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New TV Tape Recorder For Less Than $200?

A new video tape recorder-playback machine that can be sold for a price within the reach of the home recording enthusiast has been announced by a British firm appropriately called Telcan (East Bridgford, Nottinghamshire). The machine uses 1/4-inch double-track tape. An 11-inch reel of special thin tape holds 1/2 hour of recording.

The price of the tape (about $25 for a 1/2-hour record) may limit the amount of home recording. It does, however, open the door to pre-recorded video tapes that could be rented out to the user as home movie films are. And, of course, the viewer may be able to record a program he might not be able to see at the time of transmission, view it, then erase the tape and reuse it as often as desired.

Exact technical details are lacking, but the developers say that Telcan takes the signal from the TV set's detector, amplifies it and assembles it in a form that can be recorded on the tape by a special transducer mechanism. The same transducer, which has no moving parts, reconverts the signal on the tape on replay into electrical impulses which are assembled by the following circuitry into a normal TV signal, which is then applied to the grid of the video output tube in the TV set.

The tape moves past the heads at 120 inches (10 feet) per second. System bandwidth is listed as 2 me and resolution 300 lines. Signal-to-noise ratio is 28 db on the video and 40 db on the sound track. The recorder is compatible with 405-, 525- and 625-line systems.

Although Telcan describes the equipment as "available" at 59 guineas (about $175) technical journalists who have seen the equipment at work are said to feel that it needs further refinement before it can become a successful commercial device. They pointed out, however, that irrespective of its state of refinement, any machine selling under $200 that could produce a usable picture represents a tremendously important forward step in the art.

Schools Get 31 Channels

FCC has set aside 31 channels for transmitting educational programs to schools. Known as "instructional television fixed service," the new plan will allow a central transmitter to serve scattered institutions and provides licensing of facilities for transmission to schools and colleges. It could also be used to send instructions to hospitals, clinics, industries and nursing homes.

Electronic Methods Used In Optical Lens Testing

A camera lens testing method strongly reminiscent of television principles is described in a recent issue of Camera News of West Germany.

A grating of alternate black and white lines is imaged through the lens. This image is scanned by a narrow slit which moves across the lines in such a way that it sees first a white, then a black, line. A photocell picks up the light and actsuates an amplifier. If the image is good, the difference in brightness between black and white lines will be great, and relatively strong alternating current will be generated in the photocell output. If the contrast or definition between black and white becomes poorer, the photocell output goes down.

The equipment is embodied in a fully automatic electronic instrument, using amplifiers and indicating results on a meter and with red and green lights. The equipment has been thoroughly proved out, one instrument having been used by the Zeiss works for nearly two years, according to the report.

Rat Power Runs Radios

Scientists in the General Electric Valley Forge laboratory have been running small radio transmitters with power drawn from the body of living rats. Biologist John J. Konikoff says the experiments may provide important data for medical research.

Two electrodes, one of platinum and one of stainless steel, are placed in the rat's body in two different areas. Connecting a lead to the two electrodes, scientists found a small current flowing through the wire.

Electronic devices like pacemakers are now run by batteries carried outside the body, and the connecting wires must pierce the skin. But this research shows that lifesaving instruments may some day run on power generated within the body.

There are no ill effects from the inert electrodes on living tissues, and rats seem to lead normal rat lives with the equipment inside them. So far, the rat transmitter has run eight consecutive hours, but researchers are sure the operation could continue for the entire lifetime of the rat.

Using rabbits and dogs, Konikoff plans to place the transmitter inside the skin along with the electrodes, to develop body-powered devices for use inside humans.

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(Continued on page 10)
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New Laser Material Extends Range of Injection Devices

An injection laser made of indium phosphide has been reported by scientists of International Business Machines. (Previous injection lasers were gallium arsenide.) The new laser extends the injection laser operating wavelengths farther into the infrared. Its wavelength is 9,030 Angstrom units as compared to 8,400 Angstrom units for gallium arsenide.

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**Long-Wave Laser Carries 10 Messages**

A new long-wave laser, developed experimentally by Raytheon, has a range of more than a mile. Channel width is great enough to carry at least 10 voice messages. The new laser is a gas type, and operates at a previously untried wavelength of 3.5 microns. This relatively long wave makes it possible to reduce the size of the laser while increasing its range. Waves of this length are absorbed less by water vapor, carbon dioxide and other components of the air than those produced by earlier lasers. The new laser uses a mixture of neon and xenon gases.

While there are many possible applications for the new short-range communications device, one that immediately suggests itself is short-range military communications. This laser can be easily carried by one soldier, and can be used from a foxhole by adding a periscope.

**Brief Briefs**

No radios—transistor or otherwise—or other electronic devices may be played on Baltimore, Md., buses, the City Council has ruled.

Denver's pay-TV is due to start Oct. 3 on KCTO-TV. FCC's original starting date, July 3, was altered at the request of Channel 2 Corp., the station owners.

Direct broadcast from a communications satellite to home TV sets will be a fact within 12 to 20 years, says a high NASA official.

Two Cleveland translators, Channels 81 and 83, will repeat signals of Midwest airborne ETV transmitters above Montpelier, Ind., to give adequate reception in Cleveland.

TV's educational programs produced by the Indians with the cooperation of the Bureau of Indian Affairs, was sent to Burnell & Co., of Pelham, N.Y. The firm plans a $40,000-office, 40,000-square-foot, $400,000 plant in the pueblo, using Indian labor.

Frank E. Smolek, national service director of Zenith Sales Corp., died July 7 in Oak Park, Ill. He joined Zenith in 1928, had held his present post since 1932, and was credited with service policies which won the backing of the independent service technician.
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*UV combination tuner must be of one piece construction. Separate UHF and VHF tuners must be dismantled and the defective unit only sent in.

Correspondence

Metronome Amplifier
Dear Editor:
Regarding "Build a Unijunction Metronome." July, page 40: here's a cheap amplifier that works well and gives better than double output. The diagram shows the circuit. It replaces the speaker or headphone load in base 1 of the unijunction.

GEORGE W. BLANKENSHIP, WSGZ
Austin, Tex.

The Why and How of Transients
Dear Editor:
In "Watch Out for Transients" by E. H. Leftwich (April, page 28), the explanation of what happened in the transformer was not clear to me, nor, I presume, to Mr. Leftwich.

Transformer voltage and core flux are related by $E = N \left(\frac{\Delta B}{\Delta t}\right) \times 10^{-4}$, where $N$ is the number of turns, and $\frac{\Delta B}{\Delta t}$ is the rate of change of flux. In other words, voltage is proportional to rate of core-flux change.

Now look at the sine wave in the diagram. The core flux rises from zero to maximum (A to B) in $0.00166$ second (for 60 cycles). If Mr. Leftwich had managed to switch his transformer on at A, he might have saved his instruments. But the probability of that is small, and he likely switched into the wave part way toward B, which means

the core flux went from zero to maximum in a very few microseconds. That is, in the equation above, $dt$ was a very small number, making $E$ very large; or, the rate of change of flux was high, making the voltage high. (We depend on this principle for auto ignition and TV high voltage.) Since the volt-ampere capacity of a transformer is related to its core size, any high-voltage pulse is accompanied by low current output. When a transformer is heavily loaded to near its maximum volt-ampere capacity, the load current prevents high-voltage transients.

But whenever a transformer is lightly loaded by high-impedance, voltage-operated devices, such as Mr. Leftwich's unfortunate meters, that is the time to "watch out for transients."

H. B. CONANT
Conant Laboratories
Lincoln, Neb.

Nomo Error
Dear Editor:
There is an error in the Cathode Feedback Nomo on page 23 of your July issue. The graduations on the Rt/Rk scale are all marked one unit too small. Thus, for example, the point marked 20 should really be 21.

ALBERT MEYER
Supervisory Research Engineer
D. H. Baldwin Co.,
Cincinnati, Ohio.

TV Flicker
Dear Editor:
In the Service Clinic for July 1963, you printed an inquiry from Iceland regarding a "flickering" TV picture (page 56).

To those of us in the export trade this is quite familiar: it's called "non-synchronous" reception and is common in areas served by a US-standards TV transmitter but which have 50-cycle power. This occurs in US bases in Europe, and in other places-Mexico City, Teheran, Bangkok and others.

The flicker, as Mr. Darr said, is due to interaction between the 50-cycle power and 60-cycle scanning rate. In most cases, increasing the filtering helps. Sometimes, connecting a capacitor of 0.5 to 3 or 4 $\mu$F across the filter choke to resonate it at 50 cycles does the trick.

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"I HAD A PROMOTION BEFORE I FINISHED the Communications Course," reports Ronald L. Ritter, 113 Helm Dr., Eatontown, N. J., "as well as the satisfaction I could handle a job of responsibility." He works for the U. S. Army Electronic Laboratories, Ft. Monmouth. He received one of the highest grades in Army proficiency tests.

SPARE TIME EARNINGS OF $3,800 in one year reported by Emerson A. Breda, 1620 Larkin Ave., San Jose 29, California. He has a Radio-TV Servicing shop as completely equipped as you would want for a full-time business. Says Mr. Breda, "The training I received from NRI is the backbone of my progress."

"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., RDF 2, Cayuga, N. Y., says of his position with the G. E. Advanced Electronics Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."

HAS SERVICE BUSINESS OF HIS OWN. Don House, 3012 2nd Place, Lubbock, Texas, went into his own full-time business six months after finishing the NRI Radio-TV Servicing course. "It makes my family of six a good living," he states. "We repair any TV or Radio. I would not take anything for my training with NRI. I think it is the finest."

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., 1916 Fern St., New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer and holds FCC Radio-Telephone License. He says, "I can recommend NRI very highly."

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But even if filtering is sufficient, heater-cathode leakage in vertical and horizontal output tubes or a 50-cycle field from the power transformer can cause the trouble. The remedies are to replace tubes, move the transformer or shield it magnetically. Using a transformer with a copper band around it also helps.

Still other sources of trouble are in common heater wiring, ground connections ("ground loops"), etc. But these are less common.

R. Del Riego
Service Manager
Philco International Div.

Another Stereo Balance Indicator
Dear Editor:

A similar circuit to "Stereo Balance Indicator" (July, page 29) has been used by Clairtone Sound Corp., Ltd., with a 6GE12, another dual indicator tube. The schematic shows the essential details. There are no calibration pots in this version, which is meant to be used across voice-coil windings.

In the original equipment, it is used with push-pull 7189's with about 400 volts dc on their plates. I do not know whether a lower-powered system would drive the indicators fully.

J. D. Good
Richmond, Hill, Ont.

Notes on Diode Tricks
Dear Editor:

Mr. Geisler's article ("New Tricks with Diodes," July, page 36) was very useful. But the circuits have been used in carrier telephony, etc., for many years.

Some of the results may be difficult to get in practice unless you use matched diodes and carefully balanced, shielded transformers. Except at very low frequencies, stray capacitances will throw the circuits out of balance unless there is compensation.

One method, which doesn't require center-tapped windings, is to use potentiometers across the windings as adjustable center taps, with trimmers from each side to center (Fig. 1). Another, good with split windings, is to use the pot between the two halves (Fig. 2). Either method reduces efficiency but can give perfect balance.

With these adjustments and with shielded bridge transformers (General Radio 578 series or Leeds & Northrup) perfect balance is easy. With trimmers alone, you can balance for one frequency, but not for another very different one.

As Mr. Geisler states, filtering out one sideband gives "nice, clean SSB for modulating a ham transmitter." This is a standard method but takes an expensive filter because the sidebands differ so little in frequency. Another way is to use two ring modulators with both inputs to one of them 90° out of phase with the inputs to the other. This cancels one sideband. Circuits for this have been published and are manufactured commercially (see the ARRL Handbook, Bell Labs publications and a special SSB issue of Proceedings of the IRE, December, 1956).

The difference between the wave-shapes of the article's Fig. 4 and Fig. 2-b may not be clear from the small sketches. In AM the modulation envelope is alternately concave and convex but, with DSB and no carrier, it is everywhere convex and (for sine-wave modulation) consists of two sine waves centered on axis and crossing at their zeros.

A. H. Taylor
Read Island, B. C.

We Missed One
Dear Editor:

In "Is That Pic Tube Really Gone?" (July, page 26) were listed all the manufacturers of cathode-ray tube checkers and rejuvenators.

We also make this kind of equipment, and we now have on the market a rejuvenator and checker that we feel is far superior to any other product. The trade name is Simco. It has been on the market for the past 6 months.

Lawrence Hunt
President
Englewood, Colo.

[Apologies. The article had been in our hands for more than six months before publication. It is more than possible that other excellent instruments were also omitted from the list.—Editor]
NEW TWIN-TRANSISTOR SUPER POWERMATE

BREAKS THE GAIN/OVERLOAD BARRIER

Servicemen and the public long wanted it, but were told they couldn't have it—a transistorized TV antenna preamplifier with the overload capacity to handle local signals without sacrificing the gain that brings in distant stations.

But Jerrold did what couldn't be done. With the new twin-transistor SUPER POWERMATE, you have, for the first time, a transistor preamplifier with the high gain and low noise figure that made the original Jerrold Powermate famous—plus an unprecedented overload capability for local-signal situations. SUPER POWERMATE offers a gain range from 15.5db with 700,000µv max. output at Channel 2, to 11.3db with 200,000µv max. output at Channel 13. There are no tubes or nuvistors to replace. And frequency response is fantastically flat—a boon to color TV.

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The EICO 667 will earn money for you by catching the bad tubes an emission tester would miss. The 667 combines a mutual conductance test with a peak emission test to give a single reading of tube quality. Bad transistors can be spotted easily. Gain and leakage tests find the defective ones.

Tests almost every domestic or foreign receiving tube made. The EICO 667 checks 5 and 7-pin Nuvisors; 9-pin Novars; 12-pin Compactrons; 7, 9 and the new 10-pin miniatures; 5, 6, 7 and 8-pin subminiatures; octals and loctals. It will also check many low-power transmitting and special purpose tubes, voltage regulators, cold-cathode regulators, electron ray indicators, and ballast tubes. And by inserting pilot lamps into the special output in the center of the Novar socket you get an instant good-bad test of these lamps.

Tests made under actual tube operating conditions. When one section of a multi-purpose tube is being tested, all sections are drawing their full rated current. Pentodes are tested as pentodes rather than combining all the elements for a simple emission check. Leakage between tube elements is read directly on a 4½" meter in ohms.

EICO 667 never will be outdated. A new rollchart is prepared periodically. Data on one or two tubes, can be added by unsnapping the windows over the chart.

Transistors checked in two steps. First for leakage, then for Beta or current amplification factor. Both are read directly off the meter dial, and both n-p-n and p-n-p transistors can be checked.

Features of the 667. Multi-circuit lever switch sets up plate, screen and control grid voltages rapidly. 13 pushbutton switches insert alternate tube elements for rapid leakage testing. 300- and 4½-inch D'Arsonval meter is sensitive enough to give accurate readings even for tubes with low cathode current. 20 heater voltages cover all tube types including 300-, 450- and 600-ma series string tubes. Line voltage variations are compensated for by a line-adjust potentiometer. $79.95 kit, $129.95 wired.

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ELECTRONIC WEATHER CONTROL

...We Now Have the Technical Means to Modify the Weather...

It was Charles Dudley Warner (and not Mark Twain) who first observed: “People are always talking about the weather, but no one does anything about it!” True in his day, and true today. But it probably will not be true at the turn of the next century, A.D. 2000.

The key, as we see it, is a combination of meteorology and electronics. But first let us look at the problem.

Scientists are in full accord that the sun, our titanic atomic furnace, 92 million miles distant, is the supreme and chief source of all weather. Its huge caloric output varies little over the ages and may, for all practical purposes, be called constant in its radiant heating power. Its energy is so great that on each square mile of our earth we receive over 4½ million horsepower of actual energy. A good percentage of this energy is lost—radiated back into space by reflection. Much more energy is lost by the heated earth at night when the sun is below the horizon.

Our largest heat reservoirs are the atmosphere and the oceans, but on account of the seasons, the total amount of solar energy received at any given point on earth varies constantly. Meteorology is not yet an exact enough science to cope with this variability, which is further complicated by the earth’s daily rotation and seasonal inclination of its axis toward and away from the sun—its chief heat source. This is also the reason for the great variability of the weather—to an extent. Admittedly, this outline is a oversimplification of the problem, but for our purpose quite adequate. (There are other lesser factors that influence weather: internal heat of the earth, the polar icecaps, glaciation of high peaks—the Himalayas, the Swiss Alps, etc., man-made vitiation of the atmosphere by hydrocarbons, etc.)

It probably will be impossible for many thousands of years for man to influence either the rotation of the earth on its axis or change its seasons. Nor would this be advisable, even if it could be accomplished. Such a change would certainly aggravate acutely the weather problem.

But suppose we could equalize or modify solar radiation received by the earth to a certain degree. Suppose we could partly light the dark side of the earth with the sun’s radiant energy every day, during all seasons. In other words, a sort of perpetual “day” for much of the habitable world. This we can do in the foreseeable future if the world governments are willing to pay the considerable price—which in the end may be very low, if one figures the huge benefits that will accrue to humanity.

The answer to the problem is the Oberth spatial mirror. Prof. Hermann Oberth, the great mathematician and physicist, in the early Twenties published his epochal book, Wege Zur Raumschifahrt (Ways and Means to Space Navigation). In this classic book, Professor Oberth laid the entire groundwork for our present-day space navigation as well as all pertaining mathematics. Not only did he develop the proto-principles of modern space ships, but he was also the inventor of the World War II German V1 and V2 rockets.

More important was his brilliant conception of the gravitating space mirror, also called a spatial mirror. When he designed it in the mid-Twenties, 20 years before the atom bomb, the space mirror became widely known as the world’s most frightful potential weapon.

Assembled in space, the lightweight mirror was to be about 60 miles in diameter, constructed of paper-thin squares of sodium, a white silvery metal of high reflecting power. These squares were to be mounted on a light metal framework. All the metal squares would be hinged individually so they could be focused by electric motors in any desired direction.

The spatial mirror, gravitating between 400 and 700 miles above the earth, would make one complete revolution around the earth in about 134 hours. As a purely military weapon, Oberth wanted to use it as a gigantic burning glass to destroy cities, cause cyclones and hurricanes and destroy armies in the field by literally burning them alive.

It was also Oberth’s idea to have a resident (military) crew on the mirror to guide it for observation and for eventual offensive purposes. But since the advent of the A- and H-bombs, the space mirror as a war weapon has become obsolete.

Yet for purely peaceful uses and particularly for meteorological reasons, to regulate the earth’s weather, the spatial mirror now appears an ideal instrument that is certain to come into its own in the not-too-distant future.

To be fully effective, the space mirror will probably be much larger than the original Oberth concept, probably over 100 miles in diameter.

It will also be unmanned, electronically operated by radio impulses from earth. The electric power to focus the individual facets made of paper-thin chrome sheets will come from solar semiconductor batteries, which will operate continuously because the mirror will always be in full sunlight.

To be fully effective, we must use a plurality of mirrors, say eight to ten (or perhaps more). Because the mirrors are constantly moving around the earth, they cannot all illuminate the night side of the globe (at the same time), which is their prime purpose. Hence more mirrors are needed to illuminate the dark side.

The space mirrors always turn their face, the “mirror” side, toward the dark side of the earth which they illuminate; their own dark side is turned to the sun when they are over the sunny side of the earth.

The entire philosophy of the space-mirror meteorology is based on the concept that, for the maximum climatic efficiency, man requires but one season—eternal spring, or if you wish, eternal autumn. No destructive frosts, no hurricanes, no tornados, no heavy winter-long snows, no months-long glaciation. The result—blooming deserts, more abundant crops, more food for more people.

Here are a few technical details in this rather sketchy (Continued on page 74)

*Published in 1925 by Verlag von R. Oldenbourg, Munich and Berlin.

October, 1963
Valuable tips on noise suppression for car-borne CB, ham, FM radios

WITH THE EVER-INCREASING USE OF TWO-WAY—especially CB—radio in motor vehicles of all kinds, users are finding that mobile noise often prevents effective communication. Particularly in low-power CB work, motor, generator and tire noise can make a tremendous difference in useful operating range.

The generator, sparkplugs and wiring harness, the voltage regulator, coil, distributor points, condenser and gages are the chief contributors to motor noise. Sparkplug and wiring harness noise is a machine-gunlike popping sound that varies with motor speed. In tracking it down, be sure the sparkplugs are clean, properly gapped and, of course, of the type recommended by the manufacturer. Check the sparkplug leads for continuity. In newer vehicles, the manufacturer has usually installed radio-resistance wiring. Its resistance should be about 10,000 ohms. If a lead opens, the spark has to jump the gap, causing noise. The ends of the leads should be recrimped or, better still, soldered for positive contact. Make sure the holes in the distributor cap are cleaned out before the leads are pushed all the way down in their sockets.

In the distributor, check or replace the points and condenser to prevent them from contributing noise.

Ignition noise

This is the noise caused by actual firing of the spark plugs. It is generally suppressed by resistive sparkplugs, radio-resistance wiring, or both (Fig. 1). When both are used, the reduced voltage may cause the motor to idle roughly. A 5,000-ohm resistor can be connected right at the sparkplug in series with the plug leads, but radio-resistance wiring is superior. A 10,000-ohm suppressor can be installed in series with the distributor center lead. Install a 0.1-μf coaxial capacitor (Sprague No. 48P9) in series with the terminal marked BAT, located on the coil, if previous methods have not been successful.

[This is a coaxial feedthrough capacitor. "In series" here means that the inner element (of practically zero dc resistance) is connected in series with the lead to be bypassed, and the outer element is grounded. The capacitance is actually in shunt with the lead, not in series.—Editor]

What now? In occasional stubborn cases, we have to try other means to combat noises. (And believe me, "combat" is what you’re engaged in!)

If some old coaxial cable is handy, try slapping the outer shield off. This shielding can now be used as a shield for the sparkplug lead. If you push the sparkplug lead through the side of the shielding about 5 or 6 inches before the end, you can use the free end of the shielding as a ground. Connect it to a bolt on the motor. Belden makes shield braid (type 8663 or similar) for bonding or shielding.

If sparkplug leads happen to be of a length that resonates at the receiver frequency, shortening will cut radiation and reduce noise. Rerouting wires that come too close to the sparkplug leads has also helped. Any lead at a potential higher than common ground can cause interference by radiation or by capacitive coupling to other leads. Shielding on those leads will sometimes help in eliminating such interference.

Generator noise

Generator noise is identified by a high-pitched whine that varies with the speed of the motor. To verify, get the car moving, turn off the ignition switch and push in the clutch. The noise will appear when the clutch is engaged and disappear when the clutch is pushed in. Make certain the brushes are in good condition. Then install a 0.5-μf capacitor (Sprague No. 48P18) in series with the armature lead (Fig. 2). Leads should be as short as possible. Mount the capacitor directly on the generator. In most cases, this cures the generator whine.

If the trouble persists, connect 0.5-μf capacitors in series with the arm and BAT terminals on the regulator. Some technicians use a parallel-resonant trap tuned to the receiver frequency, in series with the armature lead. Install the unit as close to the generator as possible. If you wish to make your own tuned circuit, make the coil of wire heavy enough to carry the generator current. The coil should have as low a resistance as possible. No. 10 wire is good.

Noise caused by the voltage regulator is a rubbing or a rasping sound. It can be suppressed by installing a 3.3-ohm resistor in series with a .002-μf capacitor. Connect this from the FLD terminal on the voltage regulator. Do not connect a capacitor directly from field to ground—it may damage the regulator.

Other noises

Interference developed by gages, wheels and tires is most difficult to identify. When in doubt, bypass all gages right at the terminals with a large capacitor—about 0.1 to 0.5 μf. The best way to determine which one is the troublermaker is to disconnect them one at a time. The gas gage should be bypassed right at the tank. In extreme cases, bypassing the dome light will help.

Wheel static noise can be identified by applying the brakes when the car is in motion. If the noise in the receiver disappears, install grounding springs. They can be purchased at auto and electronic parts and stores. Anti-static powder in tires will suppress any tire static (usually more noticeable at 30 mph and

By D. A. DUDLEY
1/ Ignition suppression is the first step. Bypass and resistive suppressor help.
2/ Coaxial capacitor in armature lead shuts up the generator.
3/ If noise persists, bypass the regulator, too, but watch the field terminal—don't connect a capacitor directly to it.

There is a high-pitched whine heard in the receiver when driving at high speeds on dry pavement. Commercial antennas have a plastic ball on top to discharge this velocity static slowly, so that it cannot be heard in the receiver. If you have this trouble, a piece of plastic tubing can be cemented at the antenna tip.

**Bonding**

Bonding is an important item in tracking down motor noise caused by the sparkplugs or generator. Bonding is tying all parts together at common ground potential. Connect heavy copper bonds from all four corners of the motor to the frame of the automobile. Check that the ground strap from the battery has not developed any resistance.

In some tough problems, run a copper strap.
as a common ground from the voltage regulator and generator to the motor. Install bonding at both hood hinges and place a flexible piece of tin at the other end as a hood wiper. This will do much to keep the noise under the hood and out of the receiver.

The tail pipe is usually suspended from rubber supports. To keep it from acting as an antenna, bond it at intervals. Even putting a bonding strap from it to the frame of the car. In the initial installation of the antenna, a place of minimum motor noise can be determined. Placing the antenna on the top of the car will generally improve performance. The roof then acts as a good ground plane and gives a non-directional pattern.

I have mentioned coaxial capacitors. These should not be replaced by the paper bypass variety. Although more expensive, coaxial capacitors are considerably more effective at higher frequencies.

By metering the receiver and keeping the motor at the same rpm, you can determine how effective you have been in eliminating noise. This is helpful when you have more than one source of motor noise to contend with. The meter reading will decrease as motor noise is suppressed. Also radiating a signal on the receiver frequency will aid in determining what type of noise is being intercepted in the receiver, and if any improvement is being made.

In an FM receiver, a balance point for impulse noise is reached at some point in alignment. At this point, the motor noise will be reduced. Tune the i.f. coils for minimum motor noise, being careful not to detune the receiver. And be sure that your receiver is in good operating condition, of course. In some cases, a defective tube may show up as an increase in motor noise rather than a decrease in signal level. It is also advantageous to run the receiver direct from the battery. The battery then acts as a large capacitor, bypassing noise impulses to ground.

INVENTORS OF RADIO
Alexander Stepanovitch Popoff
By DEXTER S. BARTLETT

ALEXANDER S. POPOFF HAS BECOME A controversial subject of late years. The Russians claim him as the sole inventor of wireless; yet he is apparently totally ignored by the Marconi adherents. The truth, as is often the case, seems to be somewhere between. His contributions may not have been epoch-forming, but are well worth mentioning for the record. He definitely was first to make practical use of a wireless device and the first to utilize an antenna. (Loomis and Edison had previously used antennas in experiments.) He made Brany's coherer a success with his decoherer and he was one of the first to have his equipment used in saving lives at sea.

Alexander Stepanovitch Popoff (or Popov) was born in Perm, in the Ural mountains of Russia, on March 16, 1859. At the age of 17 he entered the University of Sciences and in 1883 became professor at the Marine Academy at Kronstadt. It was there that he did most of his scientific work. He died at St. Petersburg (Leningrad) in January 1906.

After hearing of the discoveries of Roentgen and Crookes, he made up a series of tubes for investigating X-rays on fluorescent materials. He also heard of the experiments of Hertz and Branly and began his many wireless experiments at the Kronstadt Naval Yard.

As early as 1895, Professor Popoff communicated to the Physico-Chemical Society at St. Petersburg the details of a device employed by him for graphically registering atmospheric disturbances with an iron-filing coherer, introduced between an antenna or "exploring rod" and ground. A relay and tapper (decoherer) were also employed, the former operating a 12-hour recorder. With this arangement, he detected thundersstorms at a distance of 20 miles.

Although Hughes and Lodge had used thumpers for decoherers, it remained for Popoff to make Brany's coherer usable by brilliantly hooking his bell tapper in the receiver relay circuit and thereby decohering after each received signal.

In May 1895, using his thunders- storm detector, along with an Hertz oscillator, he worked a distance of 1,000 meters. According to Sir Oliver Lodge, he had no thought of wireless telegraphy, but the experiment was for scientific purposes. Nevertheless, by Dec. 5, 1895, Popoff expressed confidence that he could establish a wireless telegraph system if he could perfect a more powerful transmitter.

On March 24, 1896, he and his assistant, Rybkine, gave a demonstration at St. Petersburg University, transmitting Morse signals between two buildings 250 meters apart and recording them on tape. This radio program—the first in the world, and taped, too—comprised only two words: "Henri Hertz."

In March 1897, he established a station at Kronstadt, and equipped the cruiser Africa with his apparatus. As the story of Popoff's record goes, in 1899 wireless communication was established between the battleship Admiral Aprasin and the coast, a distance of 45 miles. In 1900, a wireless dispatch from St. Petersburg, using Popoff's apparatus, was flashed to the icebreaker Ermak in the Baltic, instructing the crew to rescue a group of fishermen stranded on floating ice in the Gulf of Finland, possibly the first time wireless was used to save lives at sea.

In 1897, during experiments aimed at organizing radio communications within the Baltic fleet, Popoff is claimed by the Russian author P. Kolessov to have discovered the reflection of electromagnetic waves by naval units. More than 40 years later this discovery was to serve as a basis for radar.

A year later the Russian Army used Popoff's equipment and in 1903 the Ministry of Postal-Telegraph opened its first commercial wireless service. In 1901 he became professor at the St. Petersburg Electro-Technical Institute, but still found time to work on developing wireless telegraphy on board units of the Russian fleet.

Undoubtedly Popoff has considerable justification in his claim for firsts in wireless telegraphy as his dates are mostly contemporary with Marconi. But being a basic scientist, Popoff is said to have refused to take out patents on his wireless system, contending that the discoveries should benefit the scientific world at large.
HAVE YOU EVER STOPPED FOR A MOMENT to think how many organizations depend on movies for education or entertainment? Visit any school, church or television station and you’re sure to find at least one 16-mm sound film projector. Many larger schools have a whole fleet of them, run by an audio-visual aids staff or club. And quite a few individuals own sound projectors, too. Someone’s got to service them!

Repairing movie projectors is not difficult and can be profitable. Most of a projector is, of course, optical-mechanical. But rarely will you find any mechanisms that you might not also run into in TV tune s, tuning drives or record changers. And, since we’re talking about talkies, a large part of the machine is, in fact, electronic.

Basic 16-mm sound projector
Each unit includes a movie projector: projection lamp, lenses and a driving mechanism, with reels to feed the film and take it up after showing. The sound is on a sound track on the edge of the film. This passes over the sound head after it goes by the shutter. An exciter lamp throws a beam of light through the track, which is focused on a photocell. The resulting light variations are converted into electrical variations, and amplified by a conventional audio amplifier. Fig. 1 shows the major parts of a typical unit.

Sequence of operation
The sequence of operations is always the same, although there are normal differences between makes. The film comes from the feed reel, passes over idler rollers (not driven) to keep it in the right path, and driving sprockets, provided with teeth which engage the holes in the edge of the film. (All 16-mm sound film has holes on only one side, whereas 35-mm film, as used in theaters, has holes on both sides.) The drive sprockets are always fitted with some kind of spring-loaded latch which holds the film in place on the sprocket, but allows it to slide easily.

The film travels past the shutter, where it is projected onto the screen, then over the sound head, over more idlers, then to the takeup reel, which winds it up again. After showing, the film is rewound on the feed reel for the next showing. The reels are both mounted on cast-iron arms, which fasten to the heavy “blimp” cases in which projector and amplifier are mounted. They are driven by coiled spring-steel belts.

The sound for a given frame is always ahead of the picture. Why? Look at Fig. 1. The frame being shown is at the shutter. While the sound for that frame is just running past the sound head, several frames in advance! So, we must always thread up the machine so that there is the same number of frames between shutter and sound head. This is the purpose of the lower “loop” seen below the shutter. By adjusting the amount of “slack” in this loop, we can make the sound come out in exact synchronism with the picture. Too much loop, and the sound will be late; the character’s lips will move, and the words will come out quite a bit later! It takes only a couple of frames to make a very perceptible difference.

In most machines, you’ll find guide lines, made of metal ridges, on the face of the housing, to show you the correct film path. This information is always given in the instruction book. If the book is missing, you’ll have to figure it out for yourself. The lower loop is usually about “two fingers”: make up the loop, then insert the tips of two fingers between the bottom of the pressure foot and the drive sprocket. This can be checked very quickly as soon as the machine starts! This is important only in films showing people talking. In technical films or documentaries, where you can’t see the speaker, it isn’t too critical.

The loops
We’ve mentioned the lower loop. The upper is equally important. The film in these machines does not travel smoothly down past the shutter. It travels in jerks, due to the peculiar method of projection used.

In a theater projector, the film is pulled past the shutter by sprocket rollers and travels at a constant speed. The light is interrupted by a shutter, which closes as the interval between frames passes the gate (the vertical blanking bar!). In small projectors, however, the film is jerked down by a pair of metal teeth during one of the intervals while the shutter is closed. A special
Fig. 2—"Pulldown" action cycle in 16-mm projector film gate.

cam inside the machine causes these teeth to pull the film down on every fourth opening of the shutter. Each frame of film is actually projected on the screen three times! This is done to avoid flicker on the smaller film.

From Fig. 2, you can see this action. The pulldown teeth are mounted in a slide, inside the film gate. A specially shaped cam causes the teeth to move out through slots, engage the sprocket holes in the film, and pull it down exactly one frame. The shutter is closed at all times while the film is moving (a). On the next shutter closing, the teeth pull down again, but this time they're retracted so that they do not engage the holes (e). The shutter opens (b), and one frame is projected on the screen.

Fig. 3—Shutter of projector is actually a disc, not a flat plate. Its rotation is synchronized with the pulldown mechanism.

On the next two cycles (c—d; e—f) the same action is repeated. The teeth are driven up and down in synchronism with the shutter, but the cam keeps them retracted. So, each frame of the film is shown three times. On the fourth cycle (g), the cam pushes the teeth out again, they engage the film and pull the next frame down before the gate. The shutter is a disc (Fig. 3) with wedge-shaped slots in it.

In the 16-mm projectors used for TV films, there is a different cycle of projection. To make the frames come out “even” with the frame scanning rate, the projector shows one frame twice, then the next frame three times, then twice, and so on. This peculiar transport rate makes the frames come out even with the 60-cycle vertical scanning rate, and eliminates the flicker. (They were quite a while working that out, though!)

Now, you can see why the loops! They act as “shock absorbers” to take up the jerking motion of the film, and allow it to be drawn at a steady speed over the sound head. You can imagine what the sound would be like if this intermittent motion were used there!

**Speed control**

In sound projectors, film speed is very important. It must be exactly right, or we get the familiar wow and “funny sound” we’d get if a phonograph turntable was running at the wrong speed! So, a controller is used on the motor (Fig. 4). This is a centrifugal speed control similar to those used on electric mixers, etc. The end bell of the motor is the object lying on top of the lamp housing. The disc in its center engages the controller, and is used to drive a pulley for running the rear belt.

Many projectors provide dual-speed operation: 24 frames per second for sound, and 16 for silent films. The speed is changed by switching a resistor in series with the controller.

**The optical system**

The light from the projection lamp must be concentrated into a beam. Projectors like this use a system of reflectors and condenser lenses, as shown in Fig. 5. The parabolic reflector behind the lamp can be seen in the hand in Fig. 4. This

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**Fig. 4**—Rear view of projector motor (left in photo) shows speed controller. Hand is holding parabolic reflector used behind projection lamp. It screws into hole nearby in lamphouse.

**Fig. 5**—Typical optical system. Some machines use fewer lenses, but idea is the same.
Two more lenses are used between the lamp and the film gate. These are also removable, as seen in Fig. 6. In the front of the gate, the projection lenses are mounted in a removable barrel. (This assembly can be seen in Fig. 1.) These outer lenses are used for focusing the light on the screen by moving the lens barrel back and forth in its holder. A locking screw is provided on all machines to keep the vibration of the motor from jiggling the lens out of focus.

The sound head

The sound head assembly of the projectors consists of an exciter lamp, a phototube and some method of moving the film past a very tiny slot, so that the light will pass through the sound track and fall on the phototube. A typical assembly is seen in Fig. 7. The exciter lamp here is inside the center housing. The hole can be seen on top, just above the words FILM PATH. The photocell is above this. In operation, of course, a lightproof shield is placed over this lamp. This is usually of metal, to prevent stray hum pickup, since this is always a high-impedance circuit.

The two drive sprockets are shown in Fig. 7, with the two spring-loaded rollers that hold the film in place, the idlers. This machine uses idlers on spring-loaded arms. The one at left is in place; the one at right open, ready to accept the film.

Fig. 8 shows the same assembly on a different machine. Here, the exciter lamp is behind the partition, at the right. The lens and slot are in the partition, and the roller in the center holds a mirror. This is set to reflect the light beam onto the phototube, which is mounted on the amplifier chassis itself, inside the projector base.

The one most important thing about the sound head is that the film must be kept at exactly the right tension as it passes over it. Notice the elaborate arrangement of drive sprockets and spring-loaded idlers used on both machines. The film must be held down very snugly against the sound head. If it is too loose, you'll get a sort of "monkey-chatter" effect, like a photograph with a very bad needle and record at the same time! If you hear this kind of sound, look at the sound head to see that the drives haven't "jumped a frame" on the sprocket holes, or done something else that would allow the film to become too loose.

Next month, a look at the drive clutch and "safety shield", among other things. You'll find that threading and running are pretty much the same in all projectors, regardless of make and model. We won't get to the simpler electronics end until the third and final part, but then—making minor mechanical repairs on projectors can be a profitable venture, and will win you customers! TO BE CONTINUED

Fig. 6—Closeup of condenser lens, removable for cleaning. Other one is still inside, about 1 inch left of slot.

Fig. 7—Sound-head assembly.

Fig. 8—Another sound-head assembly. Note shielded exciter lamp, lower right, and spring-loaded idlers between sprockets. They keep film tension constant.
The experienced technician and the novice experimenter will appreciate having a variety of diagrams of common and not-so-common audio output circuits gathered together for swift comparison and evaluation. The 10 circuits here may help you build, service or design efficient, high-quality transistor output stages.

All parts values have been proved in actual lab or production-line models, so the prospective builder can be sure that all these circuits will work.

If you choose to substitute other transistors for those shown, be sure to use equivalent types. Practically no "fudging" of resistor values will be found necessary if interchangeable types are selected. The output transformers shown are representative types. No attempt to select particular types by part number has been made.

1. Probably the simplest "standard" transistor power amplifier. Gain, using the transistor listed, is a minimum of 30 db. Power consumption is high, whether the stage is idling or working at rated output. Distortion about 4 to 6%.

2. Increase the gain to over 33 db by adding the input impedance matching transformer to the circuit of 1. Because of lower resistance in the bias network, battery current may increase by 1 ma or more. Returning the emitter bypass capacitor to the bottom end of T1's secondary improves gain, tone quality and ac stability. Distortion of the stage at full rated output is from 3% to 5%, depending upon the quality of transistors used.

3. The transistor portable manufacturer's old standby! This familiar circuit, excavated from its well-worn rut, has been included as the prime example of bad design.

This circuit goes easy on the battery, but rarely can good fidelity be obtained for low cost. The amplifier takes up a lot of space and the coupling transformers add weight. Use of the circuit in a set supposedly designed for minimum size and weight is hard to understand.

4. Perfect impedance matching to the output transformer is provided by this circuit. Its input impedance is also high. This reduces loading on the signal source. Circuit gain is equal to or better than that of 2. By increasing R's resistance, it is possible to operate the output transistor class AB with a slight loss in fidelity but at a greater efficiency. The large amount of negative feedback from Q1's unbypased emitter resistor almost completely cancels distortion in the driver, so the amplifier's output is very clean-sounding, even at the overload point.

5. Two circuits of 4 wired in push-pull, double our class-A power output, nearly triple class-AB power, and cut distortion almost in half, too.

In class A, this configuration easily delivers a clean 100 mw or more output, and in AB, up to 300 mw of clean audio. The 10,000-ohm pot across the upper half of the output transformer winding adjusts the amplitude and ac balance of the "other half" of the audio signal fed to Q3. This is a "set-and-forget" control.

By substituting suitable high-power transistors for Q2 and Q4, any power output may be obtained. Of course, the output transformer must be selected to match the transistors used.

6. Q1's output impedance is matched to Q2's input by rearranging the wiring of 4 somewhat. This is a nearly perfect match and practically no power is lost. Phase shift is negligible, also.

As Q2's output is 600 ohms or less, it is possible to drive several low-impedance speakers wired in series, with great efficiency. The distortion of

By LEONARD E. GEISLER

10 transistor circuits for the technician and experimenter

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this circuit is less than 4% at full output (just barely clipping). Maximum gain is about 50 db from input to output. We have done away with the input and output matching transformers completely. If ordinary transistors are used and carefully juggled about, gains from 39 to 65 db are possible. This circuit can be made into a push-pull stage if you exercise your imagination and ingenuity. (See 5 for inspiration!)

7. Another version of 6. It has lower distortion than the other circuit, and very low output impedance. It can drive a low-impedance voice coil (16 ohms or less) through the large electrolytic dc blocking capacitor.

8. An efficient, low-distortion OTL (Output TransformerLess) amplifier combines the low output impedance of the emitter follower and the power gain of the common emitter. It also eliminates the objectionable feature of the circuit of 3-power limitation imposed by excessive back emf of the pulsed output transformer. The circuit is biased for class AB2 with the resistor values shown and may be operated straight class-A by decreasing the values of R1 and R2 by about 1,000 ohms so about 10-MA static collector current will flow in the circuit. (I feel that no useful purpose is served by increasing bias to class A. However, it is mentioned so the experimenter may make an exact measurement of the power output, if desired.)

If class-A operation is desired, it is recommended that two small resistors—about 4.7 ohms each—be inserted in the emitter lead returns to prevent thermal runaway.

9. This is nearly the end—the split load phase inverter. Not as efficient as the coupling transformer of 8, but its ac balance is excellent and automatic. Impedance matching between the phase splitter and output transistors is very close, with the two diodes acting as switches to improve overall operation further. The diodes short out excessive positive ac signal swing, which might damage the output transistors base-emitter junctions.

Transistors Q1 and Q2 are direct-coupled to eliminate parts and unwanted phase shifts. All four transistors are well matched to each other, the two output transistors operating either emitter follower or common collector. Q3 is the emitter follower, Q4 is the common collector transistor.

This type of amplifier is often shown with a matched complementary pair (n-p-n and p-n-p “mirror image” transistors) working as drivers for the output. Since well matched complementary transistors are not always available, I prefer the circuit shown here.

A low-power version of this amplifier will take up about the same cubic volume as an ordinary output transformer.

10. Bridge type OTL amplifier. It has eight times the power output of the circuit of 3. If properly constructed, it will have less than 1% total distortion. The circuit works like the one in 9 except that the extra two transistors are connected to the opposite phase output of Q2. No direct current flows through the voice coil if the four output transistors are well matched. Thus we eliminate the output coupling capacitor.

Total ac voltage across the voice coil will be nearly twice the battery supply on peaks. Both this circuit and the previous one are far more efficient than any other shown here.

In conclusion, I want to thank the many transistor manufacturers for their kindness in supplying application notes gratis. Mr. John Palmer was kind enough to assist us in developing the circuit of 8 as shown.
A report on the science of vanishing electronics

Scientists in virtually every field are striving for bigger accomplishments and larger end-products. In electronics, the best brains are going in the opposite direction. Today the emphasis is on smallness—almost to the vanishing point. The results already achieved have caused more excitement and anticipation than any development since the invention of the transistor. A new electronic technology is born—integrated circuits.

A multistage amplifier, a complete flip-flop, an elaborate computer gate, all so tiny that their individual structures can be seen only under the microscope, will be the basic tools of the electronic technician. Every phase of the industry, from engineering to servicing, from equipment production to product marketing, will feel the impact. The concept of integrated circuits heralds the beginning of a new era in the electronics art.

What are integrated circuits?

Even the electronics industry itself has not yet agreed on a precise definition. But a semblance of order was brought into the confusion last January. The EIA (Electronics Industry Association) proposed a definition that has at least tentative approval from a large number of manufacturers.

"Integrated circuits," proposes the EIA, "are the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit."

Electronically, integrated circuits are not radically different from those in common use. They still consist of separate component parts—transistors, diodes, resistors and capacitors—interconnected to form a working whole. Physically, there is no comparison. Unlike conventional circuits, whose component parts are separately manufactured and individually packaged, integrated circuit parts are all fashioned simultaneously and with identical processes. All are deposited on or within a tiny "chip" of silicon no thicker than a page of this publication and only a few tens of thousands of an inch square. And, in the completed circuit, these parts are neither separable nor repairable.

Why integrated circuits?

Integrated circuits are of major importance to the electronics industry because of their technological and economic advantages.

Small size and weight are the most obvious. Capable of being compressed into a minute volume, they are the answer to many space-age and military electronics problems. Present methods of packaging are designed more for standardization than for minimized dimensions, yet are flexible enough to meet almost any need.

Size and weight reducing capabilities are the most obvious integrated-circuit features, but by no means the most important. At least as vital is the increase in equipment reliability. Separate interconnecting wires and their solder connections are replaced with vapor-deposited metallization patterns. This promises to eliminate a major source of equipment trouble. Use of high-reliability semiconductor devices and manufacturing processes is expected to improve systems reliability further.

Finally, since a complete circuit now becomes the basic building block of electronic equipment, the number of actual parts is sharply reduced, extending the life of a complex system.

But perhaps the most important overall advantage of integrated circuits is the prospect of cost reduction. This is due not only to the small cost of the actual materials required, but also to the labor and equipment savings of the manufacturing processes.

How are they made?

Integrated circuits do not really represent a revolution in the state of the art. Rather, they are an evolution—the extension of manufacturing techniques used in transistor manufacture for over a decade. Like transistors, they have their beginnings in crystal growing furnaces, like that in the cover picture, where from a melt of semiconductor material a tiny seed of silicon slowly emerges as a rod of single-crystal material. This material is relatively pure, but does contain a small number of deliberately introduced p-type impurities.

This crystal is then sliced into paper-thin wafers (approximately 1 inch in diameter and .006 inch thick). Each of these serves as a base, or substrate, for dozens or even hundreds of complete identical circuits, depending upon the complexity of the circuit structure and the values desired.

(Since the substrate represents a large portion of the total material employed for such circuits, obviously the material cost of a circuit borders on the negligible. The greatest single item of hardware cost in the entire circuit is that of the header, or package, in which the circuit "chip" will be eventually mounted to permit interconnection with other circuits in a more complex system. The cost of the integrated-circuit package is not appreciably greater than that of a conventional package housing a single, ordinary transistor. And, since the actual manufacture of a wafer of integrated circuits takes only one process step more than the fabrication of a transistor wafer, it is expected that, eventually, the cost of a complete integrated circuit should be little greater than that of a single transistor today.)

Actually, the basic wafer does little more than give mechanical rigidity to the integrated circuit. The parts themselves are all diffused into a microscopically thin n-type semiconductor layer.
epitaxially grown (Fig. 1) on top of the basic substrate.

The concept of integrated-circuit "parts" demands some explanation. An integrated-circuit resistor, for example, is merely a tiny area on the epitaxial layer which has been impregnated with a precisely controlled impurity of the opposite polarity (Fig. 2). The actual resistance of this area is determined by its dimensions as well as the resistivity of the semiconductor material diffused into the region. Typical resistance values range from about 10 to approximately 100,000 ohms.

Capacitors for integrated circuits (Fig. 3) are also made by diffusing one type of semiconductor material into an opposite polarity type. But, whereas resistors have two interconnecting points at opposite ends of the same material, one end of the capacitor may be the substrate itself; the other is the opposite-polarity material diffused into the substrate. Thus, a capacitor may be essentially an n-p or p-n junction which, in effect, is a junction diode.

There is very little difference between a diode and a diffused capacitor except in the way they are used. It is well known that any reverse-biased diode exhibits a capacitance effect. To use a diode as a capacitor, it is necessary only to keep it reverse-biased under all circuit operating conditions. Capacitance values available by this method depend upon the size of the diffused area. Practical values range from 1 to 1,000 picofarads.

Transistors for integrated circuits can be made in the conventional manner. Transistors require three material layers, diodes and capacitors require two, and resistors only one. It should be obvious, therefore, that all diodes, capacitors and resistors can be made at the same time a transistor is manufactured.

Limitations

Progress made in integrated-circuit technology over the past couple of years has far outstripped even the most optimistic predictions. Yet everyone connected with the field will readily admit that this is just the beginning. True, a number of devices are in production and are actually being designed into equipment. But the scope of the art—the number of types of circuits being produced—is still limited.

Integrated-circuit production is largely confined to digital (switching) circuits for the computer industry. The reason is both technical and economic. Not only are digital circuits much simpler and less critical than linear (amplifier) circuits, the required parts and parts values for digital circuits are far more compatible with the present state of the integrated-circuit art.

For example, in today's technology, practical values of inductance with reasonably high Q's are still impractical in integrated circuitry. This automatically eliminates all forms of fully integrated tuned amplifiers. Moreover, capacitance values above .001 \mu F require too much space to be placed on a single chip with other "parts." Therefore, low-frequency amplifiers with R-C coupling and large bypasses cannot at present be made as fully integrated devices. And the number of parasitic parameters (stray intercomponent coupling) associated with integrated circuits is greater and more troublesome than in conventional wired circuits.

Hybrid devices

All these factors can be and are being circumvented by hybrid devices: integrated circuits that can be combined with unencapsulated microminiature discrete components, all in the same package. Also, considerable study of unique circuit designs that may eliminate the need for inductances (R-C filters, etc.) and large capacitance values (active capacitance-multiplier circuits) is in progress. Results to date are, however, far from competitive with standard circuit elements.

Hybrid circuitry is a flexible technique for obtaining many of integrated-circuit advantages without being critically dependent on technological and economic factors. Sometimes called multiple-chip circuits, hybrid circuits consist of a number of silicon substrates, each containing one or more integrated-

Fig. 1—Crystal layers are grown on the basic substrate in rf furnaces like this. Gases are flowed over the induction-heated semi-conductor wafers in the quartz tube to produce the desired epitaxial surface layer.

Motorola photos

Fig. 2—Integrated-circuit tapped resistors. Metallized "islands" provide 10% and 1% resistance increments.

Fig. 3—Integrated capacitors. The binary pattern here contains 5 capacitors of 1, 2, 4, 8 and 16 units of area.
Hybrid circuits are often combined with discrete microminiature inductors, crystal filters and other nonintegral parts. They are, therefore, highly versatile and, due to low design costs, can be adopted for custom-built and linear circuits in small quantities.

The flexibility of hybrid circuits is illustrated by a typical hybrid audio amplifier (Fig. 4). The individually mounted parts are interconnected either by separate wire bonds or by a metallization pattern. One “chip” contains a number of parts—in this case a Darlington-connected multistage dc amplifier. For hybrid circuits, therefore, it is practical to make and stock a variety of commonly used “partial” hybrid circuits and combine these with compatible parts to complete the final function.

Hybrid circuits can be mounted in the same packages as single-block integrated circuits, and are completely compatible. Since the design cycle for hybrid circuits is short, such devices can be used as an interim stage in the manufacture of integrated-circuit equipment. For example, early equipment models may be made with hybrid modules while fully integrated circuits are in the development stage. In subsequent models, fully integrated modules can replace the hybrid circuits on a 1-for-1 basis, without changing either the appearance or performance of the system.

New circuit design principles

Integrated circuits mean a change in circuit design concepts. Just as transistors demanded a departure from vacuum-tube design principles, so integrated circuits require a new approach for best performance.

In conventional circuits, the active components (transistors and diodes) are normally far more expensive than passive ones (resistors, capacitors, etc.). With integrated circuits the opposite is often the case. In addition, an increase in the number of components to produce a given circuit function often results in little or no increase in cost. It may be convenient to use a greater number of stages to do a given job more reliably, rather than drive each stage to its maximum ratings.

The circuit designer, however, will be faced with the problem of which and how many stages and components are to be placed in a single integrated-circuit package. A particular “chip” size will hold only a certain number of components—often determined by component values. The designer may elect to place more than one chip in a package, thus reducing interconnection costs and increasing replacement cost. He may specify a larger “chip” to mount more components, but in doing so he reduces circuit yield and increases costs. He will have to circumvent inductors in his circuit design, and perhaps substitute active circuitry for large-value capacitors. He will have to design circuits within the limits of available integrated parts values and cannot rely on very close resistor and capacitor tolerances. Finally, he must be acquainted with the various parasitics in integrated-circuit fabrication and learn either to compensate for them or to use them in his circuit design.

But he will be starting on the ground floor. Today, the bulk of accumulated integrated-circuit knowledge is stored largely within the confines of semiconductor device manufacturers and those equipment companies who have set up close working relationships with the semiconductor concerns. For most working engineers, the design of integrated circuits requires a learning process similar to that involved in the changeover from tubes to transistors.

Although integrated circuits are being built in production quantities and are already designed into some equipment, even the most knowledgeable integrated-circuit engineer will admit that we have just scratched the surface of this new technology. But, if the progress made in the past year is any indication, acceptance of integrated circuits will be more rapid than that of any other major development in the history of this fast-moving industry.

Reverse voltage protection for transistors

When the supply voltage to a transistor circuit is reversed, the characteristics of some or all of the semiconductors are likely to be changed—seldom, for the better. Because a reversed battery may do several hundred dollars worth of damage to a complex transistor assembly, and may cause delays of up to a month while new transistors are procured and installed, some sort of reverse-voltage protection is desirable.

Simplest protector is a diode connected in series with one supply lead. With this arrangement, the assembly will work when the battery polarity is correct, and it will not work if the battery is reversed. This protects the assembly against battery reversal. However, in practice, many assemblies are rejected as inoperative when the real and only trouble was that the battery was connected backward.

Much more satisfactory is a suitably polarized bridge rectifier connected between the power input terminals and the transistor load (Fig. 1). With this arrangement, the circuit will work, independent of battery polarity. This circuit works well, but technicians using such circuits are likely to disregard polarity completely, with unhappy effects on other unprotected equipment.

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FIG. 1. Reverse-voltage protection.

FIG. 2. Reverse-voltage protection.

The most satisfactory device tried so far is shown in Fig. 2. Here, a series diode protects the load against reversed voltage, while a lamp in series with a suitably polarized diode lights when the supply polarity is wrong. If the supply packs enough power, a loud buzzer, adjusted for a Bronx cheer tone, can be used in place of the lamp.

When the supply voltage to the transistor assembly is critical, the battery voltage must be increased slightly to compensate for the slight drop in the series diode or diodes. With silicon diodes, whose current rating is in the same order of magnitude as the actual load, the drop per diode will be roughly 1.5 volts.—Ronald L. Ives
**CUSTOM BUILT CHURCH AMPLIFIER**

This high-quality, high-versatility piece of equipment can meet many PA needs.

WE BUILT THIS AMPLIFIER BECAUSE WE couldn't buy anything quite like what we needed, at a price we could afford. What evolved is a versatile system that fits not only our needs, but looks as though it might serve other churches as well—and perhaps schools, too.

One peculiarity of this amplifier is its shape. We wanted it built into a wall, something that couldn't be done with commercially available amplifiers. We needed independent volume control of the main auditorium speakers and the "cry room" (nursery) speaker. T- or L-pads would have wasted a lot of power and created matching problems. Finally we also wanted controllable earphone output for hard-of-hearing churchgoers.

Figs. 1 and 2 show the results. Earphones and cry-room speaker share one channel, since both are wanted simultaneously all during services. All input sources are common to both channels. The auditorium speakers are driven from a higher-powered amplifier with its own volume control.

**What? No power transformer?**

At first gasp, this seems like a horrible thing to do to a church. Actually, it's a safety factor! The amplifier is mounted inside the wall, in a grounded metal box, and is connected to the power line through a polarized plug that is inaccessible once it has been polarized correctly (chassis to grounded side of line, of course). There is no chance of shock. Also, since the chassis is tied firmly to earth ground through power wiring, hum and instability are reduced. Turn all volume controls up full, even without input sources connected, and you hear nothing but tube hiss!

If you want to use this amplifier for portable PA work, use the alternate (transformer) power supply in Fig. 3. (We strongly recommend permanently connecting the chassis to a water pipe or earth ground. This will blow the fuse and eliminate the shock hazard if the polarity of the supply line should be reversed through a wiring error. If the additional ground is omitted, reversal of line polarity may raise the microphone cases and hearing aids to line potential, thus presenting a serious shock hazard.

Do not, under any circumstances, use the transformerless version of this amplifier as a portable unit.—Editor)

You might also (second gasp) notice that there is no fancy voltage feedback. We relied only on simple unby-passed-cathode-resistor current feedback, which presents not the slightest chance of peaks or instability. Top-quality output transformers are expensive and bulky, yet without them, most

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*OCTOBER, 1963*

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Fig. 1—Four mixable input sources feed a common mixer amplifier and two power channels.
attempts at long-loop voltage feedback are doomed—they can actually make an amplifier less listenable. For the occasional amplifier builder, we feel that simple current feedback is the best approach. This amplifier sounds good, and that, after all, is the final test.

The auditorium amplifier uses a universal output transformer to simplify matching to various speaker loads.

The nursery-earphone amplifier uses a single 6A05 with a receiver type output transformer. Its "listenability" is excellent. High-impedance earphones and lorngates are fed through a capacitor from the chassis plate. This channel normally runs "wide open", since the phones and cry-room speaker have individual volume controls.

Grid leak bias is used for the mike preamps. It's simple and inexpensive, and reduces heater-cathode leakage.

Fig. 3—Alternate power supply for a portable, or wherever a completely enclosed installation is not convenient.

Fig. 2—Circuit of the amplifier. Yes, there's no power transformer, but read the article before you turn away!

can-type electrolytic (Sprague TVL-3574 or equivalent)
C17—100 μf. 300 v. 60 μf. 250 v. 20 μf. 250 v. can-type electrolytic (Mallory 3953 or equivalent)
C18—150 μf. 150 v. tubular electrolytic (Sprague TVA-1422 or equivalent)
C19—200 μf.
CH—2 henry, 200-volt filter choke (Thordarson 26Ca3 or equivalent)
D1, D2—1N1763 (RCA)
F1—1-amp slow-blow fuse
F2—2-amp slow-blow fuse
1—NE-2
J1, J2, J3, J4—phone jacks
5—split toggle switch
T1—Output transformer, 5,000 ohms to 3.4-ohm voice coil, 5 watts (Thordarson 24551 or equivalent)
T2—Output transformer, universal, 18 watts (Thordarson 26846 or equivalent)
T3—Filament transformer, 6.3 v, 3 amperes
V1, V2, V3—7025
V4—12AX7
V5—6A05
V6, V7—68Q5
Chassis, 10 x 5 x 3 inches
Polarized ac line plug
Tube sockets and miscellaneous hardware.

You can buy polarized plugs from most big electrical supply houses.

Handy trick for making polarized plug—solder paper clip or one prong. That prong goes to ground side of line. This plug fits modern wall receptacle.

Fig. 3—Alternate power supply for a portable, or wherever a completely enclosed installation is not convenient.

Fig. 2—Circuit of the amplifier. Yes, there's no power transformer, but read the article before you turn away!
Rear view. Connections to jacks and terminal strips permit removal for servicing.

WHAT'S YOUR EQ?

Three puzzlers for the student, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service thinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.
Answers to this month's puzzles are on page 72.

Power Supply Puzzler

The photocell controller for a factory conveyor refused to work after reinstallation in a new spot. It was supposed to stop the conveyor motor when a box broke the beam. A 3-phase 220-volt line supplied power to the motor. The power transformer of the photocell relay control amplifier, a standard 110-220-volt tapped transformer, was connected between the center leg of the 220-volt line and ground. The transformer overheated and resistors burned up. When the tap was moved to 220 volts, the amplifier still refused to work.

The complete system was taken to the shop. There, it worked perfectly on both 110- and 220-volt supply, yet it refused to work on the machine. What's the matter? Possible hint for solution: "Industrial Electrician" employed by local factory was kid who actually didn't know what three-phase current is. Argued for three days, despite actual demonstrations on nearby power supply. He got the motor to work by following wire colors, but couldn't get the photocell amplifier to work at all.—J. J. Darr

Output Voltage

What is the output voltage across the bridge? Can you prove it mathematically?—Cameron McCulloch

Double Grid

All resistors are equal and the total current is 1 ampere. What is the value of each resistor?—Kendall Collins
Test transistors IN-CIRCUIT

Nothing to build, no special equipment — just a voltmeter and common sense!

by GLEN McKinney

ONE OF THE MOST TIME-CONSUMING jobs in transistor radio servicing is trying to find a bad transistor. It takes time to unsolder the transistor; it can be damaged by heat or accidental breaking of a lead, and putting it back in the circuit takes more time.

Many transistor checkers can determine the condition of a transistor out of circuit; a few can test it while still hooked up. However, there are ways to check a transistor in the circuit without a tester of any kind.

How to go about it

The two most common failures are opens and shorts. A reliable method for checking an open transistor is to measure the voltage drops across resistors connected to the different elements. Refer to Fig. 1, and let’s see how to check for an open transistor.

If we disconnect R1, the only current through R2 will be the emitter-base current of the transistor. If the base is open, no current at all will flow through R2. Measured from ground with a vtvm, its voltage will be the same at both ends. Should the emitter open, conduction would cease completely, and no voltage drops would be measured across R2, R3 or R4. If the collector opens, there will be no drop across R4. There will, however, still be some drop across R2 and R3. If the collector is open, the drop across R2 will go up, and that across R3, down.

Shorted transistors

In an emitter-to-base short, no voltage will be developed across R4 in Fig. 1, because the forward bias is shorted out, reducing collector current to zero. In a short between emitter and collector, larger than normal voltage drops will be measured across R3 and R4, because of increased transistor conduction. The remaining short possibility is between collector and base. This trouble would be indicated by a radical decrease in voltage across R2 and an increase across R3 and R4. A voltage check on the collector and base (measured from ground) is a quick way to spot a collector-base short. Because of the high external resistance in the base circuit, this voltage will read about the same for the collector and base, depending on the degree of the internal short.

Gain

With one of the resistors in the collector or emitter circuit (R3 or R4), the transistor gain may be determined (qualitatively). First measure the voltage across this resistor (in this case, R4). Then short between emitter and base. The voltage across R4 should drop to zero, or very nearly so, because this removes the forward bias and no current flows in the collector circuit. If the voltage across R4 does not fall to practically zero, the transistor is defective. This is an indication of the transistor’s ability to control current in the collector circuit. The more nearly the voltage across R4 approaches zero, with emitter shorted to base, the better the transistor. Bear in mind that, when we speak of voltage across the resistor, we mean the voltage measured from one end of the resistor to the other—not necessarily from ground to the ends of the resistor.

Another fairly accurate check for current gain is to measure the emitter voltage (the voltage across R3 in Fig.
Abnormal voltages are circled. With those voltages, transistor is unbiased and will not amplify. Often, juggling bias resistor values will put the weak transistor back on the job.

1). Then parallel bias resistor R2 with one of the same size (which halves the resistance), and measure the emitter voltage again. If the transistor is good, the emitter voltage should about double, to read approximately 0.6 volt. The higher this emitter voltage rises (with bias resistor halved), the better the transistor.

By paralleling R2 with a resistor of exactly the same size, the voltage on the base about doubles, causing the transistor to conduct more heavily. R3 now carries this additional current and shows a larger voltage drop—in this case 0.6 volt instead of the normal 0.3 volt.

Other methods

Signal tracing or signal substitution may be useful in isolating a bad transistor. Inject an appropriate signal first at the collector, then at the base, working from the output stage back. Each good transistor should exhibit gain when a signal is applied to the collector and then to the base. A stage that does not contribute gain indicates a defective transistor. Of course this applies only when all other parts check good.

Another method we have used in the audio section with a great deal of success is to use a voltmeter on the ac scale. If the radio is weak in the output section and you wish to check the audio stages for gain, simply switch the voltmeter to a low ac range and tune the receiver to a strong local station. Hook the common lead of the meter to ground, then clip the hot lead to the collector of the output transistor, and note the meter swing with modulation. Carefully observe the peaks. Then move the test lead to the base of the output transistor, and again note the peak amplitude. There should be a decided decrease in the meter reading if the transistor is good.

The driver and first audio transistors may be checked in the same manner if the ac voltmeter is sensitive enough.

Use a .05-uf capacitor in the hot lead of the ac meter as a precaution against disturbing transistor bias while making these measurements. A more reliable check is to use a modulated signal generator, since the readings will be constant rather than fluctuating. But with a bit of experience the station signal can be used to good advantage.

A kind of cure

Another practical situation occurs frequently in actual transistor radio servicing. Let's take a typical transistor amplifier stage (Fig. 2). Bear in mind that this example holds true whether we are dealing with rf, i.e. or audio transistor circuitry.

In Fig. 2, we have a transistor circuit with the correct voltage: emitter 0.3, base 0.5 and collector 8.5 volts. With this voltage relationship, the transistor is properly biased, and will amplify. Suppose that for some reason the voltages measure as indicated by the circled voltages, or perhaps the base might read even slightly less than the emitter. This circuit might still pass a signal, but only by "brute force"—the stage could not amplify under these conditions. After you've checked R1, R2 and R3, and found them OK, the situation begins to become a bit baffling. Why are the voltages incorrect if the resistors are OK and the supply voltage is normal? You might begin to suspect the transistor, but the voltage discrepancy is so slight that you can't be sure, and you might again start looking for circuit troubles. There are two checks you can make to verify the transistor's condition.

First, transistors tend to shift their characteristics before they become completely shorted. In cases like the one in Fig. 2, this is probably what has happened. By lowering the value of R3 we can pull the emitter voltage back down to its normal value of 0.3 volt, leaving the base with a slightly higher potential than the emitter and giving the transistor its forward bias again.

Second, by paralleling R2 with another resistor we could bring the base voltage up sufficiently to restore forward biasing and put the transistor back in operation. When dealing with good transistors, these two resistors (R2 and R3) have a decided effect on base and emitter voltages, and establish the operating point of the transistor.

Now let's see what will happen if the transistor has developed enough of a short to impair its operation. If we bridge R2 and R3, we will not get the voltage difference of 0.2 volt between emitter and base. Rather, when we lower R3 to reduce the emitter voltage, the base voltage also falls and will stay about the same as the emitter. Or if we parallel R2 with another resistor to raise the base voltage above the emitter, we find that the emitter will also rise, maintaining about the same ratio as we started out with. If you cannot reach the correct emitter-base voltage by these two operations, the transistor must be replaced.

However, if the transistor's characteristics have changed only slightly, we may be able to restore the necessary forward bias to put the transistor back in operation again, even though the base-emitter voltages may not be exactly what they were originally. If we can get, say, 0.4 volt on the base and 0.2 on the emitter, or 0.6 on the base and 0.4 volt on the emitter, the transistor might operate again. We have found many cases like this where normal operation was restored without replacing the transistor. A new transistor should be installed when possible, but this is a helpful hint when no replacement is on hand, or for a foreign make for which there is no American equivalent.

OCTOBER, 1963

"And fix it right this time! I don't want to be calling you back in 5 or 6 years!"
SERVICING 1963 DELCO AM-FM AUTO RADIO

Last month we got acquainted with the circuitry of the Delco AM-FM set and learned some general troubleshooting techniques, which we applied in checking out the AM and portions of the radio common to AM and FM.

AM troubleshooting checks out most of the stages. If the FM section of the radio does not function but AM does, the ratio detector, fourth i.f., converter and rt stages for FM are likely suspects. (The first, second and third i.f. stages also work on AM. If there is an FM defect in one of these stages, it will probably be in a defective i.f. coil, located later during alignment.)

The FM front end is largely responsible for the loud hiss in the speaker. If the front end is dead, the four i.f. stages will produce a weak hiss in the speaker. Noise level should increase when the blade of a screwdriver touches the base of the first FM i.f. transistor (Fig. 1). Place your finger on the blade when making this check.

If there is no noise or the screwdriver has no effect, the ratio detector or fourth i.f. should be suspected.

Ratio detector and i.f.

With a dc voltmeter connected as shown in Fig. 2, reading should be zero volts, with no station. This zero reading indicates that the ratio detector is balanced and will not distort the audio. If an unbalance shows (either positive or negative) distortion will result.

Adjust the blue slug on the ratio transformer for a zero reading, with no input signal. (Noise must be present for this adjustment.) Failure to obtain zero indicates an unbalance in the circuit. Check the ratio transformer windings with an ohmmeter to determine if they are at fault. The matched-pair diodes should also be checked (on the R X 100 scale of an ohmmeter). The high reading should be at least 10 times the low reading, and the low reading should be under 500 ohms.

The fourth FM i.f. stage is checked the same way as AM: conduction, bias, diodes (Fig. 3).

Normal conduction for this stage is shown by 1.2 volts across the emitter resistor, with a forward bias of 0.2 volt.

Fig. 1 — Most of the possibilities have been eliminated in AM checks. Screwdriver test pin points in FM trouble.

Fig. 2 — Balanced ratio detector will show zero volts dc on audio line with no station tuned in.

Fig. 3 — FM fourth i.f. check follows AM procedure.
The in-circuit diode readings produce a high reading five times the low reading. The low reading should be under 500 ohms on the R × 100 range of most meters.

The two .05-µf capacitors can be checked by bridging them with good ones.

**FM front end**

Check the "Z+" voltage first (Fig. 4). (It does not have to be exactly 7.5 volts.) The purpose of the Zener diode is to regulate the voltage. If the voltage reading obtained is within 10%, and it does not vary more than 0.1 volt with an input change of 11 to 15 volts, the Z+ system is functioning properly.

The normal conduction reading for this stage is 1 volt. This reading drops slightly as the oscillator is tuned. This change in conduction is a good test for oscillation. The positive probe is placed on Z+, and the negative probe goes to the emitter or the top of the 680-ohm resistor. (The top of the 680-ohm resistor is physically more convenient to reach.)

Note that the base and emitter voltages indicate no bias on this stage. This is true at one spot on the dial, but as frequency varies, bias will appear. A shift in the bias voltage also proves that the stage is oscillating.

Since this transistor is in a socket, it can be removed and checked. The afc diode can be checked with an ohmmeter in the circuit. A low reading under 1,000 ohms and a high reading of approximately 100,000 ohms is normal.

The conduction reading for the rf stage should be 0.5 volt (Fig. 5). The negative meter lead is placed on the emitter and the positive lead on the Z+ line. The bias is 0.2 volt, and the transistor can be checked out of the circuit by unplugging it.

Since conduction of this stage depends on the FM age circuit, check the age diodes with an ohmmeter if the transistor is conducting too heavily.

Avoid FM tuner adjustments unless you definitely suspect the tuner has been tampered with. These adjustments are very critical.

**FM alignment**

To align the FM i.f. stages:

1. Connect a dc voltmeter as shown (Fig. 6) to orange wire on the AM-FM bandswitch.
2. With the antenna unplugged, turn the blue slug in the radio detector transformer to obtain 0.1 volt.
3. Connect a 10.7-mc unmodulated generator to the antenna jack through the 82-pf capacitor. (If any squeals are heard, tune the radio to a quiet spot.)
4. Adjust the generator output to obtain 0.2 volt on the meter.
5. Adjust the pink slug in the ratio detector transformer and all FM i.f. coils to maximum (use a plastic alignment tool).
6. Turn off the generator and trim the blue slug in the ratio detector transformer for zero meter reading again.

**Summary**

Important points to remember when troubleshooting the Delco AM-FM set are:

- Listen on both bands. If trouble affects both AM and FM reception, troubleshoot on AM. If FM only is bad, check the ratio detector, fourth i.f. and FM front end.
- Look the set and circuit board over carefully for obvious defects. Isolate stages by "thump" testing (DS-501) and with a noise generator on AM.
- Check conduction, bias and diodes (in that order) in suspected stage or stages.
- If all voltages are normal, check capacitors and tuned circuits.

_October, 1963_

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*Fig. 4—Checks on FM front end ("tuner") include Zener voltage, bias and diodes.*

*Fig. 5—FM rf stage checks. Again, emitter resistor drop indicates current flow.*

*Fig. 6—Alignment is extremely simple and needs no special equipment.*
CAPACITOR and DIELECTRIC ANALYZER

Build a useful addition to your shelf of test equipment

By JOSEPH H. SUTTON

The analyzer panel. The LEAKAGE pilot is at the bottom center, TEST pilot is just above J5 and J6 and the CAPACITY pilot is centered below S3 and R28.

Fig. 1—Graph shows the voltage-current curve for the analyzer. It shows what is applied to the item being tested.

Fig. 2—Block diagram of the analyzer.

This instrument measures dielectric leakage through capacitors, switches, sockets, rectifiers, diodes, etc. Leakage range is from 0.2 pA to 30 mA at voltages from 1 to almost 1,000 (Fig. 1). Capacitance and efficiency of electrolytics are measured on a 1-volt ac bridge, thus permitting an undamaging test of electrolytics rated 6 volts dc or higher.

The circuits for leakage and for capacitance are not electrically connected, so you can build either circuit as a separate unit. Fig. 2 is a block diagram of the leakage tester, Fig. 3 a simplified schematic of the bridge.

Since dielectrics can short during test, both the power supply and the leakage milli- and microammeter will absorb a full short without damage. For the meter you will use your vtvm. Do-

Fig. 3—Basic diagram of the capacitance bridge.

www.americanradiohistory.com
ing so minimizes cost, simplifies construction and speeds use of the analyzer (if your vtvm is already warm on the bench).

**Want to build one?**

Parts layout is not critical. The bridge (Fig. 3) exhibits no residual capacitance. The chassis is separated from the high-voltage supply by 1 megohm (R26) to prevent shock (Fig. 4). Some newer vtvm's include this protection too, but if your vtvm's common jack is connected to chassis, the vtvm must not touch the analyzer chassis.

The function switch (S2) is assembled from wafer and index components, as specified in the parts list.

High-voltage components are mounted under the main chassis on terminal strips raised from the chassis floor by ceramic cones. This adds insulation and frees the chassis floor for mounting other parts.

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**Fig. 4—Circuit of the analyzer.**

Attach potentiometers R5 and R6 to the panel through fiber shoulder washers for added insulation. Jacks must have zero leakage at 1,000 volts (see parts list).

A subchassis holds constant-voltage transformer T1. Connection to the
main chassis is through an octal socket, plug and a cable made from No. 24 stranded hookup wire in assorted colors. (Photo shows 11-pin socket, but octal will be sufficient.)

The full brunt of high-voltage rectification falls on the series silicon diodes (RECT 3 through RECT 6), while the tube (an 807) is for voltage control only. This control is smooth at all outputs, down to and including 1 volt.

For all tests, set your vtvm to its 1.5-volt dc range. The voltage-dividing resistors R10 to R17 are calculated for an 11-megohm input vtvm. To simplify voltage calibration, carbon pots are used for R12, R13, R15 and R16. First adjust R16 for the 1,000- and 500-volt ranges. Then adjust the remaining pots in any order.

**Convenience extras**

The vtvm prods (¾-inch diameter) fit into sockets recessed so that only about 1 inch of prod protrudes from the panel. With this design, prods mate with the sockets “hole-in-one” fashion every time; no fumbling. The socket guides are polystyrene tubing ¾ inch OD, ½ inch ID, 3¼ inches long. Sockets (Amphenol 78-1P) are ½ inch OD and fit snugly into the tubing. Of course, if your vtvm probe is a combination dc-ac type, or heavier than normal, you will have to modify the design.

Extra tip jacks across the high-voltage supply let you observe voltage and leakage simultaneously. Read volts on your vom’s 1,000-volt range. (Photo shows 900-volt limit on these jacks.

(Above) Parts layout inside the case. (Below) Under the chassis. Note how many of the smaller components are mounted on terminal strips.
This limit is in error due to circuit design change.)

The suggested main chassis will protrude from the back of the suggested cabinet about 1/8 inch. Correct this by cementing strips of 1/8 inch pressed wood to the back cover. Then fasten the back cover to chassis with self-tapping screws, providing added chassis support.

Panel markings are machine-engraved on 1/16-inch "insulating" bakelite. You can do as well with decals.

Check leakage

1. Set meter switch (S1) correctly.
2. Set leakage switch (S3) to 30 ma.
3. Set VTVM control (R5) to zero.
4. Set function switch (S2) to DETACH.
5. Connect test terminals J3 (negative) and J4 (positive) to capacitor or other dielectric under test.
6. Set function switch (S2) to CHARGE-DISCHARGE.
7. Adjust VTVM controls (R5, R6), observing voltage on VTVM.
8. Set function switch (S2) to LEAKAGE position.
9. Turn leakage switch (S3) so VTVM reads upscale as desired.
10. Return function switch (S2) to CHARGE-DISCHARGE position. Repeat steps 7 to 10 as desired. (Note: the 0 VTVM position is only for convenient check of VTVM zero set.)
11. Return VTVM control (R5) to zero.
12. Depress discharge switch (S4) until VTVM reads 50 volts or less. This discharge step is absolutely necessary to prevent burnup of function switch.

Circuit tolerance for capacitor (or other dielectric) leakage depends on the application. Some circuits cannot tolerate any leakage; others a lot.

Normally, dielectric leakage decreases with the length of voltage application. This decrease is dramatic in electrolytic capacitors (after the voltage has become steady), and its also noticed in large paper or plastic units.

Long-idle or little-used electrolytics may need re-forming for 10 minutes or more. After discharge and rest for a few minutes, if initial leakage is still high, reject the capacitor.

Intermittent capacitors tend to have a jerky leakage. Rising leakage is sure sign of incipient short. Under a short, the analyzer voltage will not rise appreciably from zero except on the 15-µa and 150-µa leakage ranges.

Semiconductor diode and rectifier leakage often decreases with increasing inverse voltage. A unit testing poor on the ohmmeter may be superior under rated or applied inverse voltage. Leakage ratings for most semi-conductors are given in manufacturer's manuals. Selenium rectifier leakage usually is not given, but should not be a large percentage of rated forward current.

Leakage from terminal to terminal of phenolic switches and sockets is usually appreciable. Steatite or ceramic units should show no leakage at the maximum voltage output of this analyzer.

Check capacitance

1. Set function switch (S2) to DETACH.
2. Set capacitor switch (S3) to proper range.
3. Connect test terminals J3 (negative) and J4 (positive) to capacitor. Observe polarity here only as a matter of habit.
4. Set function switch (S2) to CAPAC.
5. Rotcor capacitor pot (R28) and efficiency pot (R27) successively for null on VTVM. At null, read R28, R27 dials.

MOBILE AUTOMATON FEEDS ITSELF—with electricity. An attempt at making a neuronlike electrical network do something, the automaton navigates around the corridors of the Applied Physics Lab at Johns Hopkins University, where it was born. The network consists of about 60 identical nor-gates connected, much as in an animal nervous system, to provide a particular behavior pattern. The automaton manages to avoid obstacles, and, when its battery gets weak, it heads for the nearest wall outlet to recharge itself!
Higher average modulation means greater range—legally

DO YOU WANT YOUR CB TRANSCEIVER TO be more effective for contacts with the mobile units in the dead spots and fringes of your service area? If so, one of the accessory speech clippers or compressors is for you.

For a given rf carrier level, the readability of a radiotelephone signal depends on the average percentage of modulation. When it is low, readability drops off much more rapidly with distance than when it is high.

Take a look at the speech waveform in Fig. 1-a. The scale on the left represents modulation percentage, and the one on the right is voltage input to a given stage in a speech amplifier. You'll see that when a transmitter is adjusted for 100% modulation on the occasional loud sound or syllable, the average modulation produced by the weaker sounds is around 25%. It may seem obvious that all you have to do to increase the average percentage of modulation is to turn up the audio gain, use a mike with higher output or talk louder.

But this doesn't work out because the loudest passages will overmodulate the transmitter. Overmodulation distorts the modulation envelope and develops audio harmonics which modulate the carrier and produce sidebands that fall outside the normal channel. These distorted spurious sidebands are called "splatter."

To raise the average level of modulation without overmodulating, you must limit modulation on peaks to 100% while increasing the amplitude of the weaker sounds. In Fig. 1-a, we see that a 1-volt input (signal A-A) produces 100% modulation while the average signal level is around 0.25 volt.

In Fig. 1-b, the signal level fed to the speech amplifier has been doubled. Syllable A-A has been clipped or limited at 1 volt. B-B now produces 100% modulation on positive and negative peaks. C-C develops 100% modulation positive peaks and 50% on the negative. Here, the average percentage of modulation is around 50.

In Fig. 1-c we have the same speech pattern as in Fig. 1-a with all amplitudes tripled. Now, the signal peaks are clipped at A-A, B-B and the positive half-cycle of C. Note how the average percentage of modulation has increased. You cannot overmodulate because the clipper sets the maximum signal output regardless of the amount of signal fed into it.

A clipped audio signal has high-amplitude, high-order harmonics and produces splatter just like overmodulation. We use a low-pass filter to prevent the useless high-frequency byproducts of the clipper from modulating the carrier.

The filter has comparatively little attenuation around 2,000 cycles but cuts off all frequencies above about 3,000 cycles.

Speech compression

Speech compression is a form of audio automatic voltage control that follows the average amplitude of the speech waveform. Weak sounds are am-

Fig. 1—What clipping and compression do to speech waveform, a—Highest peak determines maximum level, causing all lower peaks to modulate well under 100%. Full transmitter power isn't being used. b—Clipping sharply at 1-volt level allows doubling amplitude of rest of signal without overmodulation. c—Tripling original amplitude (in 1-a) still won't overmodulate, but weaker sounds modulate fully or nearly so. Transmitter power is being utilized more effectively. d—Compressed, rather than clipped, wave. Note absence of "sharp-edged," highly distorted peaks.

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plified much more than in a constant-
gain amplifier, while the louder sounds get little or no amplification. Fig. 2
compares the output of a speech or vol-
ume compressor (curve A) with that of
a conventional constant-gain amplifier
(curve B).

In a speech compressor, we rectify
and filter a portion of the modulator's
audio output and use it as a variable
negative bias on the compressor stage.
Fig. 1-d shows our typical audio wave-
of modulation for various speech levels
form (Fig. 1-a) after passing through a
speech compressor with the gain curve
(A) in Fig. 2.

We've seen how we can use clip-
ners and compressors to raise the aver-
age modulation level. Now, let's take a
look at some typical circuits.

**Executive speech clipper**

International Crystal Manufacturing
Co.'s model 150-203 Executive
speech clipper/filter amplifier connects
between the mike jack on the trans-
mitter and the microphone, and is
designed to operate from 12 to 15 volts
ac or dc. Once it has been set up for
your transmitter or transceiver, it auto-
matically maintains a high percentage
of modulation for various speech levels
at distances ranging from 1 inch to
several feet from the mike.

Input and output impedances are
100,000 ohms. The time constants of
the R-C coupling networks are set to
attenuate frequencies below 100 cycles
to eliminate hum and other low fre-
cencies not needed for communication.
Frequencies above around 2,000 cycles
are attenuated. They are not needed for
communication and tend to cause need-
less interference and overly broad
signals.

With clipping, the response at the
3-db points is 500-2,200 cycles; 380-
2,500 cycles 6 db down and 230-3,800
cycles at 20 db.

The circuit of the model 150-203
is shown in Fig. 3. Three 12AF6's are
operated with low bias, plate and screen
voltages so they are driven to saturation
on peaks. (Plate-current saturation pro-
duces a flat-topped wave similar to that
produced by some square-wave gener-
ators and diode clippers.) The low-pass
filter (L1, C9, C10 and C11) removes the
high-order harmonics generated by
clipping.

When the unit is operated from an
ac power source, diode D rectifies the
voltage for the plate and screen supply.

Power drain is 450 ma with 13 volts dc
input.

An attenuator pad consisting of
R13 and R14 reduces the maximum out-
put available from around 2 volts to
0.15. It is wired into the circuit when
the clipper is used with a transmitter
or transceiver designed for a low-output
mike. To bypass the pad, transfer the
lead from the end of R13 to the
lead to the junction of R13 and R14.

**The Sampson power modulator.**
Fig. 4 — A compressor type accessory, Sampson power modulator rectifies amplified speech signal, biases preamp accordingly to limit gain on loud signals.

Fig. 5 — “SpeakEasy” (below), another type of compressor, incorporates modulation percentage meter. High-level control signal comes from CB set’s modulator.

Sampson Power Modulator

This instrument, made by the Sampson Co.'s Communications Equipment Division, operates as a volume compressor. It has a two-way power supply for either 12-volt dc or 117-volt ac operation.

The signal from the microphone is amplified by the 12AU6 (Fig. 4) and fed simultaneously to the grid of the 12AQ5 and to the transmitter's speech amplifier via the amplifier gain control. The 12AQ5's output is rectified and filtered to produce a variable negative grid bias for the 12AU6. The filter network is arranged so the 12AU6 operates with high gain for weak sounds and low gain for loud sounds. The gain curve of the 12AU6 looks like curve A in Fig. 2.

SpeakEasy

A product of Communications, Inc., this unit is also a volume compressor. Its signal circuits are connected in series between the transmitter's mike jack and the grid of the first af amplifier. Heater and B-plus operating voltages are tapped off the transmitter's power supply.

The SpeakEasy's circuit operation (Fig. 5) is like that of the Power Modulator. Feedback or control voltage is tapped off the high side of the modulation transformer's secondary or the modulator plate when Hinging modulation is used. The modulator's output is sampled, rectified and filtered to supply a variable negative bias voltage proportional to modulation level. A meter, calibrated in modulation percentage, measures the bias voltage.

The SpeakEasy comes with internal controls preset for the average CB unit. To operate, throw the switch to out and whistle or hum a steady tone loud enough to swing the meter to 100%. Holding the same tone level, switch the SpeakEasy into the circuit and adjust the modulation control so the meter again reads 100%. Hold the tone and switch the unit in and out several times. The meter should hold at 100%. As a check, switch the compressor out of the circuit and whistle or hum softly to modulate the rig at 20%. Hold the tone level and switch the unit back into the circuit. The meter should now indicate a modulation level about twice as high.

If the SpeakEasy circuit needs adjusting, feed a 2-ke signal from a signal generator into the mike input and adjust the generator's output level for 100% modulation as indicated on a scope. Switch the compressor out of the circuit and adjust the 10,000-ohm potentiometer for −4.5 volts at the junction of the two 1-megohm grid resistors. Attenuate the generator's output 50% (6 db) and adjust the 50,000-ohm control so the meter reads 100%.
by Jack Darr
Service Editor

Service clinic

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 11, N.Y.

THERE'S A LITTLE CONFUSION IN THE audio field—a confusion which I shared for quite a while! This concerns methods of shipping audio power from place to place. From bitter experience, I picked up a few pointers, and you may be able to use them. We're not speaking of home sound work but of industrial sound jobs—factories, etc., where we need high levels, and the sound must be sent from the amplifier over great distances. Anything over 200 feet will be considered a "great distance" from now on.

We can move audio power in two ways—voltage and current. All small installations use current. In a home hi-fi system, for example, if we send 10 watts of power through a 16-ohm line, we're carrying a high current and hardly any voltage. Why? To develop 10 watts of power across a 16-ohm speaker, we have to cause a heavy current to flow through it: 1/2 amp. Because of the low impedance of the speaker voice coil, we won't develop much voltage drop, nor will we lose too much in the lines, because they're so short.

If we're sending 10 watts of audio out to several speakers in a factory building, several hundred feet from the amplifier, we'd better use a different method. Short-run speaker wiring uses the common No. 20 solid-copper "bell wire." Twenty feet of this isn't much. However, if we hang 250 feet of it on the output of an amplifier, we've got something else.

Each 250 feet of this wire has a resistance of 5.07 ohms; No. 20 solid will carry 1.46 amperes. If we put two 16-ohm speakers in parallel at the far end of our line, we'd be losing nearly half of our total audio power in the wire (5 ohms of wire, 8 ohms of speaker).

So, we use the same method the power company does. To get large amounts of power across great distances, they step up the voltage. This lets them use much smaller currents to get the same amount of power (voltage times current) at the far end of the wire. Much smaller wire can be used, which is a big saving. Fig. 1 shows what this might look like in sound work. Fig. 1-a is a typical home sound installation, with the maximum exaggerated a little. Fig. 1-b shows the same 100-watt output into the load (which would be several speakers, though only one is shown here), but now we need only carry 1 ampere in the wire because we have stepped the voltage up. Of course, this requires matching transformers at each speaker, to get our audio power back into the high-current—low-voltage shape the speakers need. If we had 100-ohm speakers, we could dispense with transformers!

Now, how can we do this? Simple. Most PA amplifiers are built with just such installations in mind. Older PA rigs had a "500-ohm line" output; 500-ohm matching transformers were used at each speaker. By raising the impedance of the line, we raised the voltage and lowered the current, as we've been saying. To divide the output in such a system, we combine speaker matching transformers, just like hooking resistors in parallel. Four 2,000-ohm transformers in parallel give us a total impedance of 500 ohms. The total sound power here is divided equally between the four speakers.

Later amplifiers use a system with different names, but working on exactly the same principle. You'll find this marked "70.7-volt line" or even "100-volt line." For those who, like myself, have been mystified by this, it means that this is the rms ac voltage that you'll read across the (properly matched) line when the amplifier is putting out full rated power.

This system permits changing speaker output powers a lot easier than the old system. In fact, it's exactly like the old system, but the transformers are marked differently! By changing the tapping of the output transformers at the speakers, you can take off any amount of audio power up to the amplifier's maximum output, and still keep your line matched to the amplifier for maximum power transfer (which is, after all, the idea of impedance matching!).

You get a lot of this, especially in factory sound work (background and paging systems, for instance). One speaker may be high in the ceiling of a noisy room, needing about 10 watts of power to be heard at all. Another might be on a wall of the coffee shop, where a 1/2-watt of power is plenty. By changing taps on the transformers, you can adjust the sound level in each speaker to whatever you want. The instructions for doing this will be packed with each transformer, so there's no need to go into details here.

So, to save yourself a lot of trouble and, above all, from having to take down an undersized speaker line scattered over thousands of feet of factory to put up the right-sized one, remember the two ways of shipping audio power from here to there, and use the right one in the right place.

**Brightness on RCA KCS-127**

What circuit change would have to be made to increase the brightness control range on an RCA KCS-127?

—C. K. P., Fanwood, N. J.

I'm just a little lost here. Do you mean that you do not have normal control of the brightness? There should be enough range to go from a complete blackout to a washout. Normal range should vary the picture tube cathode-grid voltage from 0 to about 70 volts.

This chassis uses a rather unusual retrace eliminator circuit (Fig. 2). The vertical and horizontal blanking pulses are both fed from the same

(Continued on page 54)
THE SAME ENGINEERING, SAME PLANT THAT PRODUCES AMERICA'S GREATEST SATELLITE-TRACKING AND TELEMETRY STATIONS, HAS CREATED

the revolutionary new PARALOG
...Unparalleled performance because it has **ALL 4:**

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- **RUGGED CONSTRUCTION**

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is maintained throughout high and low bands. Left: 60 mc (mid-channel 4); right: 195 mc (mid-channel 10). Lobe patterns for each channel equal or surpass these.

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4 Electronic Models feature

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**FM STEREO MODELS**

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See your Jerrold-TACO distributor now, or write Jerrold Electronics, Philadelphia 82, Pa.
Special station multiplication, gives you an easy basic control, tube trouble symptom complete guide by the power practical transistorized circuits by Allan Andrews. These two volumes are handy, informative for use on shows of internally generated heat, but leaves the horizontal oscillator circuit: changing value because of external heat, from adjacent parts, tubes, etc. So, look for resistors in some of the frequency-determining circuits: grid resistors, plate load resistors, saw-forming network resistors, and so on. With the set cold, try applying heat with the tip of a soldering iron to each resistor. The culprit will cause the set to fall out of sync (or fall in sync) when heated.

Foreign radio power transformer I have a Kaiser radio, German-made, with a burned-up power transformer. Uses European tubes and a bridge selenium rectifier. The dealer says that parts are not available for this any more. What to do?—W. B., Mundelein, Ill.

You should be able to find a replacement power transformer for this set in one of our catalogues. After all, power transformers are pretty well standardized. Also, you won’t need the elaborate tapped primary winding of the original European transformer.

Add the filament currents of the tubes. If you can’t find all of them in an American tube manual, look up US “interchangeable” types. (As a last resort, hook the tube up to a 6-volt battery and measure the heater current!)

To find the proper B-plus voltage, look at the ratings on the filter capacitors. On the diagram you sent, I note that the input filter is marked “350-385 volts”. So, since the German makers of this radio were probably pretty conservative, I’ll say that the original B-plus wasn’t over 300 volts, probably 275 or so. (See Fig. 3.)

Look up an American radio power transformer with these specs in any one of the major transformer manufacturer’s catalogues. Now all you have to worry about is the physical dimensions of the transformer; these can be measured and checked against the replacement. Don’t forget to check the circuit to see what blew the original transformer!...
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OCTOBER, 1963

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the most noise-free recordings you have ever heard

will be made on the new all-transistorized Norelco Continental '401' Stereo Tape Recorder, the only recorder using the newly developed AC107 transistors in its two preamplifiers. The AC107 is the only transistor specifically designed for magnetic tape head preamplifiers utilizing specially purified germanium to achieve the extraordinary low noise figure of 3 db, measured over the entire audio band (rather than the usual single frequency). This noise figure remains stable over large collector-emitter voltage swings and despite large variations in source resistance.

The new transistorized Norelco Continental '401' 4-track stereo/mono record and playback • 4 speeds: 7½, 3½, 1⅞ and the new 4th speed of ¾ ips which provides 32 hours of recording on a single reel • fully self-contained with dynamic stereo microphone, two speakers (one in the removable cover for stereo separation), dual preamps and dual recording and playback amplifiers • self-contained PA system • mixing facilities • can also play through external hi-fi system • multiplay facilities.


is actually the horizontal blanking bar from the same signal, has been delayed through 25-30 μsec by passing through several miles of coaxial cable. Since it is seen, there must be enough leakage from an amplifier to allow this. The delay causes it to move into the center of the screen. It looks like a stationary "windshield-wiper" effect.

There are two possibilities: an amplifier shielding-box is not properly grounded, has a loose cover, etc.; or one of the amplifiers is running at too high a level. If you'll advise the operator of the system of this and show his engineers the trouble, they will promptly correct it, I'm sure.

Jackson TV flyback replacement

I replaced the flyback in a Jackson model 277 TV with a G-E 7711 I had on hand. Doesn't seem to work so well; no high voltage, etc. Any ideas?—J. C., Ridgway, Pa.

The 7711 is not the proper replacement for this chassis. Fig. 4 shows the difference in inductance between this and the exact duplicates, such as Triad D-627, Merit HVO-46, etc.

Shadow in Sylvania I-177

If a Sylvania I-177 TV is aligned (horizontal oscillator, that is) in accordance with the instruction in the service data, it works for about 10 minutes, or until it gets thoroughly warmed up. Then a shadow creeps in on the left edge of the screen and it falls out of sync. This set has no horizontal hold control, but I can reset the horizontal frequency slug, and pull it in again, until the temperature rises.

Out on the bench, it works longer than if I put it back in the cabinet. The voltages, etc., are all good, of course! The only thing out of the ordinary I can see is a peculiar waveform (Fig. 5) in the horizontal sawtooth.—R. P., Philadelphia, Pa.

Obviously, as you have discovered, this is thermal trouble. The key clue here is the appearance of that little "squiggle" in the middle of the sawtooth waveform. I ran into a case some years ago almost exactly like this, except that mine refused to work at all (farther along the road, as it were).

This is due to feedback in the horizontal oscillator section, upsetting the horizontal oscillator frequency. The squiggle is the result of some signal from the output stage leaking back through the power supply lines. From the time constant of the trouble, I'd say it was a bad electrolytic capacitor in one of the volage supply circuits to the oscillator. Wait until the trouble shows up, then check all voltage feed points with a scope and low-capacitance probe. You'll probably find lots of "hash" on these lines, which should be completely free of any ripple at any frequency.

If you have one of those "capaci-tor-shunt" testers, this is a good place for it. If not, bridge or test all electrolytics even remotely associated with this circuit, and you'll find it. Don't overlook any of them. I found one only a week or so ago, the only trouble was a severe horizontal instability!

Flyback dc resistance

I've replaced the flyback in a Coronado TVI-9300. Resistances were identical to those on the schematic. Now I haven't got enough width. Can you explain this?—H. H., No. Hollywood, Calif.

The dc resistance of flyback wind-
tings should never be used in selecting a replacement! If you cannot locate the exact replacement, or enough information about the old flyback, use the inductance value, never the dc resistance.

De resistance of windings is valuable when checking an original flyback against the schematic. Low or high readings could mean shorted turns or corrosion inside of windings, etc.

Your trouble here probably comes from a lack of drive signal on the horizontal output tube. Or, check the screen voltage on the 6CD6. You can increase this slightly to get more width, as long as you do not exceed the 160-ma rating of the 6CD6.

Grunow power transformer

Did you ever hear of a Grunow radio? I've a model 588 that lights up, no sound. If I leave it on, the power transformer gets hot, and there's a frying sound inside of it. If it's gone, where can I get a replacement?—A. S., Miami, Fla.

Heavens, yes! The Grunow was one of the best sets built by one of the designers of the original Majestic radios. You'll find the schematic on this in Rider's Perpetual Troubleshooter's Manual, Vol. 9, listed under "General Household Utilities."

Replacement power transformers for this should be simple to get. Any standard transformer with the right rating should do. Look up the articles, "The Old Timer Helps Replace a Power Transformer" in the December '61 and January '62 issues of Radio-Electronics; all of the details are there. Disconnect all loads, even the pilot lights, and cook this transformer for a while to see if it has an internal short. A wattmeter will tell you immediately if the "bare transformer" draws any current at all. If it does, it's shorted; replace it immediately.

Radio-TV Complaints Down 12%

The Better Business Bureau reports that in the year ending May 31, 12% fewer complaints against radio and television sales and service firms have been processed than in the previous years. Radio and TV still top the list of complaints, however, with 555 being recorded by the BBB. Apparel was second with 430, home improvements 402, appliance sales and service 385, and furniture 335. The complaints included sales as well as service, and the BBB noted that "there has been considerable improvement in the use of fictitious comparative prices by local advertisers."

New Sonotone Sono-Flex® Stylus

try this with any other cartridge
(at your own risk)

No way to treat a cartridge, for sure—that is, any cartridge except the Sonotone models featuring the new Sono-Flex® needle. No more bent or broken needle shanks caused by flicking off some lint, dropping the arm, or scraping it across the record.

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OCTOBER, 1963
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10 versatile "Universal" picture-tube types from Sylvania's Silver Screen 85 line may be all you need to fill 52% of your renewal needs! This fact, verified by a recent industry survey, stems from a remarkable streamlining of the Sylvania line—making fewer, more versatile types that can be used as replacements for many others. Already 54 types can replace 217.

Think what the versatility of these "Universal" tubes can mean. An in-shop inventory of a few popular types can help you quickly take care of most of your renewal calls. Ordering is simplified...and distributor calls for special tubes can be cut way down.

Start profiting now from Sylvania's Silver Screen 85 picture tubes. Call your Distributor and put an inventory in your own shop—where it can enhance your reputation for fast service and quality replacements.

Silver Screen 85 Picture Tubes are made only from new parts and materials except for the envelopes which, prior to reuse, are inspected and tested to the same standards as new envelopes.
use it for SILVER SCREEN 85 tubes...
(10 "Universal" types meet half of all renewal needs)
electronic darkroom thermometer

Simple photo accessory pays off in better prints

A GOOD THERMOMETER IS A MUST FOR any darkroom. The ideal is to have a large scale, the correct range for photography (65°-85°F) and high accuracy. By using a thermistor as the temperature-sensing element, you can build an electronic thermometer with all these features.

The thermometer has two basic parts: a Glennite 31TD2 thermistor on a probe cable, and a case holding the meter, batteries, etc. For convenience, the case can be on a shelf or mounted on the wall, where it will be easy to read and out of harm's way.

The circuit is simple. The 31TD2 thermistor is in series with a 200-µa meter and a 2.8-volt source (two mercury cells). The thermistor has a resistance of about 1,000 ohms at room temperature. R3 and BATT 3 apply a reverse current to the meter, allowing it to be zeroed in the correct temperature range. Setting S to CALIBRATE substitutes R1 and R2 for the thermistor, allowing the meter to be set to the desired temperature. By using a selector switch and several different resistances for R1 and R2, the meter can be made to cover a number of ranges. Mercury batteries are used for their accuracy and long life. As S is a center-off switch, no on-off switch is needed.

No unusual construction is involved in the thermometer. The photograph shows the general parts layout. Any suitable case can be used to hold the meter and other parts. The three mercury batteries are mounted in a single holder. Larger mercury batteries such as the Mallory RM-42 are good if the unit is to be used for continuous duty. R1 can be an inexpensive rheostat such as the Mallory FL-500 and can be mounted by soldering one of its terminals directly to S. If you are going to mark calibrations directly on the meter scale, the meter should not be mounted into the case until that has been done. You can connect it into the circuit with a pair of long leads. On my thermometer, I substituted a blank scale for the regular meter scale and marked the calibrations on the glass face of the meter.

The probe

Constructing the probe is a little more complicated. The thermistor and its connections must be waterproof, since some photographic chemicals conduct electricity and would throw off the accuracy of the meter. Take a piece of plastic-insulated twin-conductor stranded wire and cut it so that a short length of bare wire is exposed. Hold the wire and push back the insulation until about an inch of bare wire is exposed. Cut three or four strands from each conductor and then push back the insulation so that it covers the wire again. Now you have sort of a home-made socket for the thermistor. Cut the thermistor's leads to about ⅛-inch and push them gently into the two-conductor wire. Coat the thermistor and the first inch of wire with two coats of clear nail polish. The probe can be mounted on the stainless steel plate from a small glass thermometer, as shown in the photograph. Put the batteries in the holder, and the thermometer is ready to be calibrated.

Calibration

The electronic thermometer will be only as accurate as the thermometer against which it is calibrated. The one I used was a Kodak Perfectemp, reading from 50° to 100°F in 1° graduations.

Place both thermometers in a graduate filled with water at about 75°F. Put S to the READ position and adjust R3 so the meter reads about half-scale. By adding hot or cold water to the graduate, you can check the range that your thermometer covers. If either end of the scale is too high or too low, adjust R3 until the meter covers the correct range. Once this has been done, leave R3 at its setting until the meter has been calibrated.

Add enough cold water to the graduate to bring the meter down to the low end of the scale. Stir the water thoroughly and give both thermometers a chance to reach the same temperature.
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Audio Booster for Transistor Radios

And this little amplifier has a host of other uses

This circuit requires no transformers and uses conventional p-n-p transistors. A somewhat better circuit is possible with a p-n-p-n-p (complementary) output, but n-p-n transistors are expensive. Output with 2N256A's is about 1 watt.

The output is push-pull, with each half having its own voltage supply but a common load (the speaker). The push-pull output is driven by an unbalanced phase splitter. The unbalance is necessary because the output stage is unbalanced. V2 has a common-collector configuration with a corresponding power gain. V1 is a common emitter which has a different power gain.

Coupling may be direct to save components. If higher stability is desired, R-C coupling (shown by the dotted lines and components) may be used.

All the capacitors shown are two to five times bigger than they need to be, to insure good bass response.

Because of the large variations in transistor parameters, the values given in the circuit are only nominal. It is necessary for the builder to optimize the values for the transistors and speaker he wants to use. So he should not feel limited to the use of 2N256A's only; he should choose them because they could be obtained for $1.00 each. Several outlets advertise power transistors at less than this price in the latest issues of Radio-Electronics. Any of those with a beta higher than about 30 and maximum collector ratings of 2 amperes will do. They do not have to be matched.

Once the transistors are chosen, they must be mounted on a metal chassis with an effective radiating surface of about 20 square inches, or more. V1 and V3 require anodized aluminum insulators coated with silicone grease to insulate them electrically from the chassis. V2 may be mounted directly on the chassis since its case (the collector) is connected to ground (chassis). Next the components whose values are given in the circuit may be wired.

For the next steps, a scope and 400-cycle signal generator are required, along with a dc ammeter and an ac voltameter. Connect C as shown and start off with the nominal values given for the rest of the components. Variable resistors would be convenient. Now adjust R4 so that there is zero dc in the speaker coil with no signal at input. Next apply a sine wave at the input. A direct current will appear in the speaker coil. Now R3 and R1 must be adjusted so that it is possible to get symmetrical clipping at the voice coil. For some value of R1, the dc in the voice coil will be very small and the ac voltages across the collector-emitter terminals will be equal in V1 and V2: the output will have been balanced.

If you want to leave in the R4-C coupling, the next step is to adjust R2 and R4 for a collector current in either transistor of about 400 ma and 0 ma in the speaker voice coil. To get direct coupling, remove C and R4 and connect V3's collector to V2's base. Now R3 and R2 must be adjusted so that clipping is symmetrical while the direct current in the speaker remains close to zero. It will be found that it is impossible to remove all traces of dc for all signal levels because of the nonlinearity of the transistors. However, about 50 to 100 ma may be tolerated, depending on the speaker used.

Note that, unless the transistors used are very good, the speaker impedance should be more than 4 ohms for good results. While making the dc measurements it is advisable to replace the speaker with a coil of similar dc resistance. The high current which may

By F. ADAMEK, Jr.
be encountered balancing might damage the speaker cone. The ac readings should be made with the speaker connected.

The power supply used was a 12-volt car battery with a tap at 6 volts. The tap was obtained by drilling a small hole 1/4 inch deep into the lead bar under the tar. A self-tapping screw was then inserted.

I am using this amplifier as a booster for a tiny pocket radio. The radio's output is low and it distorts with appreciable volume (which is required in a noisy automobile such as mine). By connecting the booster to the earphone jack on the radio, good volume and surprising quality can be obtained. Being very small, the radio may be hung behind the rear-view mirror where it can readily pick up signals without an external aerial.

If the amplifier is to be used in a car, check the polarity of the ground. Some cars have a positive ground. Also be very careful that your speaker does not have one end of the voice coil connected to its frame. This could result in speaker damage and a fuse burnout if the speaker frame touches the car. END

Proposed German Color TV Improves on American

Telefunken has proposed a color TV system based on the American NTSC, with some improvements. The new system would be called "PAL," and was developed by Walter Bruch in the research laboratories of Telefunken in Hanover. According to Telefunken, PAL (Phase Alternation Line) will combine the best features of the NTSC system with freedom from phase distortion along the transmission path, without deviating too much in principle from NTSC.

It will be insensitive to band limitations (single-sideband distortion). Transmission of hue is faultless and obviates the necessity for manual readjustment of the receiver. Reproduction of color pictures is said to be better than with NTSC.

In phase alternation line, the color carrier is shifted 180 degrees from line to line. This causes color impurities (caused by phase distortions during transmission) to appear complementary from one line to the next. Because the scanning lines are so close together, the eye "averages" the error and perceives approximately the correct color.

A delay line is used for that purpose, and delays the signal one line—approximately 64 μsec. In areas where phase distortion is not large, a simplified system omitting the delay line can be designed, permitting the construction of cheaper receivers.

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A delay line is used for that purpose, and delays the signal one line—approximately 64 μsec. In areas where phase distortion is not large, a simplified system omitting the delay line can be designed, permitting the construction of cheaper receivers.
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The Most Trusted Name in Electronics
SERVICING HIGH-FIDELITY SYSTEMS HAS become an almost everyday part of a technician's business. Nevertheless, few shops do enough of this type of servicing to justify a large investment in specialized audio instruments. This Radio Shack vtm offers an economical way of getting some of the basic instrumentation at a small additional cost over that for the normal service type vtm.

This instrument provides the usual ac–dc vtm ranges: ac and dc volts from 1.5 to 1,500 full scale, and ohms from 10 ohms to 1 megohm midscale. Voltages down to less than 100 mv, and ohms from less than 1 to about 1,000 megohms can be measured on these normal ranges.

But there are some refinements not found in most vtm's (Fig. 1). The power supply is stabilized with three NE-2 neon lamps in series. Once the tubes are aged, zero drift is considerably less than in the usual vtm. There is a 2X scale multiplier on the dc voltage ranges to take full advantage of the greater accuracy near full scale. The reading on the normal voltage scales is mentally multiplied by 2.

The instrument has three separate inputs selected by a switch: one for dc volts through a shielded cable and a microphone type connector; one for ac volts and ohms through a pin jack and ordinary test leads, and a third for auxiliary probes through another microphone type connector. All use a common ground through a separate lead with an alligator clip, which can be replaced with a normal test lead when a clip is to be used. The input selector switch has a position that shorts the input so the meter can be zeroed without shorting the test leads.

A high-voltage probe which extends the range to 30 kv and an rf probe useful to 250 mc are available as accessories. Since the instrument has the standard 11 megohm input, any of the standard specialized probes intended for an 11 megohm input can also be used.

On the ac ranges there are scales for reading peak-to-peak as well as rms values. There is also a db scale.

The instrument offers higher accuracy than most because there are no fewer than six calibration pots for the various functions and ranges. In the voltage dividers, 1% resistors are used. If accurate standards are available, accuracy can be kept within the 2% accuracy of the meter itself plus the 1% of the divider.

In addition to these normal vtm functions, this instrument has a high-gain preamplifier, using a 6A6U pentode, to provide two audio millivolt ranges: 15 and 150 mv full scale. Voltages as low as 100 to 200 µv can be read. Outputs of microphones and phono pickups can be measured directly, and low-level audio and signal tracing is easier.

Measuring amplifier power output provides a good way of testing some performance characteristics and of showing improvement produced by balancing, bias adjustment, tube changes, etc. Audio output power can be measured up to 15 watts on a 16-ohm load, 30 watts on an 8-ohm load and 60 watts on a 4-ohm load. The instrument does not contain load resistors. External ones must be used. A 15-ohm adjustable wirewound resistor with two sliders, one set for 8 ohms and the other for 4 ohms, is useful.

The instrument includes a current transformer for reading either current drain (up to 5 amps) or the wattage (up to 1.5 kw) of any device plugged into an ac receptacle on the front panel.

**Specifications**

| DC volts: 0 to 1.5/5/15/50/150/500/1,500 volts | Input resistance 11 megohm all ranges |
| Accuracy 3% of full scale |
| AC volts: low (rms) 0 to 15/50/150 mv |
| low (peak-to-peak) 0 to 40/400 mv |
| standard (rms) same as dc |
| standard (peak to peak) 0 to 4/14/40/140/400/1,400/4,000 volts |
| Dc -- 20 to +40 (3 ranges) |
| Response flat to 2 m |
| Accuracy 5% of full scale |
| AC amperes: 0 to 1.5/5/15/50/150/500/1,500 |
| Accuracy 5% of full scale |
| AC watts: 0 to 1,600 w |
| Accuracy 5% of full scale |
| Audio watts: 0–15 w across 16 ohms |
| 0–30 w across 8 ohms |
| 0–60 w across 4 ohms |
| Accuracy 5% of full scale |
| Ohms: 8X: 1/100/1,000/10,000/1 megohm |
| Accuracy 3% of full scale |
| Meter movement: 400 µv |
| Tubes: 6A6U, 12AU7, 6AL5, 6X4 |
| Dimensions: 11 x 8 x 6 inches |
| Weight: 5 lb |

---

**Fig. 1—Circuit is basically standard ac–dc vtm, with audio preamp (V4) and current and power measuring circuits added. Neon lamps in power supply help stabilize voltage.**
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Several probes can be connected at once and chosen by the probe switch, topmost knob.

Power consumption checks often provide useful clues to equipment faults.

Naturally, the unit is more complex and will take more time to assemble than the typical kit type vtvm, but it is still fairly easy to put together. The instruction manual is clear, and the assembly and wiring steps have been well thought out. Calibration is possible with a dry cell, and voltages available from the power line, although it can be calibrated more accurately with accurately calibrated standards. On the test model I got accuracies well within 3%.

Although about twice as big as the common ac-dc vtvm, the Realistic Dual is light and portable. It is probably most useful as a bench instrument.

At $45 in kit form and $70 wired, this instrument represents an unusually high value in all-around utility, and should be of interest to serious audiophiles as well as professional technicians.—Joseph Marshall

### Simpson Model 657 Milliohmmeter

Have you ever tried to measure the resistance of a high-current meter shunt, a switch or relay contact resistance or a high-wattage heating element with your ohmmeter? If so, you know just how difficult it is. Simpson Electric Co. has just introduced the model 657 milliohmmeter that makes measuring resistances as low as 1⁄20 ohm as simple as checking 50,000 ohms with an ordinary multimeter.

The 657 is Simpson's latest addition to the Add-A-Tester series of adapters designed to be used with the model 260 and 270 multimeters. (Seven other adapters for these multimeters were described in the article "Test Adapters" in the July 1960 issue.) It measures resistances from .010 to 1.0 ohm in four ranges. You won't find a conventional ohmmeter that can measure such low resistances accurately. The average ohmmeter usually reads 10 ohms at center scale, few read below 5. Even with a 2-ohm center, a reading of 0.1 ohm would be within about the first 2% of the scale area—a very poor spot for precision readings. Look at your ohmmeter.

Even the laboratory type Wheatstone bridge does not fare well for measurements of less than 1 ohm. Its accuracy is affected by lead resistance and contact resistance at the binding posts. The 657 milliohmmeter is the field or service-bench supplement to the laboratory Kelvin bridge normally used below 1 ohm for:

- Measuring lead and contact resistance in automotive lighting and ignition wiring.
- Measuring winding, coil and yoke resistance in servicing and manufacture.
- Checking armature and field windings and brush contact resistance in motors and generators.
- Calibrating meter shunts.
- Measuring switch, relay and connector contact resistance.
- Checking grounding and bonding connections in automotive, computer and radio installations.

#### How it works

The milliohmmeter operates by comparing the resistance of the unknown element with an internal standard. (The unknown is equal to or less than the standard selected by the range switch.) The unknown and standard resistors are connected in series with a heavy-duty 1.5-volt battery (see Fig. 2). The meter is first switched across the standard resistance $R_s$ and the calibrate control adjusted for full-scale deflection.

This fixes the current through the unknown. When the switch is thrown to read, the resistance of the unknown is read on a dc scale of the multimeter.

Each of the two internally connected test leads is a two-conductor type with the individual leads terminating in insulated contacts in the jaws of the alligator clip. Thus, each alligator clip has two contacts. These are marked A and B in Fig. 2. Battery current flows through the "B" contacts; the "A" contacts are used for measurement only. The low contact resistance of the switch and the "A" side of the clips does not introduce an error because of the high input resistance of the transistor differential dc amplifier. The contact resistance of the "B" contacts does not enter into the measurements because the voltage across the resistor to be measured does not include the voltage drop across these contact resistances.

The differential dc amplifier is simply a transistor version of the dual-triode amplifier in a vtvm, with the 50-µa meter movement in the 260 or 270 connected between the collectors of the 2N591 silicon transistors. The amplifier uses a 9-volt battery.

### Using the 657 with your meter

There are three versions of the 260. The series I, identified by its flat, square-cornered panel, is an early version that cannot be used with the 657 and other accessories in the Add-A-Tester line. The series II has a raised panel with rounded corners, a 100-µa range and pin jacks for the test leads. The series III is similar and is easily recognized by its banana jacks and 50-µa range.

Adapter cases are available for series II and III. 260's and 270's produced before June 1959. The 401 case kit is an optional accessory for the 270 and series III 260. It consists of a new case that permits latching the 657 securely to the multimeter. The 402 case kit is required for series II 260's. It contains a new case, four pin plugs to replace the banana plugs on the 657 and parts needed to add the 50-µa range needed for most of the Add-A-Testers. The photo shows a series II in the new modified case. Note the 50-µa jack on the side.—Robert F. Scott

---

The 657 milliohmmeter adapter plugs into four jacks on 260 multimeter. New multimeter case with 50-µa jack on side is part of 402 case kit.
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Specifications are important, but present measurement standards do not fully define how equipment sounds. High fidelity equipment has achieved its ultimate goal when it delivers sound so realistic that skilled listeners cannot distinguish the difference between "live" and "recorded" music in a side by side comparison. This test has been performed dozens of times before thousands of people in programs sponsored by Dynaco, Inc. and AR, Inc. with "live" portions performed by the Fine Arts Quartet. In these comparisons, Dynakits' superior performance was amply demonstrated, since the vast majority of the audiences readily admitted that they could not tell the difference between the electronic reproduction using Dyna Mark III amplifiers and the PAS-2 preamplifier, and the "live" music by the Fine Arts Quartet.

Such perfection in reproduction means that listeners at home can have a degree of fidelity which cannot be improved regardless of how much more money were to be spent on the components used. All Dyna components are of a quality level which permits reproduction indistinguishable from the original. The unique engineering in all Dynakits makes them fully reproducible. So that everyone can hear the full quality of which the inherent design is capable, Dynakits are the easiest of all kits to build — yet they provide the ultimate in sonic realism.

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\[ V = 2E \left( \frac{R}{R - jX_c} \right) - E \]
\[ = \frac{2R}{R - jX_c} - \frac{1}{E} \]
\[ = \frac{2R - R + jX_c}{R - jX_c} \]
\[ = \frac{R + jX_c}{R} \]
\[ = \frac{R}{R - jX_c} \]

But the absolute value (magnitude) of the expression in parentheses is just 1 (unity), hence \( V = E \), or exactly half the input. Note that the proof contains no f's or omegas—the voltage does not depend on frequency—and also that the R's and X's drop out. Thus the solution holds, as we said, for any value of f, c or R.

Note on "Fussy Fuses"

Several readers have written about the item "Fussy Fuses," which appeared on page 43 of the August issue. In the main, writers stated that differences in resistance of the various fuses would cause the current to divide unevenly, and out, though they might blow in the same order. The combination would carry considerably more current than suggested by Mr. Stumph.

We had thought of that one, too, and had queried the author. He made a number of measurements on fuses and reported the resistance so low that it would presumably not affect the results.

One reader, however, made a brilliant suggestion, which we followed—that we hook up a few fuses in parallel, in series with a flat iron or a hot-plate load. We did just that, using 1- and 2-amp fuses in parallel. With the help of a Varie, it was found that before the 1-ampere fuse blew, the 2-ampere fuse was usually red hot. Obviously the two-fuse combination was carrying considerably more than 2 amperes.

A brief article, "Some Notes On Fuse Resistance," will go further into this question in an early issue.—Editor

Double Grid

This is simply the old cube circuit, presented in an unconventional way. Each resistor is 6 ohms. An equivalent circuit is shown for convenience in analyzing the cube circuit. The voltages at a, b and c are identical, as are those at d, e and f. Therefore, they can be shown connected together for purposes of calculation. Then, if the effective resistance of the circuit is 5 ohms (5 volts/1 amp) the value of any one resistor in the circuit can be found:

\[ R = \frac{1}{\text{network resistor}} \]
\[ 5 \text{ ohms} = \frac{5/6}{R + 15/6} + \frac{5/6}{R} \]
\[ 5 \text{ ohms} = \frac{5}{6}R \]
\[ R = 6 \text{ ohms.} \]

50 Years Ago

In Gernsback Publications

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Some larger libraries still have copies of Modern Electrics and the Electrical Experimenter on file for interested readers.

In October, 1913, Electrical Experimenter


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Right Where Everything That's New in Electronics is Happening

OCTOBER, 1963

73
The Oberth space mirror, under construction, as it would appear approximately 700 miles above the earth. The three objects at left are the solar energy plant which furnishes power for the workers, as well as heat and light. Matter being weightless here, everything not rigidly attached floats off into space.

This shows how the spatial mirror operates. The solar energy is caught by the mirror, then is concentrated on the dark side of the earth. For clarity’s sake only one of more than 8 to 10 mirrors is shown. The mirrors’ rays concentrate chiefly on the upper part of the atmosphere. The reflected energy of the mirrors is unimaginably large.

Another view showing only one of 8 to 10 space mirrors as they gravitate around the earth, as does the moon, below. Once in position the mirrors function continuously, except during the rare occasions when the earth eclipses the sun. Mirrors usually will be focused on the upper atmosphere.

3. The solar mirrors would seldom concentrate their heat on the earth itself. The mirrors would chiefly heat the atmosphere at the stratosphere level and above. It is here that weather is created and air currents are generated, the so-called jet currents that vastly influence our weather. It will be one of the tasks of the space mirrors to regulate these air currents for full efficiency.

4. Most important, just where, geographically, are the mirrors to concentrate their maximum heat for full efficiency? These regions will change from day to day, depending upon the seasons. Hence a global meteorological network must continuously feed such information to the mirrors’ central headquarters.

This vastly detailed global meteorological information is then fed into special electronic computers and the result is then transmitted to the individual mirrors which now will concentrate their energy on the exact regions and atmospheric altitudes for the exact period required.

The above outline gives only an incomplete idea how the weather on our planet can be regulated in the future.

6. It must be realized that here we have to do with extremely vast cosmic forces running into many billions of horsepower an hour. Hence we must understand that even with all solar mirrors working at full efficiency, the climatic changes will be very slow and gradual. It will not be perpetual spring all over the world immediately.

It will take a number of years to derive the full benefit of our vast expenditures, which will run into many billions. But in the end it will be cheap and very much worth while.

—H.G.

“On the contrary, we have a very large tube inventory. However...”

Illustrations by Frank Paul
“in this corner—and still the world’s champion—the University MIL-A.” And the champ in any corner (or wherever else you install it). It’s the world’s best-selling paging loudspeaker—outselling the closest competitor ten to one! Reason? The MIL-A out-performs them all—a fact you can easily prove to yourself. Do you realize, for example, that competitive makes require almost three times the power to obtain the same level produced by the University MIL-A? For installation ease and convenience, University’s exclusive patented Omni-Lok bracket directs the speaker in any plane. One hand locks it in position with a twist of the wrist. No loose hardware—no two handed adjustments! 7.5 watts continuous duty. 350-13,000 cps. 25-watt Model IB-A Paging Speaker offers the same outstanding features. For catalog describing the industry’s most complete line of P.A. speakers, write Desk J-10,
our policy on freebies

By ART MARGOLIS

WHEN MRS. ARMOZEEN CALLS AND SAYS, "Your man was here a few days ago and the TV is out again," you brace yourself. She always adds, "And you know, it's the same trouble."

If a customer ever said, "It's a different trouble", I'd award her a prize.

Naturally they try to pin the TV seizure on you so they can exercise the guarantee you give with every repair. Of course, they want the recall to be a freebie. How do you handle the price aspect of recalls? Do you insist on sticking to the letter of your guarantee and demand full compensation no matter what? Or do you give in easily and give away parts and labor to avoid any hard feelings? Here is our usual procedure on the three types of situations the recalls fall into.

The free call

Our guarantee is the usual one advocated by most bonding companies and associations. Generally stated, we guarantee our work. This includes all parts we install and any labor needed to reinstall any of these parts should they become defective during the next 90 days. This time length can be extended or shortened for specific parts such as picture tubes, etc.

Actually, this guarantee is only as good or bad as the service operator who gives it and the customer who accepts it. Each service job must be handled individually. The 90-day guarantee simply gives us a general framework within which to operate.

In many situations, logic, justice and sticking to your guns must yield to a businesslike approach. Whether you are entitled to money or not, it's sometimes best to waive the loot and be a graceful sport.

Like a 24-inch Philco that I serviced recently. In the house, the customer, an avid TV viewer, said "Do whatever you have to, just fix the set so it will play like it used to."

It had age trouble. Tubes didn't help, so I pulled it for bench work. On the bench, with our good antenna, local stations were washed out and distant stations were coming in a little better than they normally do. The local-distance switch was inoperative.

I hooked my high-impedance bias box into the grid circuit of the first i.f. The condition cleared. Local channels came in once more and distant channels lost their extra gain. That meant the trouble was in the age line, since the bias box substituted for the age circuit.

Voltages are so tiny in the age line and the number of components so few, I began statically testing each component. It didn't take long. An 8.2-megohm resistor coming out of the switch read wide open (Fig. 1). A nearby 6.8-megohm resistor read 300 mgs. I replaced the two offenders and the age condition cleared.

The TV checked out otherwise, and it was returned to the customer with regular shop charges.

I didn't hear from the set owner for about a week. Then he called, "Art, the TV is doing the same thing."

I made the call myself. The symptoms were vertical foldover and occasional vertical roll. I checked the vertical tubes by replacement. The new ones didn't help a bit. I thought about the set's circuit. It was still fresh in my mind. It struck me that the vertical output tube's -10-volt bias came from a tap onto the horizontal output tube's -35 volts. A gassy horizontal output tube in this wild circuit could reduce the -35 volts and, by remote control, reduce the vertical output bias. I replaced the 6CD6 horizontal output amplifier. The vertical fold disappeared as the vertical tube stopped overdriving from the lack of bias.

The set owner said as nicely as he could, "Guess you didn't do too good a job in the shop. Guess you're gonna charge me some more money."

"No, sir," I replied, "the trouble was another tube cooking out. We can't predict when tubes are going to blow. However, there is no additional charge. Hope your TV gives you good service now." I packed up and left without any additional fanfare.

If I had said it was different trouble and meant more money, it would have been hard for the customer to swallow. Since I said different trouble,
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CLAROSTAT

CLAROSTAT MFG. CO., INC. DOVER, NEW HAMPSHIRE

OCTOBER, 1963
no money, he'll believe it because there's no unpleasant reason for him not to.

How can we give away a tube and service charge? Our regular shop charges include enough to take care of one service charge plus one tube on every shop repair. It's easy to do a freebie when you've been paid in advance.

Charging for parts

While it's nice to act the philanthropist, you can't do very much of it in business. If the part is relatively inexpensive, you can include it in your apparent guarantee philanthropy. However, more expensive parts cannot be given away.

Fortunately, people do not object too strenuously when you charge for a part, as long as you give your labor away. Within the framework of your guarantee, you specifically state free replacement of any parts you replace. If you can definitely show that you have had to replace another component during a recall, most times customers will be agreeable and pay for it. This can cover you on a recall if you handle it properly.

A case in point was a 23-inch Silvertone that had developed noise on all channels. There was some audio, but it was almost drowned out by the racket of the intercarrier buzzing. Fine tuning did no good whatsoever.

I fed a 400-cycle note onto the plate of the audio detector, a 4DT6 sharp-cutoff pentode. The note came out of the speaker clear as a bell. That cleared the stages past the detector.

The sharp cutoff characteristics of the tube help limit any AM noise that might be in the sound i.f. carrier. The loud intercarrier buzz was a tipoff to insufficient limiting and poor detection.

I took voltage readings on the 4DT6. All were good. I took resistance readings. When I read thecontinuity from pin 7, the suppressor, to the bottom of the quadrature coil there was none (Fig. 2). The coil was open. I removed it and examined it closely under a magnifying glass. On one end the dope had dried up and the coil form had swelled. The wire had parted at this point. A drop of solder cured all. The coil was reinstalled, the audio sounded healthy and the TV was delivered.

More no more was heard for about a week. Then the customer called, "It's the same thing." I took the house call. I turned on the set. The audio was perfect. I asked, "What's the trouble?"

"Wait a few minutes. You'll see.

I waited, then it happened. The picture developed white vertical lines, each about an inch thick. A severe case of yoke ringing. I jumped the horizontal windings individually and entirely with different small capacitors; no use.

She said, "This has been happening off and on for a year. I thought you fixed it."

I asked, "Did you mention it to me when I took the TV to the shop?"

She answered, "I don't remember, but you should have fixed it."

I said, "I'll tell you what I can do, I'll purchase a new yoke for you and I won't charge you for my labor to install it. All you have to pay for is the yoke itself. You'll end up paying exactly what you would have if we had replaced the yoke in the shop. No more."

She agreed easily. Most reasonable people will. It was a plug-in yoke, easy to install, and the profit I made between the net price and list covered the cost of the recall. The call wasn't a loser.

When to charge all over

While charging for parts can help cover costs in calls that occur during guarantee periods, you'd go broke on the less expensive items. There are some situations where a complete new service fee is indicated.

You can prepare in advance for such eventualities if you know exactly what was done to their set on the initial call. In fact, go out of your way to explain the original repair. One such call I had was on a 24-inch Emerson. The complaint was vertical roll after about 10 minutes. Since the tubes didn't help, I pulled it to the shop.

On the bench, after the condition started, I examined the vertical blanking bar. The sync pulses were blacker than the darkest picture element. That meant sync input was good and the problem was in the sync or sweep circuits.
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I ran some voltage tests on the sync separator. There was supposed to be 50 volts on the plate of the 5U8. As the seizure occurred, the 50 volts gradually dropped to 10. I crossed over the 27,000-ohm plate load resistor. There was 125 volts on the other side, as it should be. I checked the far side of the coupling-blocking capacitor leading to the sync amplifier. It was near zero volts at that point so the capacitor didn’t seem to be leaking. That left the load resistor. I felt it. It was a bit too warm. With the TV still on, I snipped off the B-plus end of the resistor and measured its resistance quickly. It read 500,000 ohms instead of 27,000 ohms (Fig. 3). That was it. The resistor was replaced, the TV checked out. I delivered it.

During delivery one point was made. I said, “Do you remember the trouble?”

She said, “I think so.”

I said, “The picture was rolling. Now look. The vertical hold control works like a charm.”

She tried the vertical hold and said, “Oh yeah, it’s real good.”

Two weeks later she exercised her guarantee. I went to the house and examined the latest trouble. The fuse resistor was open. I measured the silicon rectifiers. One had a dead short. I said, “You have an entirely different trouble.”

She answered. “Yeah, I know, it’s not the vertical hold knob this time.”

I replaced both rectifiers just to be sure and the fuse resistor. I wrote up the bill and to ease the pain a bit, said, “Now you have two 90-day guarantees. One on each job.”

I don’t have to tell you what would have happened if we didn’t make the point of the vertical hold. The customer would honestly have believed it was the same thing.

SUB
SYNC SEP
50V
27K
27K
500K WHEN HOT
125V

Fig. 3—The 27,000-ohm plate resistor would go up in value after the set was on for about 10 minutes.

To sum it all up, our policy on freebies is to play each job by ear and obtain as much money as we are entitled to without jeopardizing our hard-earned customers. A bit of customer courtesy must be used and a freebie reserve charge included in your service fees is mandatory. You can run some recalls as complete freebies, charge only for parts on other recalls and be able to recharge on the third type. Each particular job and customer is individual. It hurts sometimes, but pattern your policy around that old cliché, “you can’t win an argument with a customer.”
SEMICONDUCTOR PRODUCTS shown in 24-page, illustrated Catalog SR901. Specs on radio and TV rectifiers, silicon, selenium and cadmium sulfide photocells, power rectifiers, Zener diodes, science and experimenter kits.—International Rectifier, 233 Kansas St., El Segundo, Calif.

Rechargeable BATTERIES. 10-page brochure discusses voltage stability, discharge rate, recycling, temperature, mechanical stress, other characteristics. Illustrated by graphs and 18 photos.—Sylvania Electric Products Inc., 730 3rd Ave., New York 17, N. Y.

TELSTAR II, 72-page, illustrated color reprint of April 1965 issue of Bell Labs Record. Contains 10 semi-technical articles about engineering of project, communication links, line station, satellite launch operations—Telstar Record, Bell Telephone Labs, 463 West St., New York 14, N. Y.

TAPE HEADS described in 4-page leaflet. Full description, specs, cross-reference table for record/play, record and erase heads.—The Norton Electronic Co., Inc., 8101 10th Ave. N., Minneapolis 27, Minn.

UHF CONVERTERS described in 2-page, illustrated specs. Photos, operational features, specs on manufacturer’s two models.—Standard Rollstand Industries Inc., 2085 N. Hawthorne Ave., Melrose Park, III.

APPLICATION NOTES. Noise and gain of the RCA-8056 Nuvistor (triple at 200 mc) 4 pages, Note AN-195; new high-pain tube for i.f. amplifiers and limiter stages of FM tuners. 6 pages, Note AN-197; temperature ratings and thermal considerations for Nuvistor tubes, 4 pages, Note AN-196.—RCA, Electron Tube Div., Harrison, N. J.


REPLACEMENT SPEAKERS. 12-page illustrated book; offers automotive rear deck systems, aircraft speakers, condemns types. This book, itself models, coiling and wall-mounted speakers, intercoms, PA types. Accessories include line, transformers, baffle, crossover networks.—Uhls Sound Inc., Elmsford, N. Y.


MAGNETIC TAPE for instrumentation application. Illustrated 10-page booklet gives complete description of manufacturer’s tape line. Sections on tape selection, accessories.—AmpeX Corp., Mail Stop 24-1, 934 Charter St., Redwood City, Calif.

LOUDSPEAKERS shown in illustrated Data Sheet 174, 24-inch models, 3-12 inches, including 10 new oval models. Lists magnet weight, impedance, power output, voice coil dimensions, and set design.—Jensen Mfg. Co., 6601 S. Laramie Ave., Chicago 38, III.

PORTABLE TAPE RECORDER shown in 4-page, foldout, description, full specs on new Sony model 801-A and accessories.—Supercomp Inc., Dept. 1A, Sun Valley, Calif.

Sound, 20-page "how-to" manual, describes amplifiers and systems for industrial applications, outlines selection considerations. Sound system design charts required audio power for specific applications. Technical data and photos of manufacturer’s CA and Troubadour series transistor PA amplifiers.—Harman-Kardon Inc., 55 Ames Court, Plainview, N. Y.

MODULAR CABINET RACKS, CONSOLES described in illustrated 44-page Catalog 63. Contains engineering drawings, dimensions, photos. Illustrations show how units can be used singly or in assemblies.—Par-Metal Products Corp., 32-62 49 St., Long Island City 3, N. Y.


REPLACEMENT TRANSFORMERS, COILS, 1,500 types for TV, radio, hi-fis, are shown in 48-page Catalog 1-1063 1963/64. Instructions for selection of transformers, schematics of manufacturer’s coil products. Illustrated catalog chart. Lists 260 home entertainment tubes, with transformer for use with each.—Stancor Electronics Inc., 3901 W. Addison St., Chicago 18, Ill.

FLEXIBLE NEEDLE REFERENCE GUIDE, No. SAH-71. Foldout chart lists 1,400 phonograph models in use in which new flexible needle may be installed.—Somotech Corp., Elmsford, N. Y.

POWER FOR TELEMETRY. 4-page, illustrated brochure gives characteristics and recommendations on use of modules for L and S bands. Describes amplifier module powered by grid-type power tubes in cascade.—Edel-McCallough Inc., 301 Industrial Way, San Carlos, Calif.

BARRY’S GREEN SHEET No. 11. Illustrated 1964 catalog offers new and surplus tubes, semiconductors, transformers, chokes, meters, test equipment, industrial vacuum equipment.—Barry Electronics Corp., 512 Broadway, New York 12, N. Y.

PORTABLE INDICATING INSTRUMENTS shown in 4-page illustrated technical bulletin 99-352. Photos and specs for two series ac and dc instruments with taut-band suspension.—Westinghouse Scientific Equipment Dept., PO Box 686, Pittsburgh 30, Pa.

FREQUENCY CONTROL HANDBOOK. 44-page catalog has illustrated design parameters. Describes range of 700 mc filters, frequency 1 kc-20 mc; frequency sources 1 cycle-250 mc.—Eitel-McCullough Electronics Inc., Mechanicsburg, Pa.

REED RELAYS. 16-page Catalog B describes and pictures 12 custom types, with photos and full specs. Types include basic, pulse, crosspoint, latch, logic and infinite margin reed relays.—Struthers Dunn Inc., Pitman, N. J.

TUBE DIRECTORY. 8-page booklet lists 2,500 popular tube types, all standard brands. Includes special-purpose, transmitting, audio, phototube, telephone, miniature, subminiature, ignitor, klystron, magnetron, rectifier, strob, thyatron, socket, industrial, radio, TV tubes.—Corvair Electronics Inc., 215 Park Ave. S., New York 3, N. Y.

PRECISION TOOLS for servicing relays. 4-page catalog has photos and description of manufacturer’s line of precision, special microminiature and miniature tools, and soldering irons, burning tools, etc. For engineers and authorized personnel. Request on company letterhead.—Jouard Industrial Corp., Precision Tools Div., 3733 Riverdale Ave., Bronx 63, N. Y.


SILICON TRANSISTOR GUIDE. 2-page data sheet lists silicon planar "leaf" npn transistors, silicon diffused mesa power transistors by type number, with electrical characteristics and case type.—R. R. Miller, Bendix Semiconductor Div., South St., Holmdel, N. J.
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Mathematics for Electricity and Electronics, NRI Staff. This book gives you all the math you'll need for effective servicing of equipment. It makes it easy by tying it in directly with actual circuit problems. It provides you with a firm foundation in math so that you'll not only understand what you're doing—and be able to do it better—but you'll also be able to do it more advanced, more meaningful, and ultimately more responsible work. Written by the staff of the National Radio Institute, part of its famous home study course in electronics, the material in this book has given thousands of heads a smooth, successful start. #311-H cloth, $5.95; #311-H cloth, $5.60.

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How to Install and Repair Marine Electronic Equipment, Elbert B. Cagle. Takes the dangerous guesswork out of marine equipment installation and repair. No sailor can safely be undertaken without special study, training, or experience. This book provides anyone with a basic foundation in radio with a knowledge of the unique circuit and practices found in small boat equipment. Everything you need to know to service marine equipment is made thoroughly clear in this 256-page book. Some of the subjects covered include FCC regulations, the electrical systems of boats, power circuits and ground problems, isolation systems, problem finding, echo sounders, automatic pilot, and small-craft radio and toran. #230, soft cover $4.50; new cloth $4.95.

Electrical Interference, Rocco Fichio. All electronic systems can be, and frequently are, affected by electrical interference. This book explains how it originates, what it can do, and how its effects can be minimized in everything from radio receivers to muscle systems. While detailed enough for the design engineer, the book is equally valuable for the technician because it gives all the basic information he needs to cope with electrical interference problems. #512-H, cloth $7.50.

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<th>Frequency</th>
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<tr>
<td>AOR-40</td>
<td>150 kc — 450 kc</td>
<td>$69.00</td>
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<tr>
<td>AOR-41</td>
<td>2 mc — 6 mc</td>
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<td>AOR-46</td>
<td>2 meter</td>
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<tr>
<td>AOR-47</td>
<td>Citizens 27 mc</td>
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<th>Kit</th>
<th>Frequency</th>
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<tr>
<td>AOF-89</td>
<td>VFO 8 mc — 9 mc and buffer</td>
<td>$22.00</td>
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<tr>
<td>AOF-90</td>
<td>VFO 8 mc — 9 mc plus buffer multiplier and 6 meter output</td>
<td>29.00</td>
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<tr>
<td>AOF-91</td>
<td>VFO 8 mc — 9 mc plus buffer multiplier, 6 meter / 2 meter output</td>
<td>36.00</td>
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-Euphonics Corp., Guaynabo, Puerto Rico.


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3-WAY SPEAKER KIT, KS-2 Stratakit. 12-inch free-piston woofer, half-roll cotton surround, 6-1/2 magnet structure. Free-air resonance 25 cycles. 3-inch mid-range, butyl-coated surround, sealed off in back. 3-inch cone type tweeter, hemispherical dome bonded to 1-inch voice coil with 2-oil magnet structure. 3-way inductance-capacitance crossover network at 1,200 and 2,000 cycles. Continuously variable tweeter level control. -Fisher Radio Corp., 21-21 44th Dr., Long Island City 1, N.Y.

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power source. Accepts all Viking cartridges with pre- recorded quarter-track source. Amplifier has 10 transistors. Speaker output impedance 3-4 ohms. Distortion 2%, flutter and wow 0.3%. Signal-to-noise ratio 50 db. Power requirements 11-15 vdc, 1 amp. max. negative ground.—Viking of Minneapolis Inc., 9600 Aldrich Ave. So., Minneapolis, Minn.


PORTABLE TAPE RECORDER, Korting TR 2000. Duplicates original tapes without second output. Front-panel controls: 4-position mode selector, 3-position program selector, separate center bass, treble and volume controls for each channel, ac on-off switch, rumble filter on-off switch, speakers/phones switch and stereo headphones jack. Rear panel: speaker impedance switch (8 or 16 ohms), speaker phase switch, hum adjust, ac convenience outlet. 105-125 volts.—Lafayette Radio-Electronics Corp., 111 Jericho Turnpike, Syosset, N. Y.

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Westinghouse V-2342 Chassis

For parasitic oscillations in horizontal output circuit of Westinghouse chassis V-2342 (Radio-Electronics, July 1957, p. 58), Westinghouse Supplement No. 1 to V-2342 and V-2343 chassis Service Manual recommends shorting out C429 (or removing it completely) and changing C428 to .047 µf, 600 volts. This also applies to chassis V-2316 and V-2317, and others using the same horizontal output circuit. These changes were made later in factory production.

I have seen several cases of this trouble, and in every one, making these changes produced a complete cure. The first case I had, though, was a real puzzler until I wrote to the distributor's service manager.—W. J. Siles

Unstable Horizontal Sync

In any of the older Motorolas (and some other makes, too) with the horizontal oscillator near the rear of the chassis and the horizontal hold pot on the front panel, unstable sync can be a problem. Replace the long unshielded grid lead from the tube to the pot with a shielded wire. Ground the shield, of course.—W. G. Eslick

Heath AA-1 Audio Analyzer

One of these was found to have about 15% intermodulation distortion all by itself, with no amplifier between generator and analyzer portions!

The trouble was caused by the 3,000-ohm pot that con-
controls the composite output level. The wiper was making poor contact with the worn element, and the resulting nonlinearity caused intermodulation before the test signal even left the generator.

Replacing the pot brought the residual IM back down to under 0.1%. Incidentally, you can check residual IM simply by jumping the red IN and OUT terminals on the AA-1 and running through the test procedure as though you were checking an amplifier.—P. E. Suthum

**Hotspot 14S201 ("Q" line); GE 14T007 through 14T020**

**Buzz in sound with volume control counterclockwise:** reroute wire from ST8 toward the top and down to the output tube.

**Sync troubles (pulling):** tubes and phase diodes OK. Monitor with scope (sweep set to 30 or 60 cycles) the 200- and 60-$\mu$F sections of C402 (sections A and B). One of them may have developed an open or intermittent, putting sync pulses on the B-plus line.—W. G. Eslick

**$15 Answer to the Translator**

Since translator stations are low-power units covering a limited area, many TV sets will be repaired outside the normal reception area. This requires a uhf signal for sound alignment and tuner test. An effective answer wherever channel 4, 5 or 6 is available is the Blonder-Tongue converter BTC-99 or BTU-2 (available at most parts houses) and the simple hookup described.

Connect two pieces of 300-ohm ribbon line (as short as convenient) to the terminals marked TV SET and UHF ANT.
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6LC8, 8LC8

New miniature triode-pentodes, these RCA tubes are made for sync-separator and noise-immune, gated age applications in both color and black-and-white TV sets.

They are similar to the 6K18 and 8K18, but have separate cathodes for each unit and internal connections between pentode grid No. 3, the triode cathode and the internal shield.

The pentode section can provide a high inverted-noise output from grid No. 2 for use in canceling the positive-going noise pulses at the triode grid. The pentode plate can withstand maximum peak positive pulse plate voltages to 600.

Both new types feature controlled warmup time and the RCA dark heater.

2N2495

This is a germanium p-n-p transistor designed for use as an rf amplifier at frequencies up to 470 mc, making it ideal for TV and communications receivers. Amperex, the manufacturer, also suggests it for TV boosters, as an ultra-low-noise i.f. amplifier, and as a uhf-vhf mixer.

Its 200-mc power gain is 15.5 db, and feedback capacitance only 0.7 pf. It has a 1-ke beta of 70 and a gain-bandwidth product of 300 mc.

Amperex has designed a converter using the 2N2495 to operate at 465 mc with a sensitivity of 0.65 µV for a signal-to-noise ratio of 12 db. The rf stage of the front end is shown in the schematic.

The company has several reports available free to persons writing on company letterhead: the S-105, describing...
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Readers' Guide to Radio-Television

The new tube, which uses magnetic focusing and deflection, produces usable pictures with 0.1 foot-candle faceplate illumination. The average gamma is 0.6.

Because of its small size and sturdy construction, this Amperex vidicon has very good microphonic characteristics. To reduce accidents, the exhaust tip is centered at the base inside the pin circle, instead of protruding from the side as in many other such tubes.

2N918

Here is a transistor you may see a good deal more of—if its price ($17.50 in 100-up quantities) comes down. It's a silicon n-p-n passivated epixial transistor.

8483

Here's one that should appeal to ham and closed-circuit TV enthusiasts: a 1-inch vidicon capable of 990-line resolution, designed especially for compact, portable transistor TV cameras.

The 8483's heater draws only 90 ma at 6.3 volts—a total power consumption of 0.6 watt, keeping power drain and heat dissipation to a minimum.

Write to Amperex Electronic Corp., Semiconductor & Receiving Tube Div., 230 Duffy Ave., Hicksville, N. Y.

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sistor, designed as a low-noise rf amplifier, local oscillator up to 1,000 mc, or as i.f. or video amplifier. It provides a minimum power gain of 15 db at 200 mc, and supplies 30 mw of power output at 500 mc with 25% efficiency. Most attractive are its current gain of 50, its gain-bandwidth product of 900 mc, and its noise figure: 3 db at 60 mc.

The 2N918 comes in a TO-18 package and is made by Motorola. The diagram shows a power-gain test circuit for 200 mc, lifted from the manufacturer's data sheet. It shows one possible amplifier circuit, and may suggest others.

**Powder-metal cathodes**

Among the devices displayed at the 1963 WESCON (Western Electronics Show and Convention) were receiving tubes with new powder-metal cathodes, developed by Sylvania and General Telephone & Electronics Laboratories, Inc.

The basic material is carbonyl powder, alloyed with the necessary additives and rolled into a thin strip. The strip is then formed into cathode sleeves in much the same way as conventional nickel cathodes.

The new process prevents the contamination that occurs during the usual melting, pouring, forging and hot-rolling operations with existing alloys. It also makes fabrication of special compounds and alloys much easier.

Reduced contamination makes possible much greater reliability, as shown in a failure-rate report on the 6AF4 uhf triode. 6AF4's with ordinary cathodes have a failure rate of 13.1% per 1,000 hours; with the new cathodes, 1.5% per 1,000 hours.

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California Legislature Passes License Bill
Sacramento—California has a licensing law. The act, effective Jan. 1, 1964, regulates advertising claims, work performed, estimates and charges.

Among the advertising restrictions specifically cited in the bill are “Making . . . any claim . . . which is untrue or misleading . . .” and “Making any false promises of a character likely to influence . . . a customer to authorize the repair . . . of [a TV, radio or phone].”

All work done is to be recorded on an invoice and must describe all the work and the parts used. If any of the parts are not new, the invoice must mention that. The service dealer shall return replaced parts to the customer, except where other arrangements are necessary as part of a warranty agreement.

A service dealer may not charge for work done or parts supplied in excess of an estimate without previous consent of the customer. However, the bill makes the original estimate a voluntary, optional matter. If made, though, it must be in writing.

Repairmen Point Out Snags in California Law

The new California law regulating home service advertising practices has come in for severe criticism from service companies in the state, according to Home Furnishings Daily.

The most vigorous complaints center around the law’s provision that when companies give customers written estimates of repair charges before work is begun, actual charges may not exceed the original estimate or a revision signed by the customer.

The service operators claim that since it is impossible to make a precise estimate of repair charges, estimates will have to be inflated to cover possible unforeseen costs, creating new levels of high estimates.

“This will cause more trouble for an honest dealer than a dishonest one,” said an official of Universal Television Co., Inc. Universal, he said, will refuse repair jobs where the customer demands a written estimate.

In some cases, a company may tell its customers that its written estimates are deliberately made high, but that the final bill could be lower.

Factory service operations appear to be generally opposed to the new law, but officials of these companies point out their policies forbid them to go on record as opposing legislative measures.

California’s Gov. Edmund Brown emphasized that the laws are aimed at the dishonest operator only, and that there is no intent to license dealers but only to provide elementary policing and consumer protection.

New Florida Association
Miami—Delegates from Pensacola, St. Petersburg, Tampa, Fort Lauderdale and Miami met to lay groundwork for a new statewide electronic service association, to be called the Florida Electronic Service Association (FESA).

A temporary chairman was selected: A. Edward Stevens. Jack Norris was chosen as temporary secretary. Both men are from Miami. Others were appointed to divide the state into manageable districts and to investigate the problem of collecting dues.

The group discussed membership qualifications, voting rights and methods, and drew up a skeleton charter.

Moch Speaks at St. Louis
St. Louis—NATESA Executive Director Frank J. Moch addressed the 14th anniversary and installation dinner of

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5-ASS'ED VOLUME CONTROLS $1.00

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3 - I.F. COIL TRANSFORMER 5, 600uH, all popular types $1.00

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Butte, Mont. - The Electronic Service Association elected new officers at its annual meeting here. The organization is a recent affiliate of NATESA.

Elected were Leonard Barrough, president, replacing Patrick Gordon, who became recording secretary. Kenneth Venner was re-elected as treasurer, as was Raymond G. Tuszyński to his office of corresponding secretary.

Harry Carroll and Donald Lassila were elected trustees.

The group confirmed Mr. Tuszyński as NATESA-director for the coming fiscal year, and Howard F. Neier as his alternate.

The organization reports concern over the city's licensing system, which makes it possible for incompetent persons to obtain licenses for TV service.

**Butte, Mont., ESA Elects**

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A REVOLUTIONARY NEW METHOD FOR MARKING ELECTRONIC EQUIPMENT

**new Patents**

**Jamming Suppressor**

**PATENT No. 3,015,026**

Leonard Milton, Lake Success, N. Y., and Murray Gunar, Lakewood, N. J. (Milton assigned to the Filtron Co., Inc.)

A radar receiver can be jammed by a strong signal that sweeps through a wide frequency spectrum. When the jammer frequency is the same as that of the receiver, it overloads the i.f. and renders it inoperative for a time.

Fig. 1 shows basic circuits of the jamming suppressor. The mixer has two secondaries: A, which feeds the i.f. as usual, and B, which has a wide-band response (Fig. 2). Hence a jamming signal, as it sweeps through the band, will cause a response in B before the radar signal does. B's signal generates a negative pulse which blocks cathode follower V2. In turn, V2 blocks i.f. amplifier V1. As soon as the jammer output from B drops to zero, V1 resumes operation.

**Multi-Oscillator**

**PATENT No. 3,085,202**

Edward Jakubowics, Fairhaven, N. J. (Assigned to USA as represented by Secretary of Army)

Many crystal frequencies can be generated by a few crystals. For each crystal selected by S1, four crystal frequencies will be available at S2, giving a total of 20 from the mixer. With the crystal frequencies shown, the output will range from 4.525 to 5.475 mc at intervals of 50 kc.

For example, when S1 selects 20.275, the mixer outputs will be: 4.525, 4.575, 4.625, 4.675. If S1 is switched to 20.475, which is 200 kc higher, the outputs will also be 200 kc higher: 4.725, 4.775, 4.825, 4.875 and so on for the others.

Only lower sidebands are used here. If the upper sidebands are also used, the number of output frequencies is doubled. This principle, called frequency synthesis, is being used in many commercial devices (see "Frequency Synthesis Improves CLI Coverage," August 1963, page 44).

**Zener-Coupled Amplifier**

**PATENT No. 3,080,528**

James J. Davidson, Laurence Township, Ind. (Assigned to RCA)

This amplifier includes several unusual features. Zener diode D couples the stages. Being reverse-biased, it isolates the stages for dc, but transmits ac. Any change at its anode (from Q1) appears without loss at its cathode (to Q2), because D maintains constant voltage difference. The frequency discrimination of a coupling capacitor is not present.

Q1 is an emitter follower, and its output impedance is low. The input impedance is high because the input signal is amplified by both transistors, then fed back to Q1's emitter. Output has the same phase as the signal.

Q1 and Q2 are in series for dc, so temperature affects them equally. The inventor claims efficient operation to 100°C.

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**PATENTS**

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**Radio-Electronics**
Pipe Forms Instrument Dolly

Many larger instruments are best suited to dolly mounting, and that added mobility makes them more useful.

The synthesizer type frequency meter shown in the photograph measures about 19 x 19 x 25 inches and weighs a bit less than 160 pounds.

The dollies can be made from standard pipe fittings. Construction details are self-evident. Standard 1½-inch water pipe T's, caps and various length nipples are threaded together. The top caps are drilled to pass the equipment mounting bolts and the bottom caps to mount the threaded stud casters.—Roy E. Pajenberg

Vom Capacitor Check

To check leaky capacitors with a vom, clip one meter lead to one end of a suspected capacitor. Switch the meter to an "ohms" range and charge the capacitor by touching the other meter lead to the remaining capacitor lead. (One end of the capacitor must be disconnected from the circuit.) Now wait half an hour and check the meter reading. Any reading greater than zero indicates the capacitor is leaky.

October, 1963

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a minute or so and touch again. If the meter pointer jumps again as it did initially, the charge on the capacitor has leaked away and the capacitor is leaky. Try again to be sure.

This trick works most reliably with paper capacitors of .001 µf and more. —Clare E. Ernst

Relay Prevents Clock Confusion

If clocks and timers start automatically after the end of a power failure, the systems they control will be out of synchronization. This can cause considerable confusion as, for example, when school bells ring at wrong times.

This can be avoided by keeping clocks and associated timing devices turned off until they can be manually reset and started. This can be done easily with an inexpensive 117-volt spdt relay wired as shown in the diagram. To start the clock motor, depress the armature of the relay manually. (An insulated button is attached for this purpose since the armature is “hot.”) This closes the circuit to the N.O. contact, to which the clock motor and the relay coil itself are connected. The relay is thus energized and the N.O. contact is kept closed. As long as the power stays on, the relay will stay closed and the clock will run. If power fails, the relay will open. A lamp or alarm of some sort connected to the N.C. contact announces there has been a power failure. The clock circuit remains open until the relay armature again is manually depressed.—William B. Rasmussen

Extra Eyes

When working on a midget transistor radio with subminiature components and almost invisible terminals, even a young 20-20 vision man needs optical aids of some kind. Try a binocular magnifier of the type built like an eyeshade. They come in various focal lengths, of which No. 5 seems to be the most useful. This has a magnification of 2 times which is adequate and easy to work with. A binocular magnifier allows natural use of both eyes and retains the stereoscopic effect. The work may be moved around to get the best light and viewing angle.

For a closer single-eye view, a watchmaker’s loupe (with headband) is very good. A focal length of 3 inches is the best compromise between magnification and ease of handling.

But a real closeup of a cracked line in a printed circuit calls for a 10-power Coddington magnifier. This is made of a piece of glass rod with a lens on each end, giving excellent field and definition. —Nicholas B. Cook

Magnet Anchors Washers

In servicing record players it is sometimes necessary to remove the C-washer that holds the turntable in place. These little washers are small but ornery, and they can sail through the air with the greatest of ease to get lost somewhere. But I have learned to keep them earthbound with a small magnet held against the washer during removal. Then I leave the washer on the magnet until reassembly.—Nicholas B. Cook
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