern and give peak performance across the entire VHF TV band.

The actual gain curves measured for the LPV-11 in the JFD Antenna Research Laboratories confirm this fact. Within the band for which it is designed, the principle will also be adapted for UHF and other uses, the log-periodic LPV's impedance, polar patterns and front-to-back ratio are virtually constant—with gain for each channel as high as that furnished by a comparable-sized single-channel Yagi.

The JFD LPV-11 is a new antenna—it is not a cold adaptation of an old design.

Each antenna in the LPV series consists of an array of resonant V-dipoles and crossed phasing bars, constituting a group of "cells." The size of each cell differs from the one before it by a logarithmic factor. For any particular frequency, the active portion of the antenna centers on the resonant dipole (equal to one-half wavelength at that frequency), with the adjacent elements also absorbing significant signal energy. The resonances of adjacent cells overlap, so that as the frequency increases or decreases, it is transferred smoothly from one cell to the next.

In effect, the signal is passed along as the frequency increases—the active array moving toward the apex or small end—until, as the fundamental harmonic reaches one end, the other end approaches resonance in the third harmonic. Conventional wide-band antennas are like rows of compartments, one for each channel desired, with sharp cutoffs. The log-periodic antenna is like a continually moving belt that accepts smoothly any frequency that hops aboard.

SEE THE JFD LOG-PERIODIC LPV AT YOUR JFD DISTRIBUTOR NOW—AND BE THE FIRST ONE IN YOUR AREA TO INTRODUCE AND PROFIT FROM THIS NEW ERA IN TV RECEPTION.

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(Continued from page 59)

(Continued from page 59)

plication of B+ to the set until the tubes have warmed up.

In some old sets, we deliberately replace selenium with silicon to get a wee bit more B+ for added width, etc.

Pips and blips

In a Philco 22B4400 TV, I get a peculiar blip on the vertical oscillator grid waveform (Fig. 5). It moves up the sawtooth and, when it hits the top, the picture rolls. I'm not sure what it is or even that I'm using the right scope probe.—F. S., Pensacola, Fla.

You're using the right probe, ob-

Fig. 5—If the blip on the vertical sweep waveform does not crawl when scope sweep is synchronized to the line the trouble must be in the set's power supply. Obviously (the low-capacitance probe), or you wouldn't even see the blip. This must be some sort of spike voltage getting into the vertical oscillator. This is 60 cycles, but not quite in phase with the vertical oscillator. If it were leakage from the vertical output, it would not move or crawl. Therefore, it must be from the 60-cycle ac power supply somewhere.

To check this, set the scope sweep on "line" and recheck the waveform. If the blip stands still and the waveform crawls, then it is definitely local power supply frequency. The most common cause of this is a glitch (a small spurious peak) in the filter system caused by open line bypass capacitors, slight trace of gas in one of the rectifier tubes or a defective filter capacitor.

END

Correction

A ground was inadvertently omitted from pin 3 of the 6X4 rectifier in Fig. 1 of the article "High-Fidelity TV Sound" on page 29 of the December issue. Add this ground to complete the heater circuits of all tubes except the 6X4.

The B—plus current drain is 29 ma, not 40 ma as on the diagram.
What’s Your EQ?
(These are answers—See puzzles p. 47)
Efficient Measurement
The assistant takes one resistor from box A, two from B, three from C, four from D, connects them in series and applies the ohmmeter as shown.

If the series runs 100 ohms over 22,000 ohms, box A is the mismarked one; 200 ohms high points to B; 300 to C, and 400 to D. If the series is exactly 22,000 ohms, obviously E is the high box.

Open Circuit
Use Thevenin’s theorem. Assume a high voltage source and a series Thevenin resistance. With output shorted, \( V = R_I \). With the series resistor inserted, \( V = 3R_I + 32 \). Substituting, we find that \( 2R_I = 32 \) and \( R_I = 16 \) ohms. Going back to our original, \( R = 16 \) ohms, \( I = 5 \) amperes. \( V \), then, equals 80 volts. If no current is drawn, there is no drop across \( R_I \), output voltage is 80.

Lights and Chicken Farmer
The drawing is self-explanatory.
Industry Production and Design professionals put Heathkits to work in their factories and laboratories for high performance at low cost. Typical Heathkits used are: IO-10 3” DC Oscilloscope, $79.95...IM-11, world’s largest selling Vacuum Tube Voltmeter, $24.95...IG-82, Sine & Square Wave Generator, $51.95...IP-32, Variable-Voltage Regulated Power Supply, $56.95...IP-20, Hi-Current, All-Transistor, Regulated Power Supply, $72.95...IM-30, Laboratory Transistor Tester, $54.88...IM-21, Vacuum Tube Voltmeter for precision AC measurements, $33.95.

Technicians around the world put Heathkits on their service benches for rapid, precision measurements...complete trouble-shooting facilities at lowest cost. Typical Heathkits used are: IM-32, Service Bench Vacuum Tube Voltmeter, $32.95...IO-12, Wide-Band 5” Oscilloscope, $76.95...TT-1A, Mutual Conductance Tube Tester, $149.95...IG-62, Color Bar and Dot Generator for Color TV servicing, $64.95...IG-52, TV Alignment Generator, $54.95...IT-11, Deluxe Capacitor Checker to test capacitors of all types, $29.95...See the complete line in the Heathkit Catalog.
Who is Heathkit?
Heathkit is the pioneer and world's largest manufacturer devoted exclusively to the design and manufacture of do-it-yourself electronic kits. All our efforts are aimed at creating more kits, better kits, easier-to-build kits.

What are Heathkits?
Heathkits are electronic equipment in unassembled form. All parts are packaged in convenient groups and complete, easy-to-read, well-illustrated instruction manual tells you how to put them together. Heath offers over 250 kits from simple portable radios to big analog computers.

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Millions build Heathkits. People with absolutely no mechanical ability or knowledge of electronics as well as skilled electronic experts—all find value, economy, fun, relaxation, and pride of accomplishment in Heathkits. You can too.

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Hobbyists of all kinds find Heathkit test equipment invaluable for pursuing their hobbies with refined techniques. Audiophiles, amateur radio operators, kit builders of all kinds use these Heathkits in their workshops: IO-21, General Purpose 3" Oscilloscope, $49.95...MM-1, Sensitive Volt-Ohm-Milliammeter for all-purpose measurements, $29.95...IT-21, Tube Checker for fast tests of tubes of all types, $44.95...IG-102, Radio Frequency Signal Generator, $27.95...IG-72, Audio Signal Generator, $41.95...IP-12, Low Ripple Battery Eliminator, $47.50.
AN SWR POWER METER IS IDEAL FOR matching a CB antenna to a CB transmitter. The better the match, the more efficient the equipment. The Knight-Kit P-2 measures standing waves, has its meter calibrated in terms of relative power and is easy to use. The relative power scale uses the power output of the transmitter as a base, and measures the increase or decrease in output as adjustments are made.

Here's how it works (see schematic): Inside the pickup box is a section of coaxial cable, between J1 and J2. Two stiff wires, one on each side, are placed parallel to the cable's center conductor. These wires, with their associated capacitances, inductances and resistances, form a bridge circuit. The rf picked up by them is rectified by diodes D1 and D2 and brought out through a cable to the meter box.

S1 in the meter box selects the FORWARD or the REFLECTED position. The meter reads rectified radio energy, so no power or batteries are required.

The 100-ma meter gives full-scale deflection with plenty of reserve sensitivity, even with the low power levels of CB gear. It can be used on either 52- or 72-ohm cable by using the proper resistance for R1 and R2.

The P-2 will also detect power losses in a length of coax cable. Simply attach a dummy load to one end of the coax and the SWR/Power Meter pick-up box between the other end and the transmitter. Then, with the transmitter on, adjust the sensitivity control to give a relative power reading of 10. (A simple nonreactive dummy load can be made from 150-ohm 2-watt carbon resistors—three in parallel for 52 ohms and two in parallel for 72 ohms. Check final resistance—resistors do vary.

Now take out the pickup box from between the cable and transmitter and insert it between the cable and load. Any drop in the reading indicates a
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"The Best Tube Checker they ever used."

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A complete tube tester that is smaller than a portable typewriter yet outperforms testers costing hundreds of dollars. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters.

Even though the Mighty Mite weighs less than 8 pounds, new circuitry by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Then too, it checks for emission at operating levels and shorts or leakage up to 120,000 ohms between all elements. This analytical "stethoscope" approach finds troublesome tubes even when large mutual conductance testers fail. And it does all this by merely setting four controls labeled A, B, C, & D.

Check these plus Sencore features: New, stick-proof D'Arsonval Meter will not burn out even with a shorted tube • Meter glows in dark for easy reading behind TV set • New large Speedy Set-Up Tube Chart in cover, cuts set-up time • Rugged, all-steel carrying case and easy grip handle • Smallest complete tester made, less than one foot square. • The Mighty Mite will test every standard radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes (without damage) plus the new GE Compactrons, RCA Nuvistors and Novars and Sylvania 10 pin tubes.

Mighty Mite also has larger, easy-to-read type in the set-up booklet to insure faster testing. Why don't you join the thousands of servicemen, engineers, and technicians who now own a Mighty Mite tube tester? Tube substitution is becoming impossible and costly with nearly 2000 tubes in use today. Ask your authorized Sencore Distributor for the New Improved Mighty Mite. Size: 10¼" x 9½" x 3½". Wt. 8 lbs.

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Sencore Sam says . . . "They all agree . . . the Mighty Mite is the real answer for the man on the go."

SENCORE ADDISON, ILLINOIS

FEBRUARY, 1963

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loss in the cable—if the meter now reads 5, cable loss is 3 db, indicating that half the transmitter output is lost in the cable. While this is excessive, even the best cable will introduce some losses. These range from 0.93 db in 100 feet of RG-8/U to 1.8 db in 100 feet of RG-59/U.

When checking swr, remember that the swr reading can be interpreted as percent of reflected power—the power not delivered to the antenna. For example, if the swr is 2.11%, the power leaving the transmitter is reflected, and the antenna radiates only 89% of the energy produced by the transmitter.

A swr reading of more than 1 on the line connecting your transmitter to its antenna is caused by a mismatch between the antenna and the transmission line. This results in less than maximum possible power being radiated, which shortens the effective communications range of your equipment. With the P-2 SWR/Power Meter you can adjust your antenna to make it operate at top efficiency and get the maximum possible range from your equipment.

The HO-10
A HANDY INSTRUMENT FOR THE TECHNICIAN or CB or amateur gear operator, this monitor gives a minute-by-minute picture of the rf signal being transmitted and reveals such things as overmodulation, no modulation, nonlinear modulation, etc.

The schematic shows the circuit. A portion of the rf signal to be monitored is picked off the transmitter's antenna feed line and fed to vertical deflection plates of the CRT. A receiver can be checked by taking off a portion of the signal voltage in the i.f. circuit. This signal is applied to the monitor's vertical input, then through an amplifier and on to the CRT vertical deflection plates.

The single-stage horizontal amplifier (V3-c) is one third of a triple-triode compartment. It has a frequency response of ±3 db from 10 cycles to 500 kc and a sensitivity of 500 mv per inch.

The sweep generator requires two triode sections (V3-a and V3-b) hooked up as a free-running multivibrator sawtooth generator. Sweep frequency can be adjusted between 15 and 200 cycles with the front-panel sweep-frequency control.

The oscillator circuit uses a twin pentode compton (V4), each pentode section operating as a phase-shift oscillator. One unit oscillates at 1,000 cycles, the other at 1,700. The pots in the cathodes of these pentodes will vary the frequency slightly, but their primary purpose is to control the output amplitude of their oscillators. These oscillators are used together for test-modulating SSB transmitters.

The clumper circuit automatically deflects the no-signal spot off the screen to keep it from burning the phosphor.

The Heath HO-10 monitor scope is a handy little instrument.

This is needed during a setup for a trapezoid display of a transmitted signal as the trace comes down into a single spot when there is no signal. This circuit, using triode V1-b and diode V1-c, is inserted into the circuit whenever the function switch is in either trap position and the clamp disable switch on the sweep-frequency control is pulled out (switch open).

The power supply is isolated from the ac line by a power transformer. The IV2 half-wave rectifier delivers a negative 1,600 volts for the CRT. A full-wave voltage doubler produces 270 and 580 volts. The rectifiers are silicon diodes—four are used.

The HO-10 will cover 160 through 6 meters. It can be used on 2 meters but some distortion will result. Any transmitter between 5 and 1,000 watts can be monitored.

END
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add $1 handling charge plus postage. Orders over $5. plus postage. Approx. 8 tubes per 1 lb. Subject to prior sale. No C.O.D.'s outside continental U.S.A.
Little \textbf{Dipper}

Build a sensitive hand-sized dip meter

\textbf{By I. Queen}

\textit{EDITORIAL ASSOCIATE}

This dipper, simple and inexpensive to build, covers \textit{3.8} to \textit{100} mc with \textit{four} coils. It uses an inexpensive transistor energized by only \textit{3} volts. Power drain is insignificant. A single calibration suffices for all bands. Measuring only \textit{4} x \textit{21/4} x \textit{21/4} inches, the instrument weighs less than \textit{11} ounces. Most important, its dip sensitivity is very high.

Many transistorized dipmeters use a capacitor between collector and emitter for oscillator feedback. The method is simple, but it favors the higher frequencies. In this dipmeter (Fig. 1) capacitor \textit{C1} provides feedback for the two higher bands. The two lower bands use tapped coils in a Hartley circuit. It is true that a \textit{larger} \textit{C1} is often used to provide adequate feedback over the entire range, but this has two disadvantages: It degrades the frequency ratio (maximum to minimum on each band) and drives the oscillator too much at high frequencies, making the dipmeter less sensitive. This dipmeter has a frequency ratio better than \textit{21/2} to \textit{1} on each band.

The instrument uses miniature plug-in coils. To keep leads as short as possible, mount the coil socket so that pin 1 touches the "hot" terminal of \textit{C4}. Keep transistor leads short too.

Mount the transistor socket on a small strip of perforated board. Then connect \textit{C1} with very short leads. Wind all coils so the collector end (which goes to pin 1 of the socket) is at the top of the coil.

Most experimenters have had experience with the miniature Amphenol polystyrene coil forms. If you have some, they are excellent for \textit{L1} and \textit{L2}. Note that these are tapped as shown in Fig. 2. Winding information is given in the table. Unfortunately, these handy forms are no longer available, but you can make an excellent substitute. Combine a length of \textit{3/4}-inch polystyrene tubing with a miniature bakelite five-pin plug (Amphenol 41-MPM5L or equivalent). This plug comes with a metal shield, which is not needed. Use the tubing in place of the shield.

[E. F. Johnson Poly Plug \textit{3/4}-inch plug-in coil forms are listed in the Allied and possibly other catalogs. These are 5- and 6-pin units.—Editor]

\begin{center}
\textbf{COIL-WINDING TABLE}
\end{center}

<table>
<thead>
<tr>
<th>COIL</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>4-10</td>
<td>8-20</td>
<td>16-40</td>
<td>40-100</td>
</tr>
<tr>
<td>Wire size</td>
<td>26</td>
<td>26</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Total turns</td>
<td>29</td>
<td>11</td>
<td>9</td>
<td>221/2</td>
</tr>
<tr>
<td>Toped section</td>
<td>2</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Diameter*</td>
<td>3/32&quot;</td>
<td>3/32&quot;</td>
<td>1/16&quot;</td>
<td>1/16&quot;</td>
</tr>
<tr>
<td>R4</td>
<td>none</td>
<td>none</td>
<td>33K</td>
<td>10K</td>
</tr>
</tbody>
</table>

*See text

Because of the higher frequencies, \textit{L3} and \textit{L4} are wound on \textit{3/8}-inch poly forms. These are placed inside the outer \textit{3/8}-inch tubing. These coils also require a built-in bias resistor \textit{R4}.

\textbf{Calibrating the coils}

I use only one basic calibration for all coils. This runs from \textit{4-10} mc. \textit{L2} is wound to cover exactly \textit{twice} this range. \textit{L3} covers \textit{4} times \textit{and} \textit{L4} \textit{10} times this basic range. Wind \textit{L2} first and base the calibration on this coil. Then wind the others, starting with a few more turns than called for in the table, removing a turn at a time until the calibration is matched. \textit{L1} may be off slightly at the high end of the dial, due to its large distributed capacitance. All bands may be calibrated by listening for the dipmeter signal on a short-wave receiver.

\begin{center}
\textbf{DIAGRAM FOR L1 \& L2 (L3 \& L4 ARE UNTAPPED \& CONNECTED TO PINS 1 \& 3)}
\end{center}

Fig. 1—Circuit of the 1-transistor unit.

---

Fig. 2—Coils L1 and L2 are set up in this fashion.

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Note that dipmeters are not recommended for precision frequency measurements. Don't try to tune TV traps or precise networks with a dipmeter. The better commercial dipmeters specify 2% accuracy, and the ordinary ones don't specify at all!

The photo shows that C4 is mounted off center. This permits its knob to extend beyond the box for thumb-tuning. If you hold the dipmeter in your left hand, the thumb of this hand can press against the knob and tune it.

To protect completed coils, cover them with polystyrene cement.

If you set the meter to near full scale at the high end of L1 or L2, you need not reset thereafter. The deflection will tend to be highest near the high-frequency end of each band, but you need not operate near full scale for maximum sensitivity. Actually, sensitivity will probably be greatest at the low end of a band, in spite of the reduced meter reading. Near 100 mc (L4) the reading may fall somewhat, depending upon the efficiency of the particular transistor you are using. In fact, you may use this dipmeter to check the condition of the transistor.

The instrument's high sensitivity results from having optimum bias on each band. The voltage applied to the base is kept just low enough for reliable oscillation. The actual dip varies with the Q of the test circuit, and also with the capacitance to which C4 is tuned. At a distance of about 1 inch from the external coil, you may expect dips of about half-scale. A perceptible dip will often occur at a distance of 1½ inches or more.

The case may be small, but it isn't overly cramped.

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(See advertisement on page 108)

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BUDDY WHIP
96 inch fibre glass mobile antenna. Can be adjusted to any position from driver's seat. List Price 24.50

By ALEX M. SCHOTZ

THIS intercom is designed to keep initial and operating costs low. It draws power only when in operation. With a 12-volt supply, it uses about 75 ma and the output power is in excess of 100 mw.

The amplifier is housed in the master station's enclosure. The slave unit has the same speaker and enclosure, but no amplifier (see circuit).

Switching is set up so that the master station is normally in the receive position. When the slave switch is closed, it applies power to the amplifier through the transmission line and common ground. The slave speaker then acts as a microphone through the master's switch and feeds the amplifier input. This signal is fed through the input blocking capacitor to the base of V1, which is operated as a common-emitter amplifier. Thus, reasonable power and voltage gain are provided.

Further amplification is needed so V1 is coupled through a capacitor to V2, which is also operated as a common-emitter amplifier. V2's output is directly coupled to V3. It forms a common-collector stage and serves as an emitter follower to match V2's output impedance to the speaker voice coil.

When the switch at the master unit is operated, it connects the batteries and also connects its speaker to the amplifier input. It then acts as a microphone and the amplifier output is connected through the transmission line to the speaker in the slave unit.

Volume can be controlled either by adding a potentiometer in the amplifier input or decreasing the voltage from the power supply.

When building the amplifier, no shielding or special precautions are necessary, as all circuits are fairly low impedance, although you may get bet-

The completed master unit. The remote is in a matching cabinet, but uses a different type switch.

Make your own transformerless Intercom 3-transistor unit draws power only when in use

Parts layout under the amplifier chassis.
you have this now...

SECONDS LATER!

it's a SNAP with CENTRALAB'S NEW FASTATCH® II

(see next page)
The other end of the pencil pointed straight up.

The slave unit has both a spring return and a locking position so, when necessary, the unit can be left on in the locked position—for baby sitting, for example.

The cabinets for these units were hand-made, and the construction is simple for anyone handy with woodworking. Similar finished cabinets are readily available and can be purchased by those who do not wish to make their own.

**Unusual Bench Aids**

By JOHN A. COMSTOCK

Here are four little aids that you'll find extremely handy on your bench. They're inexpensive and--most important—worth owning and using.

---

First is a radio-chassis vacuum cleaner. It's simply a flashlight type vacuum cleaner you can use for clearing dust from the chassis of radios, TV's and hi-fi gear. It gets into places where you could never use a regular vacuum cleaner.

Next is a nail-clipper wire stripper. As is, that pocket nail clipper can be used to strip insulation in a pinch. You can make it even easier to use if you file a little notch in one of the cutting edges. It will protect the wire and make stripping even easier.

The last little item comes from the Boeing Airplane Co. It's a standard metal clip lined with felt. The felt is dunked in water and the clamp attached to the lead between the soldered joint and the component. Heat traveling along the lead is dissipated by evaporation of water from the felt.

---

This soldering pencil stand is another handy item. It holds the pencil pointed straight up, letting you use both hands to hold the work. What is the stand? It's simply one end of a box wrench. The other end is clamped in a vise.
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Solid Sync for Your Scope

2-tube circuit you can add in an hour or two

Did you ever wonder what you could do to make your scope trace stand still like those on laboratory scopes? If so, this circuit is the answer. It can be added simply and inexpensively to almost any oscilloscope. Once it is wired in, your scope will present rock-solid pictures of the input signal, even when the vertical deflection is so small as to be almost invisible. And it will not lose sync with every small signal-frequency or line-voltage change.

Both sections of V1 (Fig. 1) combine to form a wide-band high-gain amplifier which boosts the low-level sync signal enough to allow the circuit to operate no matter what the input level. In addition, the second stage, V1-b, limits on high-level inputs to avoid overdriving V2.

V2 is a Schmitt trigger. V2-b is held near saturation under steady-state conditions by the voltage divider formed by R8, R10 and R11. V2-b’s cathode current flows through R9, causing a high-voltage drop across it. This in turn makes V2-a’s grid more positive than its grid, cutting off the tube.

When a signal is applied to V2-a’s grid, nothing happens until the grid voltage approaches the cathode voltage. Then V2-a begins to conduct, forcing V2-b toward cutoff because the increasing voltage drop across R8 forces V2-b’s grid to go more negative. Also the increasing cathode current through R9 forces V2-b’s cathode to remain at a high positive voltage. Both actions occur almost instantaneously. V2-b remains cut off as long as the input remains above the voltage required to keep V2-a conducting. As soon as the input drops below the critical value, the circuit reverts to its original state.

This switching produces a square-wave output across R12, in phase with the input signal.

Since most sweep generators require a negative pulse rather than a square wave for best sync, the output must be differentiated. This is done by C5 and R13, which form a simple R-C differentiator. The output across R13 is both positive and negative pulses. The positive pulse is clipped by diode D, leaving only the negative pulse. If your scope’s sweep generator requires a positive pulse, reverse D.

The reason why C4 is included is not apparent from the description. However, the explanation is simple. At higher frequencies, the time constant formed by R8, R10 and V2-b’s input capacitance slows up the transition. By adding C4 across R10, the resistor is shunted by a low impedance at these frequencies, thus speeding up the action.

Construction tips

Parts layout for this circuit is not especially critical, but be sure you keep the amplifier input away from the pulse output. Also, shield the whole circuit to minimize triggering from extraneous pickup, and radiation of pulses into the vertical channel.

I built my unit on a 3 by 3½-inch piece of aluminum which was then mounted on the front lip of the scope chassis. I made a shield for the bottom from a piece of sheet aluminum.

To install the circuit in your scope, first locate the sync selector switch (Fig. 2). Its wiper will probably connect to the sync amplitude control. Disconnect this wire. Connect the sync circuit input to the arm of the selector switch. Connect the output (C5) to the high end of the sync amplitude control (R13 in Fig. 1, replace if resistance is not correct). Connect D across the control, observing polarity. Connect the heater and B-plus leads to convenient points.

Power for the unit can usually be obtained from the scope’s main power supply. If this is not possible, a simple transformer half-wave rectifier supply will be ample.

---

By IAN N. McLEOD

Fig. 1—Circuit of sync solidifier. The author reports better results by increasing R6 to 1.1 megohm (5%).

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Fig. 2—Where unit goes in scope.

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RADIO-ELECTRONICS
RCA Wins NATESA Award

Irving J. Toner, president, National Alliance of Television & Electronic Service Associations (left), presents the NATESA Friends of Service Management Award for 1961 to Douglas Y. Smith, vice president and general manager, RCA Electron Tube Div., and W. Walter Watts, RCA group executive vice president. The award citing RCA's Electron Tube Div. for its outstanding service in creating better customer relations was made by NATESA directors at their 1962 convention.

New Service Data System

The TV Colorgram Service Pak is a new color-coded circuit diagram system that enables the technician to pinpoint TV receiver troubles quickly. It consists of individual Colorgram charts—each illustrating key circuits and signal flow paths in distinctive colors; a color-coded master schematic and a Rapid Repair Manual.

Individual 8½ x 11-inch charts cover the following circuit sections: i.f., video, audio, vertical and horizontal sync, B-plus distribution and age circuitry. Each includes voltages, waveforms, test points, component values and signal-flow and continuity patterns. The ground conductor is shown in its own distinctive color.

If the TV technician has a video problem, he selects the video chart; or the horizontal chart when symptoms indicate trouble in this section of the set. The charts are especially helpful when working on sets with printed circuits since each is a replica of the con-

(Continued on page 84)

Tarzian offers FAST, DEPENDABLE TUNER REPAIR SERVICE (ALL MAKES)

It just makes sense that a manufacturer of tuners should be better-qualified, better-equipped to offer the most dependable tuner repair and overhaul service.

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Tarzian-made tuners are identified by this stamining. When inquiring about service on other tuners, always give TV make, chassis and Model number. All tuners repaired on approved, open accounts. Check with your local distributor for Sarkes Tarzian replacement tuners, replacement parts, or repair service.

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I laughed when Fred Williams, my old high school buddy and fellow worker, told me he was taking a Cleveland Institute Home Study course in electronics. But when our boss made him Senior Electronic Technician, it made me stop and think. Sure I'm glad Fred got the break... but why him... and not me? What's he got that I don't. There was only one answer... his Cleveland Institute Diploma and his First Class FCC License!

After congratulating Fred on his promotion, I asked him what gives. "I'm going to turn $10 into $10,000," he said. "My tuition at Cleveland Institute was only $10 a month. But, my new job pays me $10 a week more... that's $520 more a year! In twenty years... even if I don't get another penny increase... I will have earned $10,400 more! It's that simple. I have a plan... and it works!"

What a return on his investment! Fred should have been elected most likely to succeed... he's on the right track. So am I now. I sent for my three free books a couple of months ago, and I'm well on my way to Fred's level. How about you? Will you be ready like Fred was when opportunity knocks? Take my advice and carefully read the important information on the opposite page. Then check your area of most interest on the postage-free reply card and drop it in the mail today. Find out how you can move up in electronics too.
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Cleveland Institute of Electronics
Dept. RE-76, 1776 E. 17th St., Cleveland 14, Ohio
(Continued from page 79)
ductor pattern. A component-location guide list each part according to its position with respect to vertical and horizontal guide lines on the chart. This makes it easy to pinpoint hard-to-find components.

The master schematic shows all circuit sections in the same colors as on the Colorgram charts. It also includes test points, waveforms, voltages, and parts values. The Rapid Repair Manual contains official manufacturers’ service notes, special instructions, production changes, circuit modifications, parts lists, tube and component location charts and a tube-failure guide.

TV Colorgrams, developed by former service technician and later technical editor Bob Cornell, and introduced by Colorgrams, Inc., a subsidiary of TV Development Corp., Mineola, N. Y., will initially cover the most popular RCA, G-E, Admiral, Westinghouse, Philco, Emerson and Magnavox TV chassis. They will be sold through electronic parts dealers at $1.95 per Service Pak.

Service Group Pays $1,000 Fine

Officers of the Brooklyn Radio & Television Service Guild agreed to a $1,000 settlement and accepted a permanent injunction against violating New York State anti-trust laws. The group was charged with obtaining agreements among service technicians on a fixed price for TV service calls.

Telsa New Britain Formed

New Britain, Conn.—Local TV service dealers held a reorganization meeting, whose purpose was to form an active local of Telsa of Connecticut. The meeting was successful, and a slate of officers was elected. Henry J. Giszenwski is president of the new group; William Brighenti, vice president; Richard M. Houghton, secretary, and John Sidoti, treasurer. The organization has been accepted into the State Chapter of Telsa.

TV Antenna Liabilities

TESA King County, Washington, uses the Weather Bureau's table of wind velocities in determining liability and defining guarantee limits covering an-
tenna installations suffering wind damage. TSA guarantees, approved by the Seattle Better Business Bureau, cover antenna installations in winds up to gale force (39 to 54 miles per hour), as rated by local Weather Bureau reports.

Sylvania Reduces Warranty Period

This firm's new reduced warranty coverage is encouraging to technicians massing opposition to the extended warranty policies adopted or proposed by some manufacturers. The firm's new policy provides a 90-day warranty on parts and labor on conventional tube and transistor radios. Previously, Sylvania's transistor radios carried a 5-year warranty on parts and labor and 1-year coverage on tube sets.

Technician Restores Pipe Organs

Chicago, III.—Irv Toner, the newly elected president of NATESA (National Alliance of Television & Electronic Service Associations) has one rather unusual hobby—he restores old pipe organs of the type used in theaters. In fact, he heads an organization called "American Theater Organ Enthusiasts."

Speaking about service technicians, Mr. Toner points out that his pet peeve is "the extreme number of unqualified service men who get into the field. They use up their life's savings before they become qualified. Largely responsible for these unqualified service men are the technical schools who are turning them out."

"To enter the service business," he continued, "an individual must be technically qualified, have business knowledge, capital, and experience (working with some other service dealer, something like an intern in a hospital)."

Toner went on to say that the biggest problem facing the service industry is its poor public image, plus a rather ridiculous dealer-distributor relationship, whereby the consumer is able to buy at dealer prices. Toner puts the blame for this situation on the manufacturer. He thinks that passage of the price-quality-stability bill would be helpful in solving this problem.

FTRSAP Working with NARDA

The Federation of Television & Radio Service Associations of Pennsylvania (FTRSAP) named Joseph Doyle, its Pittsburgh delegate, to represent the federation at the NARDA (National Appliance & Radio-TV Dealers Associations) convention in Chicago in January. Mr. Doyle has plans for joint FTRSAP-NARDA action in a nationwide campaign against extended warranties. The plans were drafted along the lines of information required by the Federal Trade Commission.

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, Founder

Modern Electrics

Wireless Association of America

Electrical Experiments

Radio News

Science & Invention

Cyclopedia

Television

Radio Craft

Short-Wave Craft

Television News

Sylvania's transistor radios carried a 5-year warranty on parts and labor and 1-year coverage on tube sets.
ELECTRONICS RANGE IN THE HOME

Technicians will find repair and maintenance of microwave oven ranges simplicity itself after reading this descriptive article. This new type of cooking range is a housewife's delight. Hamburgers will cook in seconds; a roast, in minutes, with no fear of burn or kitchen heat. Learn microwave range repair before customers call.

BUILD THE AUTOGEN

An excellent beginner's project; old-timers will get a nostalgic kick constructing this unusually selective and sensitive one-transistor regenerative receiver.

HOW TO HANDLE UHF TV

All TV receivers manufactured after April 30, 1964, are required by Act of Congress to have all-channel tuners included in sets. Are you ready for them? Learn uhf installation, conversion from vhf to vhf-uhf where possible, and quirks and problems in installation and repair maintenance. Get ready now! Uhf is coming!

MAKE YOUR METER MORE SENSITIVE

A simple adapter will increase the sensitivity of conventional volt-ohm-milliammeter so it will measure millivolts and microamperes. Why spend money for ultra-sensitive meter when the one you have will do the job with this modification?

HIGH-GAIN ANTENNA FOR FM

Build this antenna designed along the lines of a broadcast transmitter type but at one-tenth the weight and a fraction of the cost. Cut to correct lengths, the antenna will work on TV bands or other frequencies. Perfect for hi-fi systems. Can be directional or omnidirectional as desired by simply changing the design. What good is your top equipment without a first-class antenna?

Radio-Electronics
March Issue On Sale February 21

SOUND-LEVEL METER, model 2203, shown in 8-page technical brochure. Full specs, application data, many accessories.—8 & K Instruments Inc., 3044 106th St., Cleveland 13, Ohio.

TRANSFORMERS, CHOKES featured in 48-page Catalog No. 63. Specs on M1L spec if chokes, i.f. transformers, adjustable coils wound on ceramic and Resistive materials, exact replacement coils. More than 1,500 items. Many illustrations.—J. W. Miller Co., 5917 S. Main St., Los Angeles 3, Calif.

SEMICONDUCTOR GUIDE, 4-page leaflet lists transistors, silicon rectifiers and power vector diodes by type number, with electrical characteristics and case type. R. R. Meijer, Manager, Product Planning, Bendix Semiconductor Div., South St., Holmdel, N. J.

TEST EQUIPMENT, 25 major items plus accessories offered in 8-page Catalog No. 44 T. Photos and specs on voms, vmsm, tube and transistor analyzers, others.—Triphlett Electrical Instrument Co., Buffalo, Ohio.

BATTERY MANUAL, Booklet RDG-111, 62-page illustrated information on dry batteries. Includes classification chart, service-life data table, mechanical and electrical characteristics, dimensional outlines, terminal connections for each type. Theory section outlines history of dry cells and explanation of basic types. 40 commercially available, Engineering Activity, RCA Electron Tube Div., Harrison, N. J.

THERMISTORS, THERMOCOUPLES, CHROMELALUMEL detailed in 4-page Data Sheet 3201, 9201, respectively. Illustrated sheet gives outline drawings, photos, application data, complete specs.—General Electric Co., Magnetic Materials Section, PO Box 72, Edison, Mich.

INDUSTRIAL ELECTRONIC SUPPLIES listed in 664-page Catalog 37. Many phonor, full specs, product and manufacturer's indices. Items include amateur equipment, audio supplies, selection of construction kits, PA equipment, soldering devices, test instruments, many other items. Industrial buyers request on letterhead.—Allied Electronics, Div. Allied Radio, 100 N. Western Ave., Chicago 80, Ill.

AIR-CORE INDUCTORS, 10-page illustrated folder lists Air Dux inductors for amateur rigs or prototypes of rf transmission equipment. Includes technical data on coils for pi output circuits, conventional L-C output transformer and oscillator circuits.—Illuntronics Engineering Corp., 680 E. Taylor Ave., Sunnyvale, Calif.

TOUCH CONTROL SWITCH offered in 6-page illustrated leaflet. Block diagram explains circuit operation of the capacitance-operated device. Electrical and physical specs included. Other types of Dualmaxx tubes also described.—Tungsol Electric Inc., 1 Summer Ave., Newark 4, N. J.

CB BROCHURE, Over a Quarter of a Century in Electronics, describes manufacturer's history and methods in CB production. Full-color photos, complete specs and descriptions of 5 CB products.—Brownie Labs, Inc., 100 Union Ave., Lacomia, N. H.

SILICON RECTIFIERS, voltage impulse protected (V.I.P.) types, described in 4-page leaflet. Controlled avalanche enables these rectifiers to withstand transient voltages higher than the rated peak reverse voltage. Leaflet gives avalanche characteristics, maximum ratings, electrical specs.—General Instrument Corp., Rectifier Div., 65 Government St., New Haven, Conn.


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STEREO HEADPHONES and accessories described in foldup Brochure MH. Features head- phone remote-control center and cross-feed net- work.—Jensen Manufacturing Co., 6601 S. Laramie, Chicago, Ill.

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The absolute maximum characteristics of this Tung-Sol transistor are:

\[
\begin{align*}
V_{CE} & \leq 80 \\
I_{C} & \leq (500 \text{ ma}) \\
I_{E} & \leq (15 \text{ ma}) \\
P_{E} & \leq (170 \text{ watts})
\end{align*}
\]

2N2374, 2N2375, 2N2376

Germanium-alloy p-n-p junction transistors for medium-power audio driver and output stages in auto and portable radio and communications applications. The 2N2376 is a matched pair of 2N2375's used in push-pull output stages. They feature an especially linear beta over a wide range of operating conditions. Noise figure is very low at currents down to a few hundred mA.

The ratings of these Philco transistors are:

\[
\begin{align*}
V_{CE} & \leq 35 \\
I_{C} & \leq 35 \\
I_{E} & \leq 35 \\
I_{B} & \leq (500 \text{ ma}) \\
P_{T} & \leq (250 \text{ watts}) \\
P_{E} & \leq (9 \text{ watts}) \\
I_{B} & \leq (210 \text{ ma})
\end{align*}
\]

2N2288, 2N2289, 2N2290

Diffused-alloy power DAP transistors for high-current switching at high frequencies. Suitable for hi-fi amplifiers, TV horizontal output amplifiers and power converters.

Absolute maximum ratings on these Bendix transistors are:

\[
\begin{align*}
V_{CE} & \leq 40 \\
I_{C} & \leq 10 \\
I_{B} & \leq 0.5 \text{ watts} \\
P_{E} & \leq 60 \text{ watts}
\end{align*}
\]

150-amp controlled rectifier

This unit is designed for high-power industrial and military applications and can be obtained with forward-blocking voltages through 400.

Westinghouse rates this unit, called the 200 Trinistor, at 150 amps for 180° conduction and a case temperature of 85°C. The rms rating is 235 amps and the surge-current rating 3,500 amps.

It can be used to control power inverters, converters, frequency changers, battery chargers and light-dimming and magnetic amplifier equipment.

6JB6, 12JB6, 17JB6

Novar beam-power tubes for TV horizontal-deflection amplifiers. They are especially designed for minimum interference from "snivets" (one or more dark vertical lines near the right edge of a TV picture, caused by spurious oscillations in the horizontal output stage being picked up by the front end of a TV screen) and have a lower noise figure than other tubes. They are available in 200- and 300-amp versions.
and displayed on the screen). This is done by applying a positive voltage to grid 3, which is brought out to a separate pin on the base.

The three tubes are electrically identical except for their heaters. The 6JB6 has a 6.3-volt 1.2 amp heater. The 12JB6 has a 12.6-volt 600-ma heater. The 17JB6's heater is rated at 16.8 volts 450 ma.

Maximum ratings for these RCA tubes are:

<table>
<thead>
<tr>
<th>Tube</th>
<th>V_b (boost and dc)</th>
<th>V_a</th>
<th>P_a (watts)</th>
<th>P_d (watts)</th>
<th>I_b (average ma)</th>
<th>(peak ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6JB6</td>
<td>770</td>
<td>70</td>
<td>220</td>
<td>17.5</td>
<td>175</td>
<td>500</td>
</tr>
<tr>
<td>12JB6</td>
<td>900</td>
<td>70</td>
<td>220</td>
<td>17.5</td>
<td>175</td>
<td>500</td>
</tr>
<tr>
<td>17JB6</td>
<td>1000</td>
<td>70</td>
<td>220</td>
<td>17.5</td>
<td>175</td>
<td>500</td>
</tr>
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SC-3185

This is a 21-inch direct-view rectangular cathode-ray tube for character writing and data display. The Sylvania tube has two pairs of high-sensitivity, limited-scan electrostatic deflection plates for writing alpha-numeric characters and symbols.

A 72° magnetic deflection system is used for positioning the characters and for full-screen scanning. The tube is made with long-persistence P7 and P19 phosphors but can be supplied in several other types.

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A gallium arsenide infrared source diode is available from Texas Instruments for experimental engineering evaluation. Designed as a source in communication links, infrared radar equipment and for tape and card readers in computers. The SNX-100 operates as a forward-biased diode and emits light in a narrow band in the near infrared. Its output can be modulated by varying the forward bias current. Modulation range is 0 to 900 mc. Quantum efficiency (the ratio of photons leaving the device to electrons entering) ranges from .03% at 25°C to .053% at -195°C.

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[Diagram of Pix Tube Jig]

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- 10-150 MEG VOL CONTROLS
- 6-TV ALIGNMENT TOOLS
- 10-ROCA #128 TUBES
- 10-ROCA #954 TUBES
- 10-ROGERS #2X2 TUBES
- 4-SYLVANIA 35W4 TUBES
- 5-AMPERITE #3-3B TUBES
- Most popular Ballast Tube
- 6-1-F COIL TRANSFORMERS
- 60-120 volt, 500 mwa
- 1-90-FOOT TRANSFORMER
- 16-AMPERITE Transformer
- ER including schematic diagram
- 1-HEARING AID AMPLIFIER
- For 3-Tubes, Mike, etc.
- 100-ASSORTED SOCKETS
- All type 7 pin, 8 pin, 9 pin
- 100-ASSORTED FUSES
- 340 and other popular sizes
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- CONDENSERS 10-20-50
- to 6000
- 20-STANDARD CONDENSERS
- 140-4000. 80-2000. 10-4000
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- 5000 all inv. sizes offered
- 1-CHAPT ZU DI MITZIA
- "JACKPOT!" Limited supply
- 1-4 SPEED PHONO ARM
- 2 with sponge rubber Cartridge

OUR "SENSATIONAL VALUES" ARE NO SECRET!

Last month we sold a 4-Tube Radio for $1... We sell a $200 HEARING AID for $2
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Our TREMENDOUS BUYING POWER & PURCHASING EXPERIENCE make it possible. We invest Thousands of Dollars (in just a single item) to create a good DOLLAR BUY, resulting in the AMAZING & EXCITING OFFERS that follow:

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1-6" x 9" OVAL PM SPEAKERS, 9.75
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1-3-AUDIO OUTPUT TRANSFORMERS, 860 or 8.6K type
3-1-F COIL TRANSFORMERS, 110, 220, 500, 1000 volts
3-15-RADIO OSCILLATOR COILS, standard 500K
3-1-COIL TRANSFORMERS, 110, 220, 500, 1000 volts
2-G.E. #43114, 110, 220, 500, 1000 volts
3-3-TRANSFORMERS—450 mc, 450K
4-3-TRANSFORMERS—820 mc, 820K
8-250'-LONG, BRAIDED METAL JACKET WIRE
8-250'-SINGLE-CONDUCTOR, BRAIDED, HI-GAIN, 170 mc
20-1/2'-LONG, BRAIDED METAL JACKET WIRE
10-50'-LONG, BRAIDED METAL JACKET WIRE
50-50'-LONG, BRAIDED METAL JACKET WIRE
250-1/2"-SINGLE-CONDUCTOR, BRAIDED, 170 mc
250-1/2'-SINGLE-CONDUCTOR, BRAIDED, HI-GAIN, 170 mc
10-50'-LONG, BRAIDED METAL JACKET WIRE
10-250'-LONG, BRAIDED METAL JACKET WIRE
1-5'-LONG, BRAIDED METAL JACKET WIRE
5-50'-LONG, BRAIDED METAL JACKET WIRE
10-100'-LONG, BRAIDED METAL JACKET WIRE
10-150'-LONG, BRAIDED METAL JACKET WIRE
10-200'-LONG, BRAIDED METAL JACKET WIRE
10-250'-LONG, BRAIDED METAL JACKET WIRE
10-300'-LONG, BRAIDED METAL JACKET WIRE
10-350'-LONG, BRAIDED METAL JACKET WIRE
10-400'-LONG, BRAIDED METAL JACKET WIRE
10-450'-LONG, BRAIDED METAL JACKET WIRE
10-500'-LONG, BRAIDED METAL JACKET WIRE
10-550'-LONG, BRAIDED METAL JACKET WIRE
10-600'-LONG, BRAIDED METAL JACKET WIRE
10-650'-LONG, BRAIDED METAL JACKET WIRE
10-700'-LONG, BRAIDED METAL JACKET WIRE
10-750'-LONG, BRAIDED METAL JACKET WIRE
10-800'-LONG, BRAIDED METAL JACKET WIRE
10-850'-LONG, BRAIDED METAL JACKET WIRE
10-900'-LONG, BRAIDED METAL JACKET WIRE
Protect Your Transistors!

While experimenting with power transistors such as the 2N227 which have a punch-through voltage of 80 or more, install a small NE-2 neon lamp between the collector and emitter (Fig. 1). As soon as the voltage reaches 70, the neon lamp will flash and indicate the danger. Even small rf spikes will be indicated immediately, yet the neon lamp will not affect the circuit when not lighted.

Lower-voltage transistors can be similarly protected by using a small battery in series with the neon lamp (Fig. 2). For a 20-volt transistor, use a 45-volt battery; for a 50-volt transistor, a 22-volt battery, and so on.—Tom Jaski

Electric Combination Lock

This simple electric combination lock is practically tamperproof. You must dial three three-digit numbers in correct sequence to open it. Fumbling will get you nowhere. The lock uses three single-pole 12-position rotary switches, two 500-ohm relays with two sets of make-before-break contacts and two sets of normally open contacts, and a dc solenoid to operate the lock's bolt.

To open the lock, set the switches

---

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Model 212 $18.50 Wired
Model 212 Kit $13.50

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Completely modern! Completely flexible! Completely new! Checks all the new 32 pin (Compactron),VISION, Nuvistor, Nuvic and 10 prong tubes. In addition to octal, octal, miniature, and 9 prong tubes. Tests each tube for shorts, leakages, inter-mittents, opens, as well as for quality. Each section of multi-purpose tube is checked separately. Magic eye. Voltage Regulator and Hi-Fi tubes are also tested. Unique switching arrangement makes the checker obsolete proof. Supplementary tube listings supplied periodically at no cost to keep instrument up to date. It comes complete with instructions and tube charts in ring bound manual.

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Just before our warranty expires on a repair or component we've installed, we send a card to the customer calling attention to the deadline and inviting him to call within a week if he has any complaints on his TV, radio, record player, etc. We offer to check and adjust it for free if he can bring the unit in or our technicians can catch it on their rounds.

The card shows we have confidence in our work and our products. On top of that the customer can't come back and gripe later that something was needed right along, because we've given him the opportunity to holler before our guarantee expired.

As to getting loaded up with free work, it doesn't work that way at all. Sure, we get a few kickers; but we also have people who stop by to thank us and this, in turn, often generates new business.—Stanley Clark

P.I.C. Electric Counters

When these counters fail to operate, don't scrap them without a check. Many times a simple repair job will restore proper operation. The counter is actuated by a solenoid which moves the counter one count each time a pulse of current is switched to the solenoid. While external circuitry is 117 volts ac, the counter has an internal full-wave selenium rectifier which supplies dc to the solenoid. This bridge occasionally burns out and must be changed. The replacement unit is easily installed. Use Selectron model 1614 or equivalent.—F. G. Lewis

Philco F-3041 Portable

The picture shrank and bloomed in perfect sync with peaks in the sound. Investigation disclosed a big, fat, blue spark in the 12CA5 audio tube each time the picture jumped. The tube was very gassy and peaks in the audio made it fire like a thyratron. This dropped the 135-volt line, the horizontal oscillator plate voltage, etc. Picture size changed whenever the tube fired.—Jack Barr

Motorola 56CD Radio

A customer brought this small table model in for repair and merely said that the radio was dead. After it was fired up, we found that, instead of being dead, it was intermittent. When the radio played, all tubes were lit; when it stopped, the 35W4 heater was real bright, while the rest of the tubes were out.

If the short lasted too long, the 35W4 would pop. Another rectifier tube was plugged into the socket and the

(Continued on page 104)

No. 1 choice of phono manufacturers.
Now, your most logical choice for exact replacement

New Euphonics Orbit Action Cartridges are exact replacements for millions of Euphonics Cartridges now in use, and all other ceramic cartridges. Rugged, trouble-free and easiest to install, Euphonics cartridges offer you these important advantages:

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**Other Advantages:** Unique mounting bracket permits fast, snap-in installation of cartridge • Low tracking force (2 grams) for minimum record and stylus wear • Stylus automatically retracts when arm is dropped • PZT ceramic elements eliminate magnetic hum and are impervious to heat and moisture • High compliance: 4 micro-cm per dyne • 4 terminals—complete with jumper for 3-terminal installation.

Complete with dual needles.
U-8 .0007 Sapphire and .003 Sapphire
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(June, 1962)

"RCA Home Training has given me the necessary background to pass the required tests for my present position."

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Robert David Regina, Marienville, Pa., (July, 1962)
former mechanic, now Test Maintenance Technician

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Clarence Reneau, Dandridge, Tenn., (June, 1962)
former electrician, now self-employed Radio-TV Technician

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(Continued from page 99)
radio took off. Again it went dead, but the 35W4 stayed lit for quite a while until the trouble was found. A capacitor from plate to cathode of the 50C5 would short out, drawing excessive current through the output transformer. Since the heater and plate pin 5 were wired together, half the heater would open, popping the 35W4 when the capacitor shorted.

—Homer L. Davidson

Increase TV Picture Width

Here are a few simple methods that will increase raster width when nothing else seems to work:

1. Decrease the size of the horizontal output tube's cathode bias resistor.

2. Increase the screen voltage on the horizontal output tube. Use some discretion when trying 1 or 2. Too drastic a change may exceed current-handling capabilities of the horizontal output tube and associated circuitry.

3. Shunt the width coil with a 600-volt capacitor (100 pf to .05 µf) or shunt a small number of turns on the horizontal output transformer with a capacitor within the same range. If the capacitor used is too large, you'll get a noticeable folower on the left side of the raster. For this reason, use as small a value of capacitance as possible.

4. If the width coil is shunting part of the turns on the horizontal output transformer, rewire it so that it shunts a fewer number of turns, if possible.

5. Replace the width coil with another of greater inductance. Again, you may get noticeable folower if the alterations are too great.

These methods should not be used to increase the size of the raster more than ½ inch.—James A. Koepke

“Why are you complaining you’re not busy? Here’s one call from your Aunt Mac; here’s one from your sister Fran; here’s another one from your sister Fran, and here’s . . . .”
NEW PRODUCTS

HEART-SOUND MIKE, model SP-5 (illus). Detects heart and other sound vibrations in human and animal tissue. Direct-coupled controlled magnetic transducer. Used with standard medical phonocardiograph equipment. Vibrations detected may be transmitted through loudspeakers, earphones, oscilloscope, graph recorders; pre-served on magnetic tape with standard tape recorder. Model SP-55 strain to patient for hands-free operation. Model SP-6 for mass survey work with unit mounted to chair.—Medical Applications Engineering Dept., Shure Bros. Inc., 222 Hartrey Ave., Evanston, Ill.

SOLID-STATE DC POWER SUPPLY, Series 46*. Supplied with modular remote sensing regulator to maintain regulation without regard to load resistance. Each of 3 available units has 2 matching separable regulators with adjustable output and remote sensing feature. Regulation instantly changeable from standard ±1.0% to ±0.25% or ±0.1%. No wiring changes or removal of supply from mounting, no external heat sink, fans or blowers needed. Supply 6.3, 12 or 28 volts at 2 amps from 95- to 130-volt 60-cycle source. Overload and short-circuit protected outputs. Output regulation ±1% for line; output ripple 1% rms. Output voltage at full load, accurate to ±5% of nominal. Operating temperature range -20°C to 50°C.—Victors Electronics, Inc., 145 Michael Dr., Syosset, N. Y.

TRANSISTOR REGULATED POWER SUPPLY, model RPS-4. For transistor and tunnel diode operations. 0-28 volts, constant voltage within 3% at 50 ma, within 5% at 100 ma. METER and output ranges: 0-1/2, 0-15, 0-30, 0-150 ma. Special tap for simultaneous bias collector supply. Overload protection circuit permits feeding into full short. Maximum ripple 0.001% at full load, output impedance 0.4 ohms. Metered variation tested to manufacturer's specs including firing point, regulating voltage and current range. Panel for second-section test in dual-section tubes—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

GRID-DIP METER, model TE-18. Used as grid-dip oscillator to find resonant frequencies of tuned circuits and as signal generator, absorb-

of supply from mounting, no external heat sink, fans or blowers needed. Supply 6.3, 12 or 28 volts at 2 amps from 95- to 130-volt 60-cycle source. Overload and short-circuit protected outputs. Output regulation ±1% for line; output ripple 1% rms. Output voltage at full load, accurate to ±5% of nominal. Operating temperature range -20°C to 50°C.—Victors Electronics, Inc., 145 Michael Dr., Syosset, N. Y.

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Actually gives you 110 volts, 60 cycle A.C. from your 6 or 12 volt D.C. battery! Plug inverter into cigarette lighter, and operate lights, electric shavers, record players, electric tools, portable TV, radios, testing equipment, etc. Frequency will not change with change in load or input voltage.

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POWER METER, kit model HM-11. Shows antenna-transmitter match. Indicates forward or reflected power and vswr 1.1 to 3.1 on built-in meter. Band coverage 160 through 6 meters. Handles peak power over 1 kw, may be left in antenna-system feed line at all times. Components provided for matching 50- or 75-ohm antenna lines. Heath Co., Benton Harbor, Mich.

SUBMINIATURE AUDIO TRANSFORMERS/INDUCTORS. In flat hermetically sealed steel case with mounting studs and straight pin terminals for welding or printed circuits. Connection data on case. Transformer operating level 100 mw, impedance range 50-20,000 ohms, response less than 2 db. Split inductors allow series or parallel connection, ranges 15 ohm at 64 ma. 1.5 ohms-2.4 h at 2 ma 160 ohms.—United Transformer Corp., 150 Varick St., New York 13, N. Y.

WIREWOUND RESISTORS, type S. A. 18 sizes, 0.5 watt to 10.5 watts. Completely welded terminal-to-terminal construction. 0.5% drift in 1,000 hours operation at full wattage rating. Temperature coefficient .00002%. C. Close tolerance...
to 0.5%, rated at 100°C ambient.—California Resistor Corp., 1631 Colorado Ave., Santa Monica, Calif.

DC/AC/DC TRANSDUCER for use as servovalve-feedback element on hydraulic control actuators, as position indicator for remote positioning systems, or as iclometering transducer. Variety of configurations and mountings. Typical unit op-

erates on 5-vdc excitation, provides 0-2.15-vdc output. Nominal power requirement 1/4 watt, output impedance approximately 15,000 ohms. Strokes 1/4 to ±5 inches. Output linear 15% to 1%, depending on requirements. Resolution infinite. No wearing parts.—Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.

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Popular Electronics, Oct. 1962

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Audio, April 1962

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American Record Guide, Sept. 1962

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All specifications are from manufacturers’ data.

EDITORIAL (Continued from page 23)

transmitter is on the air. Thus patients will not interfere with each other.

Probably the best antenna for the patient will be an 8-inch, ½-inch-wide adhesive tape stuck to his forearm (See illustration). Processed inside the tape will be an ½-inch-wide insulated copper flexible conductor. Such an aerial will not get in the patient’s way. The transmitter could send the signal to a nearby converter, which could put the signal on telephone lines, or amplify it for radio transmission to the doctor’s office.

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<tr>
<th>PIV/RS5</th>
<th>Low Pass</th>
<th>High Pass</th>
<th>Guaranteed</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>500</td>
<td>200</td>
<td>750 MA</td>
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</table>

**LOW LEAKAGE NEWEST TYPE**

<table>
<thead>
<tr>
<th>PIV/RS5</th>
<th>100 Hz</th>
<th>500 Hz</th>
<th>2000 Hz</th>
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</thead>
<tbody>
<tr>
<td>200</td>
<td>500</td>
<td>2000</td>
<td>5000</td>
</tr>
</tbody>
</table>

This device measures the magnetic strength of a relay coil. The indicator is a d'Arsonval movement used in reverse. Normally a permanent magnet surrounds a moving coil that is supplied with a variable current to be measured. Here, a predetermined current flows into the moving coil and the meter measures the strength of a relay-coil magnet.

**Transmitter Tester**

**PATENT No. 3,009,657**

Marcus Glasser, Lawellin, N. Y. (Assigned to Shell Electronics Manufacturing Corp., New York, N.Y.)

Maximum power from the nearby transmitter is picked up by the antenna when L-C is tuned to the proper frequency. A diode detects the signal. When S is thrown to the left, the meter indicates relative strength of the carrier. In other position, the rectified audio is amplified by a transistor and led to the earpiece. This permits checking for distortion, hum, noise, level, etc.

**Two-Position Control**

**PATENT No. 3,028,503**

Ira W. Stecknow, c/o Kelton Works, Glasgow, Scotland.

This instrument controls temperature by switching on a heater when it gets too cold, and switching on a cooler when it gets too hot. Within the intermediate range, both heater and cooler are off.

The moving-coil galvanometer indicates temperature and may be calibrated in degrees. It is mounted on a friction disc with two control arms which may be set independently to the desired temperature limits. Each control arm carries a mirror, lamp and photocell. Normally, light from each lamp falls on its photocell. When this beam is interrupted, a relay (not shown) is energized.

When the temperature rises, the galvanometer pointer moves upscale until vane 2 blocks off light coming from lamp 2. This switches on the cooler. If the temperature falls, the pointer moves downscale until vane 1 blocks light from lamp 1. This turns on the heater.

**END**

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Discusses the most important of all service techniques—satisfaction engineering. In easy-to-read "Red and Bob" dialogue style, bad service is discussed at the end of each narrative.


A fundamental guide to the structure and operation of electronic devices and their applications in many types of electronic circuits.


Starting with Ohm's law, this home-study course shows the beginner (with examples and problems) how to use network algebra, trig, vectors and logarithms. It includes log and dit tables as well as useful formulas.

Basics of Gyroscopes (Vols. 1 and 2), by Carl Machover. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y. 6 x 9 in. 101 and 114 pp., respectively. $3.30 per volume in soft cover, $7.75 per set in cloth binding.

Vol. 1 introduces the gyroscope and covers basic theory. Vol. 2 covers specialized types including rate and integrating types, stable platforms and gyro construction and applications.

Understanding Transistors and How to Use Them. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. 5½ x 8½ in. 96 pp. Paper. $3.90.

A little theory, followed by such do-it-yourself projects as an amplifier, simple radio, timer and flasher.


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