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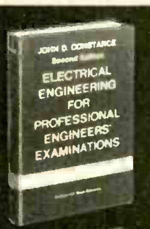

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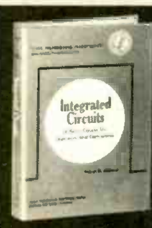

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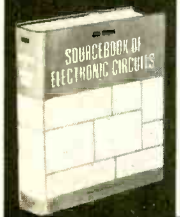

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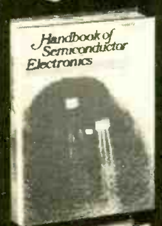

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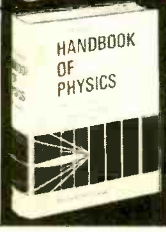

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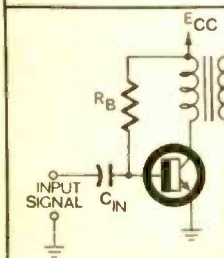
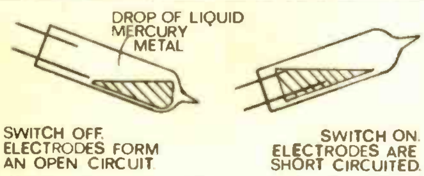


CLASS-A amplifiers are discussed in detail in this first-rate design article. . . . see page 55



SIMPLE MERCURY SWITCH is the heart of $5 vehicle alarm system. . . .see page 35

GET BETTER SOUND from your component system. Try these record player hints and see what happens. . . . see page 32

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looking ahead

Screen-size roundup

The new 25-inch super-rectangular color tube introduced last year seems to be on its way to replacing the 23-inch. In the first half of 1971, according to official industry figures, 44.5% of all console television receivers were of this new size, as compared with 48.5% using the 23-inch tube and 7% in smaller screen sizes. Of all U.S.-brand television sets—console, portable, table model and phonograph combination—the big screen (23- and 25-inch) was the most popular category, taking 47.6% of all sales. Next in importance was the 18- and 19-inch group, representing 29.6%, followed by small screens (below 17 inches) with 15%, and the 20- and 21-inch sizes last with only 7.8% of the market. As compared with a year earlier, the 18- to 19-inch group was by far the fastest-growing screen-size category.

FCC and Cable TV

There are some hopeful signs that the FCC's long freeze on major new CATV systems could end some time next year. There's no certainty, of course—the Commission's proposed rules could be held up by Congress, the courts, or even the White House. But the FCC has outlined its plans for the regulation of CATV to Congress, and they envision the eventual expansion of cable into a vehicle for multi-channel two-way communication into and out of the home. The Commission noted that 40-, 50- and 60-channel systems are currently being installed, and has decided that its rules will specify from the outset that all new systems in the nation's top 100 markets must initially be equipped to carry a minimum of 20 channels.

The FCC also said it will adopt a rule that for each broadcast signal carried, "cable systems must provide equivalent bandwidth for non-broadcast uses." These additional channels are to include one which is freely accessible for public expression at all times, one for educational use and one for the use of state and local government. The Commission states that its "basic goal is to encourage experimentation that will lead to constantly expanding channel capacity." It will also require that all new systems have "the capacity for two-way communication." The first two-way uses it foresees include "surveys, marketing services, burglar-alarm devices and educational feedback," and it warns that "viewers should also have a capability enabling them to choose whether or not the feedback is activated."

Home TV chronometer

The home television set may soon do double duty as a highly accurate clock and frequency standard. The National Bureau of Standards has conducted successful tests over a Denver television station, using one line of the vertical interval between TV frames to transmit reference frequencies for the calibration of equipment as well as time pulses. A decoding circuit in the home television set could provide digital readout of the correct time on the screen when a button is pushed, or the time pulse—accurate to within one microsecond—could automatically keep every clock in the house accurately set. Currently, the decoding circuit for the receiver costs about $400, but an NBS engineer estimates that an IC version could be built in mass production at about $10. A nationwide test of the system may be conducted soon on one of the television networks. FCC approval would be required before the system could be put in regular use.

The age of the Nixie

Electronic readout systems are beginning to come into their own in consumer products, and the first steps in higher-priced products could lead in a year or two to a stampede to softly glowing numerals and letters all over the home. Consumer electronic devices using the Burroughs Corporation's Nixie tubes and other electronic indicators have already been introduced—there are several stereo receivers with digital glow-tube readouts. General Electric last year introduced a digital electronic clock and a clock radio with no moving parts. Television manufacturers are experimenting with varactor-tuned all-channel receivers which show the channel numbers on two-tube electronic displays.

The electronic calculator, constantly moving into lower price brackets, is setting the pace and introducing the consumer to the new type of display—which, we predict, will be billed as the "computer look." The first major field for this computer look probably will be the clock radio, which has already undergone a progressive metamorphosis from the traditional round easy-to-read clock face to the harder-to-read square clock face to the impossible-to-read oblong clock face to the too-small drum-type digital readout to the inadequately illuminated and sometimes noisy leaf-type digital readout to the rear-illuminated belt-type digital readout. What's next? Well, it just has to be some type of electronic readout.

Electronic indicators for clocks and clock radios can be more than just a new showy way of reading the time. The Triumph Division of General Time Corporation, for example, has introduced a digital clock radio using a Sperry cold-cathode neon display tube, with all clock circuitry on a 24-function IC chip. Pushbuttons control alarm-setting, AM-FM radio switching—in fact, it looks like an electronic calculator. This isn't as far-fetched as it sounds—General Time is exploring the possibility of adding more digits to the readout, and more pushbuttons, and expanding the concept into a combination clock radio and home electronic calculator.

Look Ma, no tube

Elimination of the picture tube has long been a somewhat vain dream in television. The newest plan to scuttle the CRT comes from Edgar E. Price, who carries the credentials of optical design manager of Zerox Corporation.

Price recently received a patent for a television display system which is claimed to be brighter and to have greater color purity and potentially provide a bigger picture than the conventional cathode-ray tube technique.

Price's application of optical engineering to the television picture involves the scanning of a whole line at a time, rather than painting a picture from sequential spots. His principle envisions a projection system utilizing a bundle of fiber-optic tubes, using a time-delay system to store an entire line. A revolving prism, at 450 rpm, is the scanning device. The fiber-optic bundle, using an external light source and red, green and blue filters, projects a line at a time on a rear or front screen. There are 600 points of light, each utilizing a single fiber-optic strand. **R-E**

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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19EXP22
19EXP22/ 19GVP22
19EYP22
19EYP22/ 19GWP22
19FMP22
19FXP22
19GLP22
19GSP22
19GVP22
19GVP22/ 19EXP22
19GWP22
19GWP22/ 19EYP22
19GXP22
19GYP22
19GZP22
19HBP22
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19HFP22
19HJP22
19HKP22
19HQP22
19HRP22
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19JBP22
19JDP22
19JHP22
19JKP22
19JNP22
19JQP22
19JYP22
19JZP22
19KEP22
19KFP22
490AB22
490ACB22
490ADB22
490AEB22
490AFB22
490AGB22
490AHB22
490AHB22A
490AJB22
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490AKB22
490ALB22
490AMB22
490ANB22
490ARB22
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490JB22A
490KB22
490KB22A
490LB22
490MB22
490NB22
490RB22
490SB22
490TB22
490UB22
490VB22
490WB22
490XB22
490YB22
490ZB22

Replaces 22 types

19VABP22
19VACP22
21AXP22
21AXP22A
21AXP22A/ 21AXP22
21CYP22
21CYP22A
21FBP22
21FBP22A
21FBP22A/ 21GUP22
21FJP22
21FJP22A
21FJP22A/ 21GVP22
21FKP22
21GUP22
21GUP22/ 21FBP22A
21GVP22
21GVP22/ 21FJP22A
21GXP22
21GYP22
21GZP22
21HAP22

Replaces 71 types

23VACP22
23VADP22
23VAHP22
23VALP22
23VAMP22
23VANP22
23VAQP22
23VARP22
23VASP22
23VATP22
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23VAWP22
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23VBAP22
23VBCP22
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25AP22A
25AP22A/ 25XP22
25AQP22
25ASP22
25AWP22
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25AZP22
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25BCP22
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Implantable hearing aids

Electronic implants may someday replace conventional hearing aids, a Stanford University ear, nose and throat specialist predicts. The know-how for developing electronic hearing implants is now available, Dr. Richard Goode said, but more animal research is required to evaluate their performance before the devices can be routinely implanted in humans.

At a recent conference at Stanford an association of experts dealt with the problems and approaches of such implants. Dr. Goode states that researchers are now finding out more and more what takes place when sounds are received in the ear and transformed into the neurological impulses that travel to the brain, which then translates these impulses into "recognizable" interpretations—speech, singing, music, and so forth.

One device that will electronically "trick" the brain into thinking it has received 'normal' sound waves is being explored by Dr. Goode and Dr. Theodore Glattke. It uses a basic concept of electrical engineering whereby electromagnetic waves are converted into sound waves. In this case, however, a magnet is implanted on the ear drum or ear bones. A tiny amplifier with a microphone is worn behind the ear, but the earphone is replaced by a small output coil. Amplified electromagnetic waves then radiate from this encased coil to the implanted magnet. As a result, the magnet moves, driving the bones and ear drum, thus producing the sensation of sound.

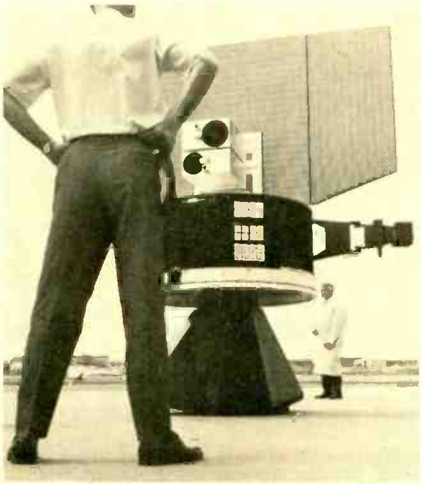
Total implantation, including the amplifier, is not possible now, because of the short life of batteries; however, nuclear power may ultimately provide the answer. Dr. Goode cautioned that routine application of any electronic hearing implants in humans is at least several years away.

Sun watchers

Engineers at Hughes Aircraft are shown checking out a scale model of a new group of Orbiting Solar Observatory Satellites (OSO's) being built for NASA. The new OSO's will accurately point instruments at the sun, 93 million miles away, to help scientists understand how and why the sun, 10,000°F. at its surface, heats up its corona to 4 million degrees.

The primary objective of the OSO's is to investigate X-ray and ultraviolet radiation in the "chromosphere-corona interface", a turbulent gaseous band around the sun. The rise in temperature from the sun's surface is a phenomenon solar physicists know little about, states Dr. Steve Maran, project scientist.

Each spacecraft will consist of a spinning section, called the wheel, and a stationary platform known as the sail. The sail, containing solar panels to provide power, will carry two instruments able to scan the sun or point at any position on it. One, from the University of Paris, will make fine structure studies of the chromosphere. The other, from the University of Colorado, will make high-resolution ultraviolet spectrometer measurements. Both will scan the sun for other "targets of opportunity" such as flares or sunspots when the sun's surface activity is relatively calm. Six experiments, carried in the wheel section, will survey various X-ray sources.



The experiments will be commanded automatically by a memory system programming itself. Ground controllers used to have to wait about 1½ hours for completion of each orbit before they could send new commands to the satellite.

Magnetic tape copy system

DuPont has developed new thermal technology for duplicating video tape that is ten times faster, less expensive, and of better quality than present electronic rerecording methods. The new process uses DuPont *Crolyn* chromium dioxide video tape to produce high-performance tapes with identical properties for both master and copies.

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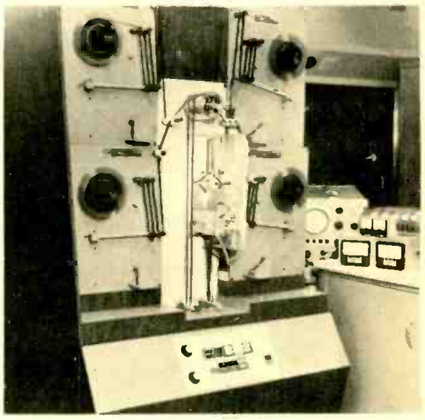

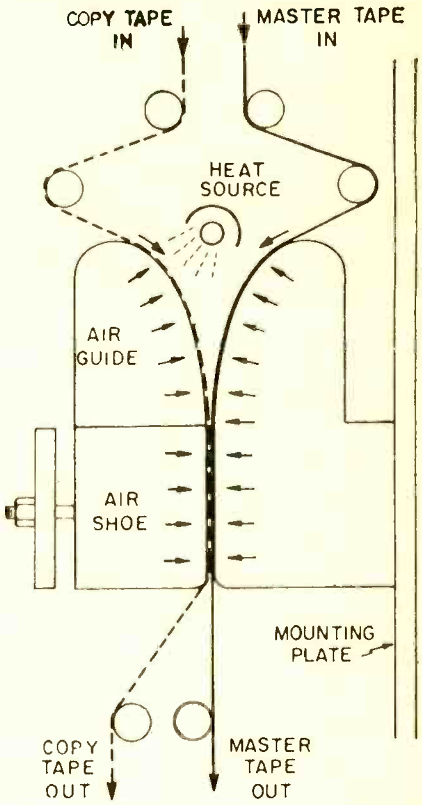

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(continued on page 12)

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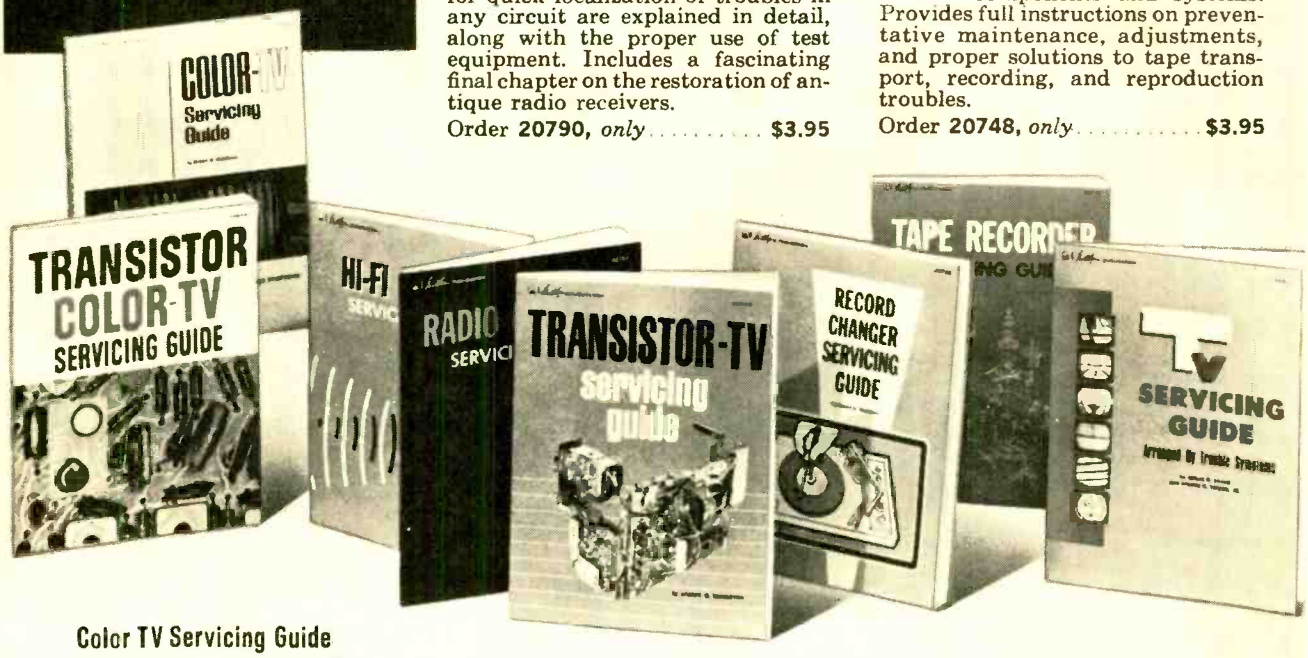

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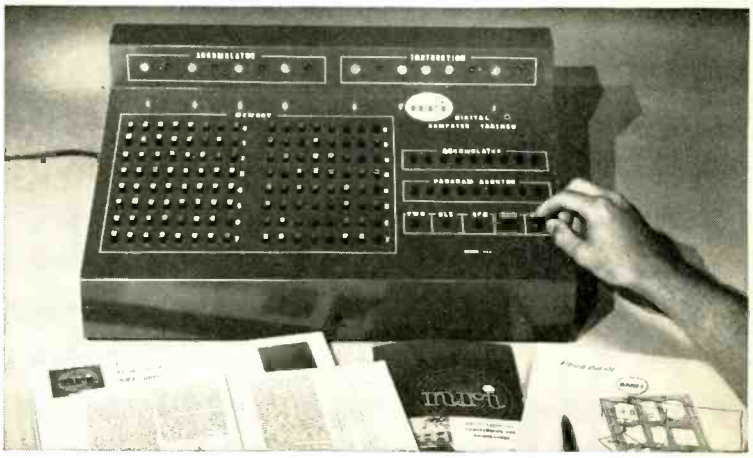

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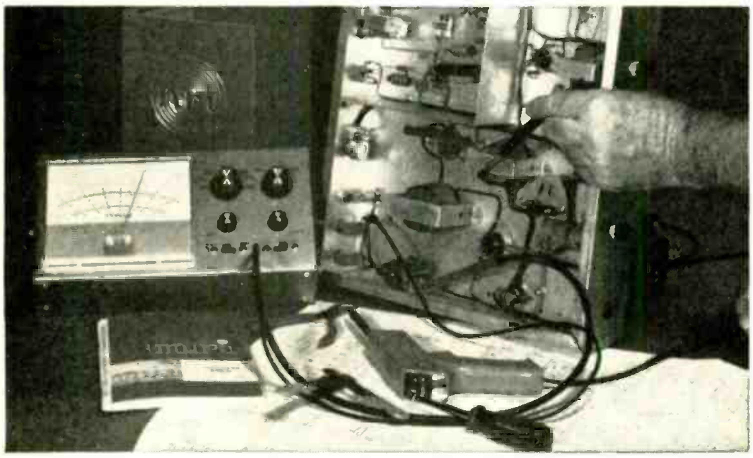

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new & timely (continued from page 6)

netic images can be transferred by a simple heating process.

Thermoremanent research also led to a developmental tape-to-tape copy machine in which the master and copy tapes are drawn together by an air clamp. The apparently simple but ultra-precise machine may hold the key to mass production of video cassettes.

Although DuPont has no plans for manufacturing thermal tape copiers, it intends to continue equipment development in order to assist in the design of commercial models by licensees.

Microwave oven leakage

The Public Health Service estimates that one out of every 10 microwave ovens in home use in the United States last year probably leaked radiation in excess of the industry's own voluntary limits. The estimate was based on tests of almost 5,000 ovens in 25 states.

Leakages in the ovens were due in some cases to faulty design, especially in models built prior to 1968, the agency said. In other instances, shipping damage and consumer carelessness were to blame, according to the report.

Vehicle location system

An electronic system developed by GTE Sylvania allows a driver to report the location and status of his vehicle in less than one second. Using the *digimap* system the driver needs only touch a pressure-sensitive map in his car and a color-

coded indicator appears immediately at that spot on the headquarters map.

"With *digimap*, a dispatcher, who must know the status and location of his vehicles, need not cope with radio congestion. At present police cars, ambulances, taxicabs . . . report their whereabouts by voice when a radio channel is available," explained Robert M. Beebe of GTE Sylvania. "This can delay important messages."

The system also enables transmitting preselected messages such as "send ambulance" simply by pressing a button. They can transmit numerical and descriptive text by typing on the keyboard.

Aircraft electronics

Two new electronic devices were exhibited by GTE Sylvania at the 1971 Air Show in Reading, Pa.

The first is an anti-intrusion system to protect parked aircraft from vandals and thieves and alert airport personnel by a horn, beacon, light, or remote alarm. An attempt to disarm the system would also activate the alarm. This portable set-up has a remote alarm monitor which operates with one or several sensor-trans-

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mitters. One lead is clipped to the metallic surface of each aircraft to be protected and the other lead is grounded. When the unit's antenna is extended the equipment is activated and will function unattended.

The second device is *Sky-phone*, two-way telephone equipment which operates in the ultra-high frequency range and allows passengers to place and receive calls to and from airport facilities or outside numbers while flying at altitudes up to 45,000 feet.

Hugo Gernsback scholarship winner

RCA Institutes has awarded its Hugo Gernsback Scholarship for 1971 to Andrew A. Hoffman, Jr., of Metairie, Louisiana. This award of $125.00 is given annually by **Radio-Electronics** to students at each of eight home study schools of electronics.

Mr. Hoffman is an electronics trainee at Avondale Shipyards in Louisiana. His hobbies are music and theatre, and his goal is to manage and own a television repair service after he has completed his studies. **R-E**

STOP BURGLARS

Three articles in this issue are valuable aids to protect your property. First is a story on how to select an alarm system; it starts on page 23. Then there's a story on how to build a $5 Anti Theft Alarm starting on page 35. Finally, there's a dual purpose, fire and intruder, alarm you can build. That article starts on page 58. Read them, build them and stop burglars.

editorial

This copy of **Radio-Electronics** is different. It may not look very different; the articles in this issue cover the same subjects we've been covering for more than 60 years. But the way this issue was published is different.

The very words you are now reading were typeset by a computer instead of the traditional linotype machine, as were all of the articles this month. For with this November 1971 issue **Radio-Electronics** has taken a giant first step into tomorrow. To you, as a reader, go the benefits of clearer and easier-to-read type, cleaner and more detailed diagrams, and a more-accurately edited magazine.

At the same time we switched to computer typesetting we made other facelifting changes in the appearance of the magazine. We've restyled our presentation for our news features, New & Timely and Looking Ahead. There are newer more readable type faces used for New Products and New Literature. Caption type has also been changed to make them more easily read.

We are especially proud of our Production Manager, Vincent P. Cicenia. He designed and executed the many layout and type changes that have been made.

One most important item has not and will not be changed. The content. **Radio-Electronics** will continue to bring you the same kind of state-of-the-art coverage of the electronics field it always has. As we mentioned earlier, the change is a facelifting to make the magazine more useful to you; we haven't changed the guts of the magazine, and we won't!

All of our staff put considerable time and effort into the change and I'm sure they want to know what you think of it—good or bad. With your comments as a guide we can continue to keep **Radio-Electronics** a modern magazine that provides the kind of reading you want.

Larry Steckler

EDITOR

letters

AUDIOPHILES REPLY

I would like to reply to Robert M. Sickels' letter in your July 1971 issue. He feels that fully one-half of **Radio-Electronics** readers are not audiophiles at all, and that you devote too much space to audio problems and equipment.

Let me refute this by complaining that you do not devote *enough* space to audio matters! In fact, they seem likely to be forgotten among the many articles on CB equipment, color TV, and other topics.

Please accept this plea to keep with it in audio amplifiers, preamplifiers, speaker systems, and other equipment and concerns of the audiophile.

CARL HARTMAN
Newport Beach, Calif.

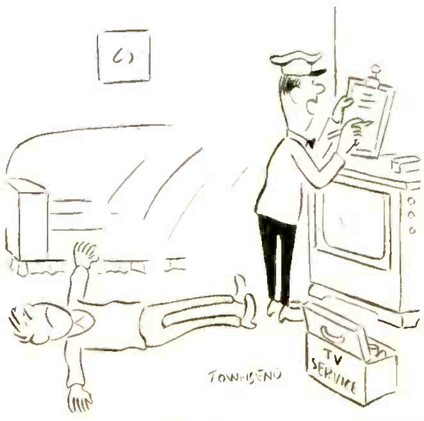
ANTIQUE RADIO BUFFS

Many of our readers write to ask about clubs or associations for antique radio fans. Some ask about a source to purchase antique radios.

We know of only one association, the Antique Wireless Association, Mr. Bruce Kelley, Secretary, Holcomb, N.Y. 14469.

Can you help your fellow readers? Let us know if you belong to an antique radio club, or if you stock antique radios. Give us all the details—name, address, officers, or a general description of your stock.

We will let **Radio-Electronics'** readers in on the facts. **R-E**



"Now don't get the idea this two hundred and thirty is your bill. It's just the number of the semiconductor I need for your set."

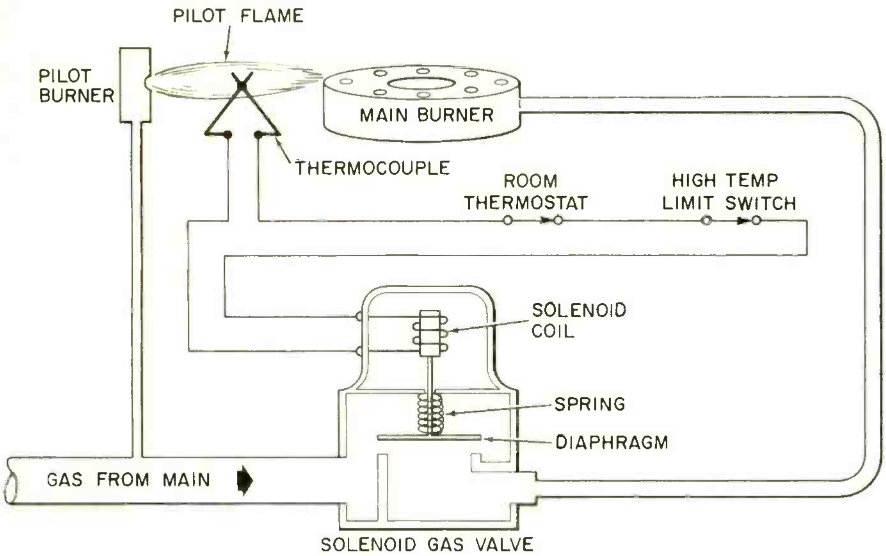
appliance clinic

More on fail-safe—

Millivolt systems

LAST MONTH WE TALKED ABOUT FAIL-safe systems in general and showed big units. Now we come to another version. Much smaller, but basically the same thing. All functions of the devices are exactly the same. There are not as many of them, and they're smaller, but they still perform the same tasks—control the system automatically and provide fail-safe protection for the user. They are found on gas furnaces, gas driers, space heaters, and that kind of thing.

The major difference lies in the fact that many of these are *self-powered.* There is no external 24-volt ac supply to operate the main gas valve. You *will* find "combination" systems, using thermocouple safeties *plus* the 24 Vac valves in some units. However, the one we want to talk about here is the self-powered type. All of the electrical power needed to open the main gas-valve is generated by a small thermocouple. The drawing shows the basic circuit.



The thermocouple itself is mounted on the side of the main burner, usually as a part of the pilot burner assembly. It must be here so it can sense the presence of the pilot flame. No flame, no voltage, and no workee! (Which is the idea of the whole bit!) Fail-safe operation!

If you can see the pilot burner, you'll see that the thermocouple is positioned so it is right in the middle of the pilot flame. Some of the instructions refer to this as being in a ring of flame. This is necessary for maximum heating of the thermocouple.

The dc voltage generated is almost directly proportional to the heat. The pilot burner must be correctly adjusted for a *non-blowing blue flame.* That is, the pilot gas pressure should be adjusted so the flame does not blow away from the orifice. This lowers the temperature. If the pilot flame shows a distinct yellow tinge, it has too much air and not enough gas, and once again the temperature goes down. Instructions for adjusting this flame are in the service manuals. There will be an adjustment for the pilot flame, on the side of the control unit itself.

To go back a little, the original application of this system used a manually-set relay between the thermocouple and the gas-valve power supply. With the pilot burner lit, the relay is closed by pushing a button. If the thermocouple is working properly, it will *hold* the relay closed, although it will not close it. If the pilot burner should go out, the relay drops out, opening the circuit to the main gas valve. This is a manual-on/automatic-off system. It is widely used.

(continued on page 76)

10 Reasons why RCA Home Training is your best investment for a rewarding career in electronics:

Performing transistor experiments on programmed breadboard — using oscilloscope.

equipment report

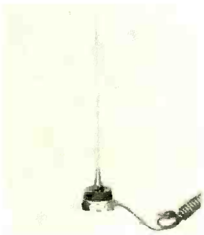
Simpson Model A 2-meter FM transceiver

Hy-Gain MMG-150 mobile whip

Mosely Diplomat-2 2-meter ground-plane

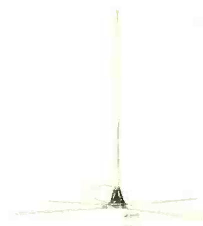
Simpson Model A FM transceiver
Circle 22 on reader service card

BEING AWARE THAT I'M A FAIRLY active ham—I've just replaced the HT-32/75A-4 combination with the new Heathkit SB-102/SB-200—and the Editor asked if I'd do an equipment report



Hy-Gain MMG-150 mobile whip
Circle 23 on reader service card

on the Simpson Electronics Model A 4-channel FM transceiver for 2-meter amateur mobile operation. I jumped at the chance, completely unaware that 2-meter operation and techniques have



Mosley 2-meter ground-plane
Circle 24 on reader service card

changed drastically since I last used my "Benton Harbor Lunchbox" (Heathkit "Two'er") around 10 years ago. Most of my ham activities have been confined to SSB operation on 80, 40, 20 and 15 meters with just enough CW to keep my hand in at the key.

Boy! Two-meter FM is a whole new world! On the bands below 2 meters, you are free to operate anywhere in any band that your vfo takes you and the FCC permits. On the other hand, 2 meters, by "Gentlemen's Agreement" and usage has been divided into 10-kHz channels 30 kHz apart and transceivers use crystal control for transmitting and receiving. You can operate on any channel but not all are active and you'll have to select crystals for the channels used in your area.

The Model A has two 4-channel selector switches on the front panel; one selector for the receiver and the other for the transmitter. When fitted with selected crystals for the transmitter and receiver, you have sixteen transmit/receive frequency combinations. The unit supplied by Simpson for tests came with four crystals. Two for transmitting and receiving on 146.94 MHz—perhaps the most popular simplex or direct channel nationwide—and two for transmitting on 146.34 and receiving on 146.76 when working through repeaters. Yep, repeaters!

When you are barreling along an Interstate highway, you'll find your operating range is extremely limited, especially when working another mobile or the base station "just over the hill". To overcome the limited coverage available from a low-power mobile rig with its near-ground-level antenna, some ham groups have installed repeaters on elevated sites. These transmit/receive devices generally use high-power transmitters and high-gain antennas to greatly increase the operating range of most installations.

(continued on page 88)

STOP BURGLARS WITH ELECTRONICS

Pick The Right System For You

There are all kinds of alarm systems. Some work better in one type of installation than another. Get the system that will deliver for you

by JIM SQUIRES

AN EMPTY RATION TIN HANGING ABOVE THE MUD FROM a roll of barbed wire in front of the trenches might have worked in 1916 as an intruder alarm, but today the image of security has changed. Though all of the basic parts of a good security system were there, electronics did for the tin can what Cleopatra did for courtship.

Modern intrusion detection systems have become so sophisticated that that problem has swung from one of insensitivity to changes in the outside world to oversensitivity in the guise of that dirge, the false alarm. Combinations of intrusions systems then can provide virtually foolproof safety. Company management, like the homeowner, realizes that the up-to-date thief is stealing the pants off the corporate image.

Alarm systems may be classified according to the area they are designed to protect. Thus came the names of **spot, perimeter** and **volume** detection systems. As it was with the banging tin can, all alarm systems have certain things in common. They include the sensor or transducer, in this case an empty tin can sounding against the wire, a communications media, noise of the racket traveling through the air for our primitive system and finally, a response action, a guy sweating in a trench with his finger on the trigger. New alarm systems are sophisticated to the point that they will respond with an alarm if a scrap of paper ripples off the desk onto the floor.

Spot or point protection devices are only useful where the entry or intrusion point can be anticipated as from a window, door or sky light. They include such defenses as foil tapes along the edges of the window glass guarding against both broken glass as well as actual opening of the window. Each window and protected opening is placed in one continuous closed circuit. Wiring can be included to indicate at which window entry was affected. Again, as also true with the spot detectors, a burglar may cut through a wall unnoticed by this type of system.

Other spot detectors include special floor mats, stress sensors mounted under the floor joists so that pressure on the floor above sets off the appropriate alarm. Panic buttons and special medical assistance call-buttons may be wired to this basic system or may be interconnected with a more sophisticated central security system.

Regardless of the complexities, intrusion detection can be subdivided into three basic components. They are the detector or transducer, the communications link and the monitor-responder components. In the original example, the tin can was the detector, the sound waves the communication, and the waiting soldier the responder. Any system, no matter how basic its transducers might be, when linked through communications to a massive responder system consisting of an entire police contingent forms quite an effective security wall. The most reliable form of security protection arises from the use of two or more types of systems backing up each other. For example, perimeter protection might be used to back up an ultrasonic volume system.

Perimeter protection may also form a component of a larger closed-circuit protection network which might include tape switches mounted under the rugs, mat switches, driveway and window-sill switches, all wired so that any switch opened by an intruder would set off the alarm. A closed circuit of this type might also include window foil and special valuable object pads. These pads are designed to open or close a circuit when an item resting on the pad is removed by a thief. Perimeter systems can also be buried in the ground alongside a protective fence or between buildings in likely paths of movement.

Several firms offer perimeter protection of any fenced area through the use of motion sensors placed at 30-foot intervals along the fence perimeter. An intruder, shaking the wire apron of the fence effectively causes the sensor in that section of the fence to open circuit. An additional wire to the sensor enables the security console operator to determine which sensor has open circuited. The fence sensors can be adjusted to "open" at any preselected vibration sensitivity, being careful not to adjust them so fine that a wind sets off the alarm.

Photoelectric devices

Early versions of the photoelectric optics for perimeter protection included beams of visible light, easy to detect and easy to avoid. Modern photoelectric systems have gone to invisible infrared light beams of coded pulses of light that have built-in delays designed to allay false alarms caused by falling leaves, twigs or small birds. Effective range of these transmitter-receiver units starts at 200 feet and may go as high as 500 feet for some units. Rigidly mounted mirrors are used to bend protective beams around corners and are available from photoelectric manufacturers. Available today is a miniature infrared "eye" photoelectric system with a range of 50 feet in which both the receiver and transmitter units fit into standard wall outlet boxes using decor matching faceplates. Battery powered, both the transmitter and receiver will operate continuously for one year.

Volume detectors

A third prominent method of detecting intrusion into home or business deals again basically with motion. All *volume* detectors are motion detectors and will give the same alarm for Boss as well as Burglar.

Under the broad title of volume detectors are the infrared, the ultrasonics, the radars, and on a somewhat less reliable scale, the passive light and sound detection systems. While they provide the best possible protection available, they are also most vulnerable to false alarms. Combinations of the acceptable features of each of these systems produces a reasonably reliable intrusion protection system.

Infrared systems

Development of the infrared diode has elevated "black light" techniques above the old infrared filters of a white light source and made them extremely useful as perimeter and volume intrusion detectors.

One modern infrared transmitter produces a conical beam that spreads to twelve feet in diameter at 400 feet. Any portion of the beam, three inches in diameter, reflected back to the receiver for a period exceeding 60 milliseconds will operate the alarm. The infrared produced by a gallium arsenide diode beam is pulsed at a rate of 2 kHZ and directed to a reflector. Range of the unit, up to 400 feet, depends on the reflector system used.

One passive infrared intruder detector has no transmitter but continually monitors the normal ambient level of infrared energy in the room. An intruder either entering or leaving the area and moving at a rate of 1 foot/second or faster changes stable reference infrared conditions and initiates an alarm condition. This model protects an area approximately 20 by 20 feet. As with most security devices, an alarm is also sounded if the instrument cover is removed or cables are cut.

Assuming the intruder could avoid passive infrared scan or a cone of active infrared light, an ultrasonic motion detector might be the next step.

Doppler shift

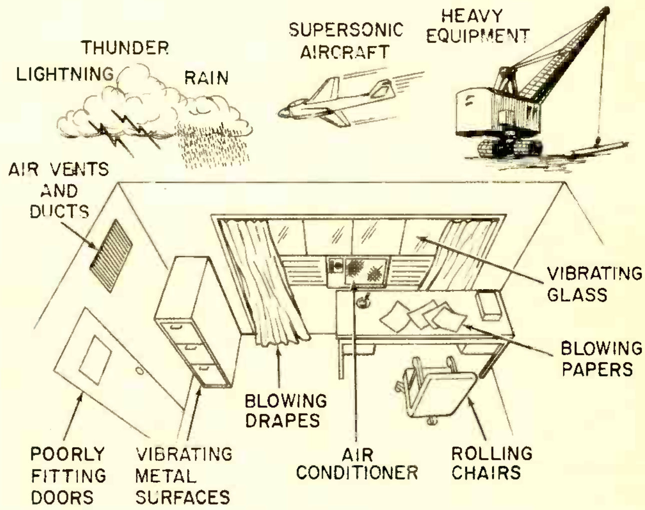
Microwave, radar, ultrasonic and certain types of infrared alarm systems all work on the Doppler frequency shift principle of detection. It is based on the principle that any motion within a fixed frequency field will alter the reflected frequency pattern back to the receiver by some measurable amount. This will shift the frequency either higher as the object approaches the transmitter or lower as it moves away. This difference, measured by some sort of phase-shift detector, is the magnitude of the output of which is interpreted by the alarm unit as some mode of intrusion ranging from air drafts to human intrusion. Filter circuits located ahead of the phase detector admit only those frequency shifts necessary for detection.

Ultrasonic detectors

Operating in the range of 18 to 45 kHZ (high-frequency sound waves) the ultrasonic detector produces a protection pattern roughly shaped like a football, typically forty feet or less in length and fifteen feet across. Ultrasonics, due to the nature of the sound energy pattern, unlike microwave radars, is a contained system within the room housing the transmitter-receiver unit. The motion of a human in the ultrasonic field will cause a reflected energy shift of about 40 Hz.

This shift from the radiated frequency pattern is detected by the phase detector and is enough to trigger the alarm cir-

FALSE ALARMS can result when an intruder alarm is triggered by something other than an actual intruder. Some of the kinds of things that can cause false alarms are shown in the diagram below. The table shows which types of systems are susceptible to which kinds of false alarms.



CAUSES OF FALSE ALARMS

GENERAL CAUSES OF FALSE ALARMS FOR VARIOUS DETECTOR SYSTEMS

Detector System	Moving Walls, Drapes, Office Equipment	Electronic Jamming	Weather Changes	Defective Electrical Equipment Other Than Alarm System	Moving Animals
Point or Spot	No	No	No	Yes	No
Perimeter	No	No	No	Yes	No
Area	No	No	No	Yes	No
Light	No	No	No	No	Yes
Sound	No	No	No	Yes	No
Impedance Change	Yes	Yes	Yes	Yes	Yes
Ultrasonic	Yes	Yes	Yes	Yes	Yes
Radar	Yes	Yes	Yes	Yes	No

cuit. Transducers for lower frequency ultrasonic units are either directional or omnidirectional high-frequency tweeters. Those ultrasonic units operate below 25 kHZ. the upper limits of animal (dogs) hearing, so we might expect that a dog could detect the operation of the system. As the frequency goes higher, piezoelectric crystal transducer units (see schematic), often a silver-coated chip, are used.

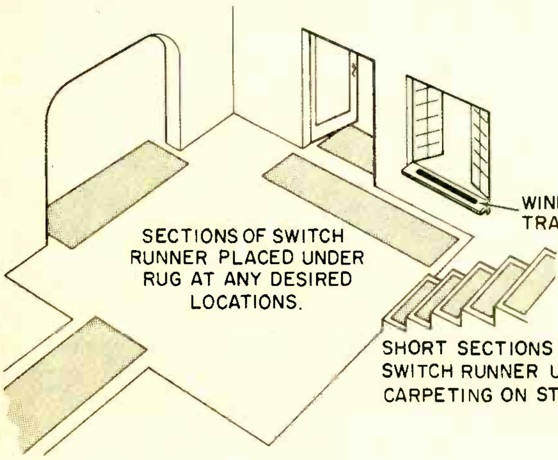
A somewhat older technique uses the magnetostrictive transducer resulting in less sensitivity to motion within the protective ultrasonic pattern than with crystal transducers.

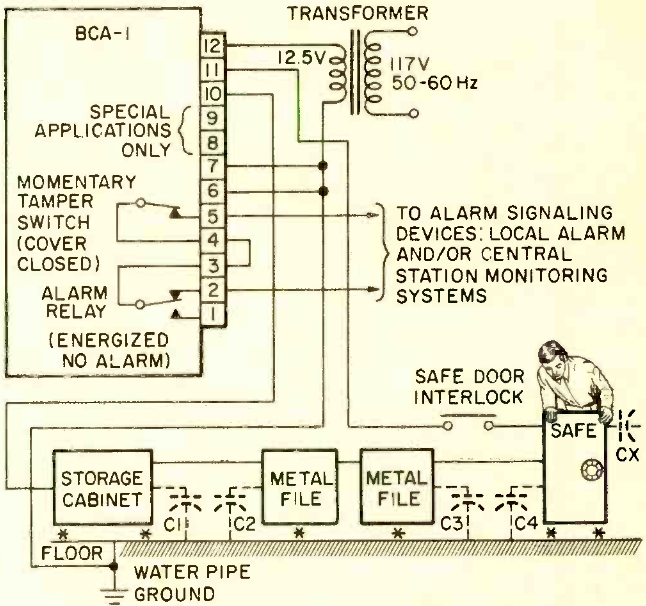
Regardless of the system used, the possibility of false alarms, defined as any alarm generated by the system other than for the intended security purposes, must be examined. Since ultrasonic energy is contained within the protected room, the characteristics of the room play an important part in the false alarm picture.

The room may be either 'hard' or 'soft,' these terms referring to the structure of the room. Hard rooms, that is, rooms filled with glass, polished floors, large metal surfaces, result in more false alarms than do comparable soft rooms where there are rugs, draperies, cork walls and other softer construction materials and furniture. As the absorption characteristics of the room change, so can it be expected that there will be a change in the ultrasonic pattern in both range and coverage provided by a particular setting of the range control of the unit. Noise and room temperature will to some extent also influence reflected frequency shifts and in some cases introduce false alarms. Drafts of air passing through the main

SIMPLEST DETECTOR IS a pressure switch. These units are available in tapes, mats and other forms. The diagram shows several ways these materials can be used. The table below lists various types of detectors to protect against intruders along with a listing of the appropriate transducer.

CAPACITANCE ALARM SYSTEM (at right) is normally used only in industrial applications. Other systems that can be used for the home as well as office and industrial applications are presented in the table at the bottom right. The type of detector, how it works, and some comments on cost and problems are listed.





*NOTE: SAFES, FILES AND CABINETS INSULATED FROM FLOOR. CAPACITANCE BETWEEN FLOOR AND THE SAFE, FILES AND CABINETS IS DESIGNATED AS C1, C2, C3, AND C4 (DASHED LINES). CX IS ADDED CAPACITANCE OF INTRUDER TO CABINET.

DETECTORS AND RELATED TRANSDUCERS

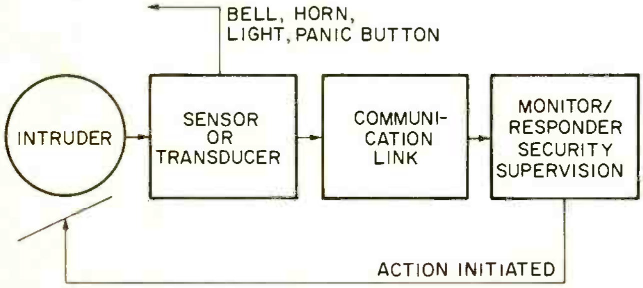
Detector	Transducer
POINT	
Point Entry	Foot switch
	Reed switch
Vibration	Mercury switch
Pressure	Diaphragm
Fire	Thermocouple or thermistor or low-melting-point metal
PERIMETER	
Photo-electric	Photo-sensitive diode
Strip Switches	Switches—normally open or closed
Infrared	Infrared filter
Infrared	Gallium-arsenide diode with reflectors
VOLUME	
Ultrasonics	High-frequency tweeter speakers
	Magneto-restrictive device
	Piezoelectric crystals
Radars	Quarter-wave-length antenna with corner reflector
Microwave	¼-wave and ¾-wave antenna rods

ELECTRONIC DETECTORS FOR HOME, OFFICE AND INDUSTRIAL USE

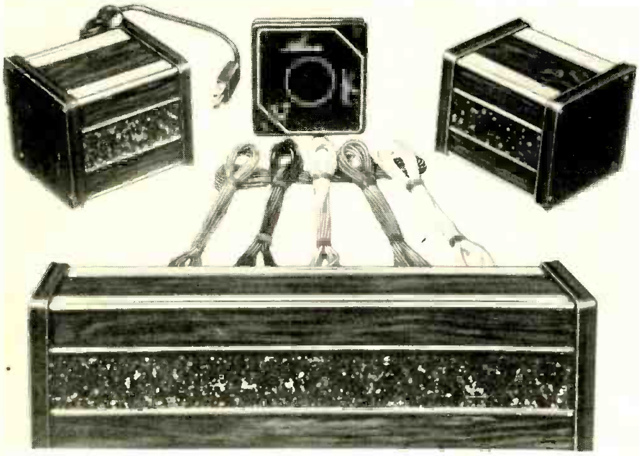
Detector	Mode	Comments
Point or Spot	Electrical Contacts	Low Cost
	Pressure Pads	Low Cost
	Aluminum Tape	Medium Cost
Perimeter	Visible Beam Light	Coded, Moisture Affected
	Infrared Beam Light	Coded, Moisture Affected
Areas	Mirror Deflected Beam	Coded, Precise Alignment
Volume	Light Sensor	Low Cost
	Sound Sensor	Low Cost
	Impedance Change	Low Cost, Simple
	Ultrasonic	Small Volumes
	Radars	Expensive

part of the elliptical radiated pattern create false alarms. A window, for example, left slightly open causing an air draft to blow the curtains will trigger the ultrasonic alarm. Small animals, such as cats or mice, also set off the alarm though the owner isn't aware that there are animals on the premises.

Ultrasonic transmitter-receiver units must be mounted away from vibration. Heavy street traffic, large in-plant machinery or earth moving equipment in operation near the ultrasonic chassis will cause false alarms. Doors or slamming files located near the wall on which the unit is mounted will also trigger false alarms.



BLOCK DIAGRAM OF BASIC ALARM SYSTEM shows what must be present to have an effective alarm system. Not all systems include all of these features.



ULTRASONIC ALARM SYSTEM is made by Delta Products. Transducer unit is in foreground. Remote horns are shown above.

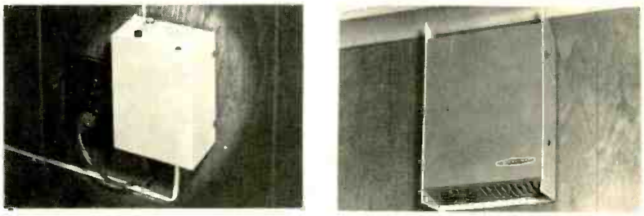
CAPACITANCE ALARM SYSTEM IS SHOWN in block diagram at right.

SCHEMATIC OF ULTRASONIC Delta Products model 10,000 alarm system.

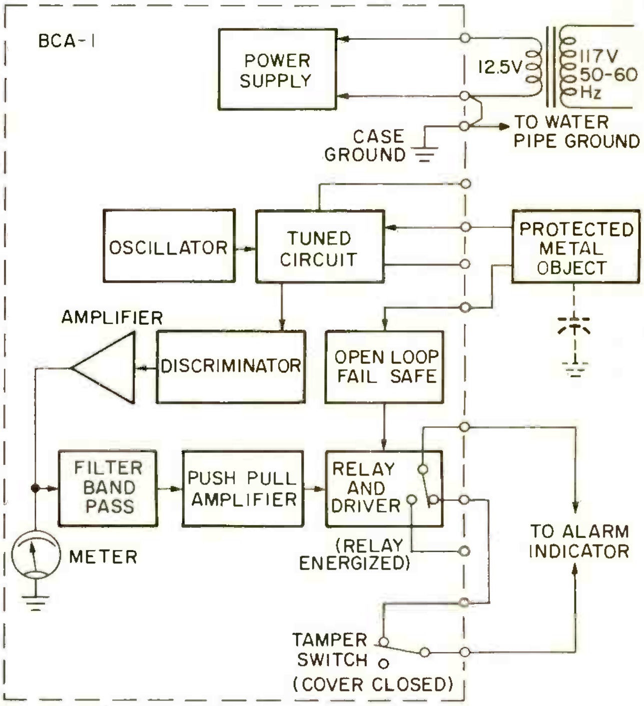
Radar and microwave detectors

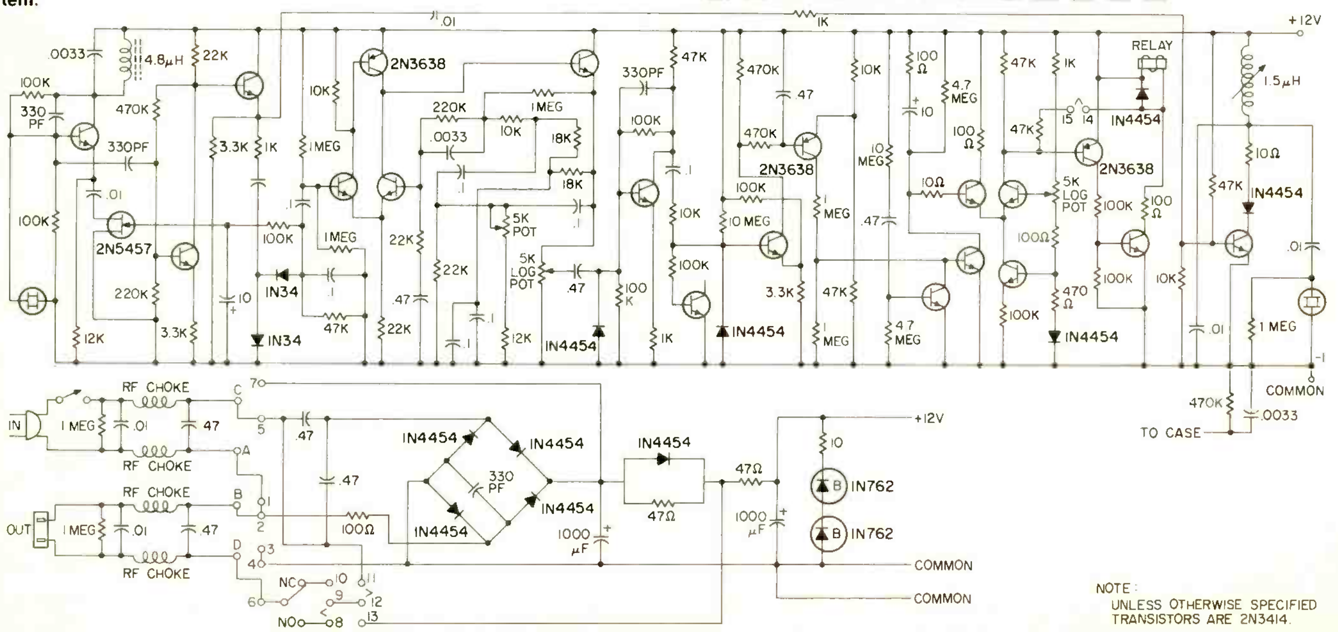
Starting somewhere in the region of 400 MHz or 75 cm and going to 500 MHz and beyond, radar security systems protect a volume represented by an area up to 3500 square feet on the floor. It has two modes to its alarm system. They are "motion detected" which is human movement in the field for 5 seconds or less and a "motion persisting" mode if the motion continues beyond this time. Reset time for this alarm is adjustable from 5 to 200 seconds.

As we move up the frequency scale from infrared to microwave intrusion devices and the energy wavelength shrinks,



HEATHKIT HOME PROTECTION SYSTEM includes these two elements among its many options. At right above is smoke detector model GD-87. Above left is utility transmitter GD-97.



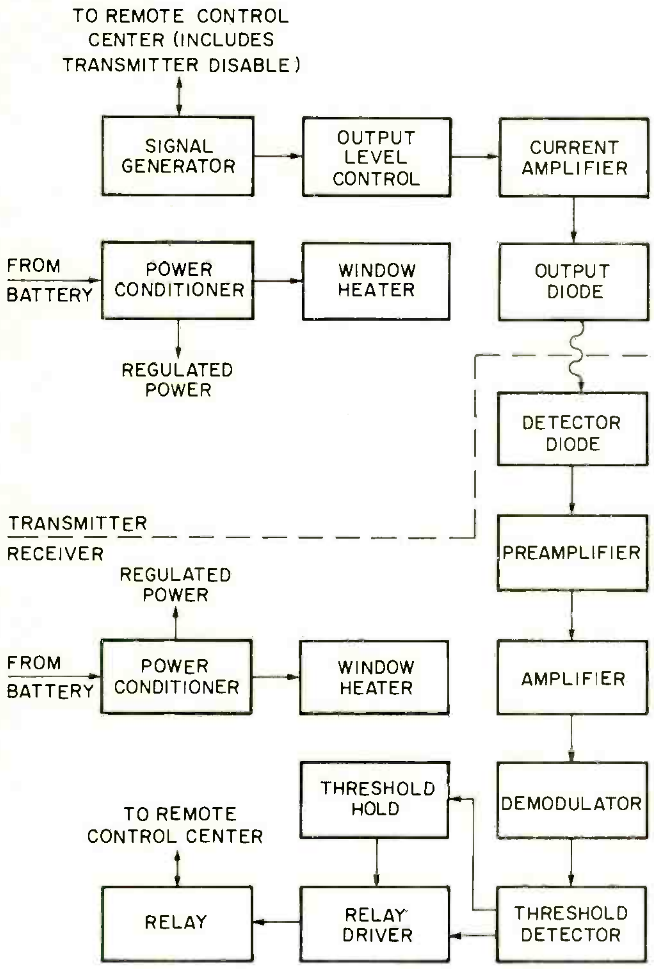


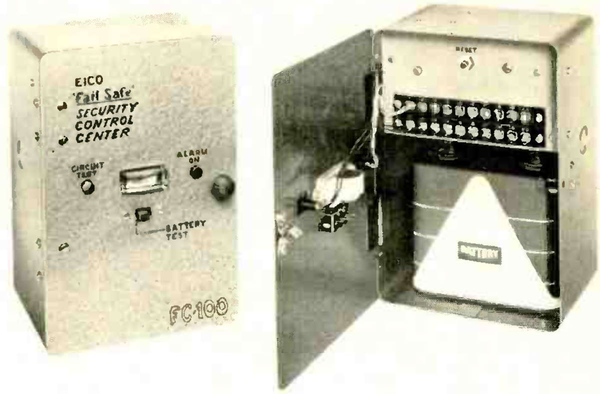
the types of surfaces that reliably will reflect the microwave energy become fewer and fewer. Shorter wavelengths penetrate glass and certain walls and doors. This means that exterior things in motion will now be detected or seen by the microwave and radar protection devices. Jet aircraft flying at twenty thousand feet have triggered some systems. Moving walls, rustling leaves, all are prime suspects for false alarms. Installation procedure matures from a box that you unpack and switch on into a careful study of the premises and a thorough knowledge of the equipment prior to any activation of the security system.

Complete control systems

Some companies offer complete surveillance and supervisory security systems. One typical system will function with any switch protected areas such as a freezer, doors or windows, water-pressure sensors and fire alarm and smoke devices. A single console security cabinet uses a number of modular alarms and one warning horn or other audible signaling device. The power supply is external to the main console. The alarm module features horn turn-off but will not reset a warning light until the cause for the alarm has been

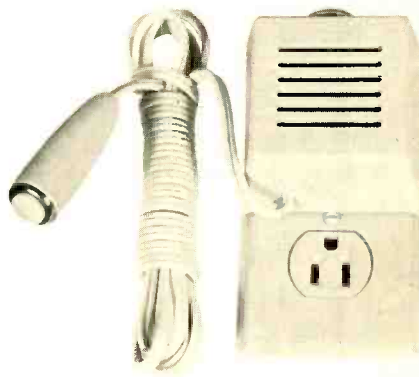
(continued on page 94)





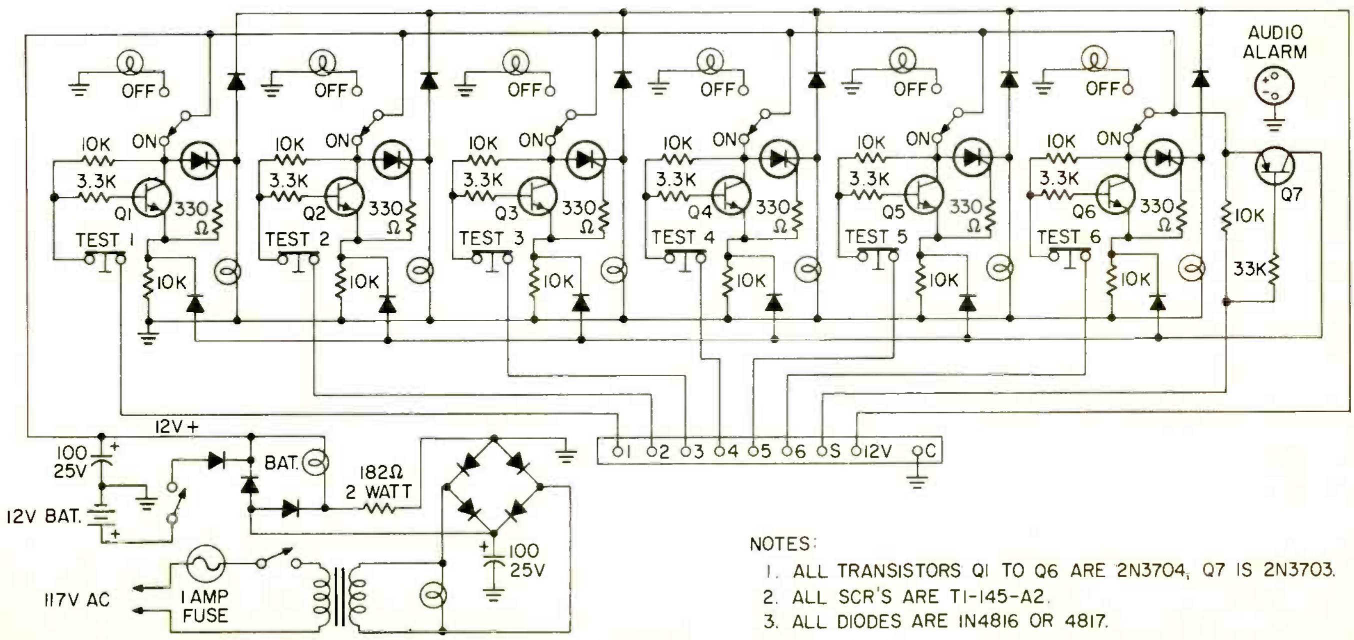
EICO FC-100 (above) is part of their new security system.

INFRARED intrusion detection system (left) shown as a block diagram.



PANIC ALARM (right) is part of Functional Devices wired-wireless system.

RECEIVER SCHEMATIC of multichannel unit made by Airspace Devices Inc. The receiver shown is a 6-channel unit.



NOTES:
1. ALL TRANSISTORS Q1 TO Q6 ARE 2N3704, Q7 IS 2N3703.
2. ALL SCR'S ARE TI-145-A2.
3. ALL DIODES ARE IN4816 OR 4817.

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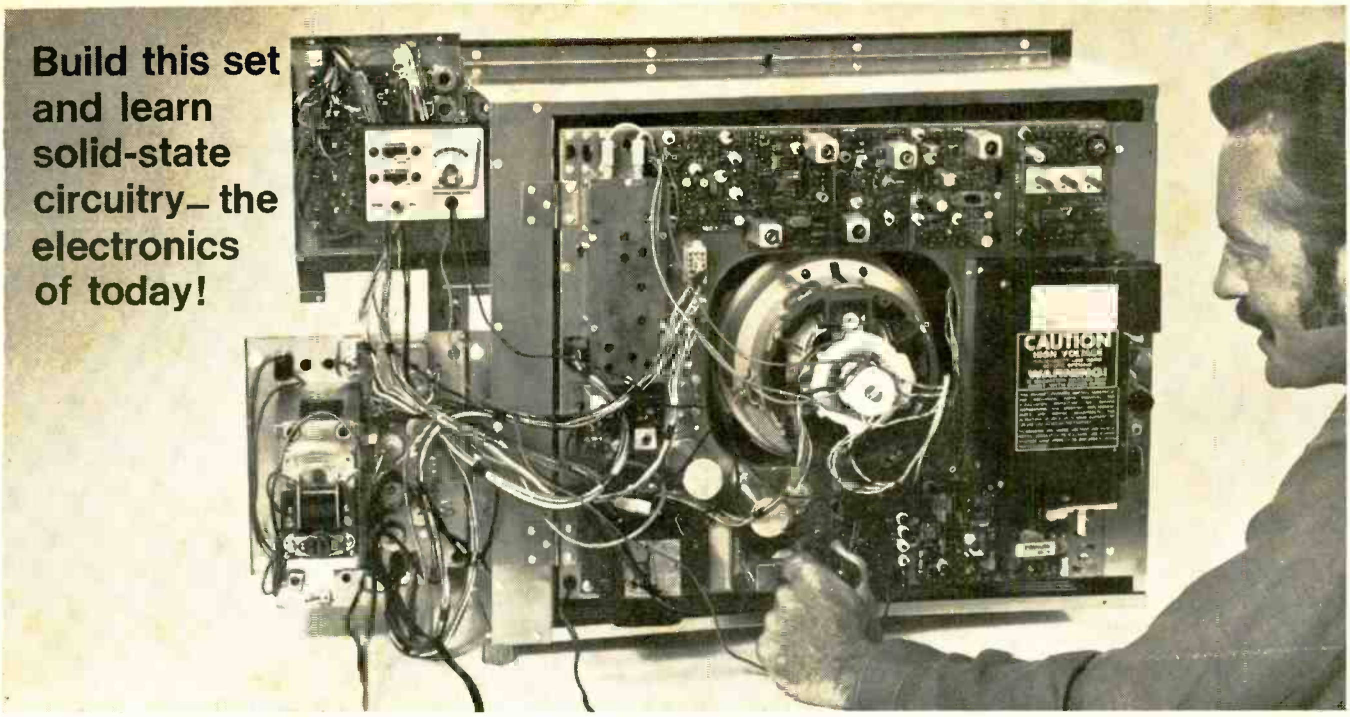

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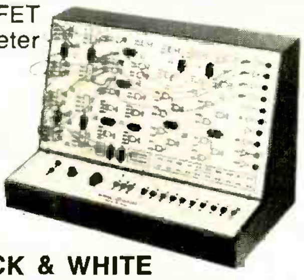

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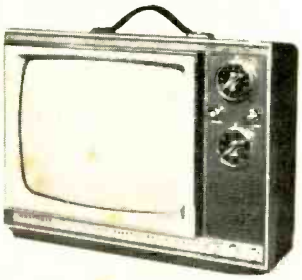

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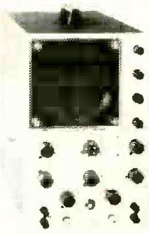

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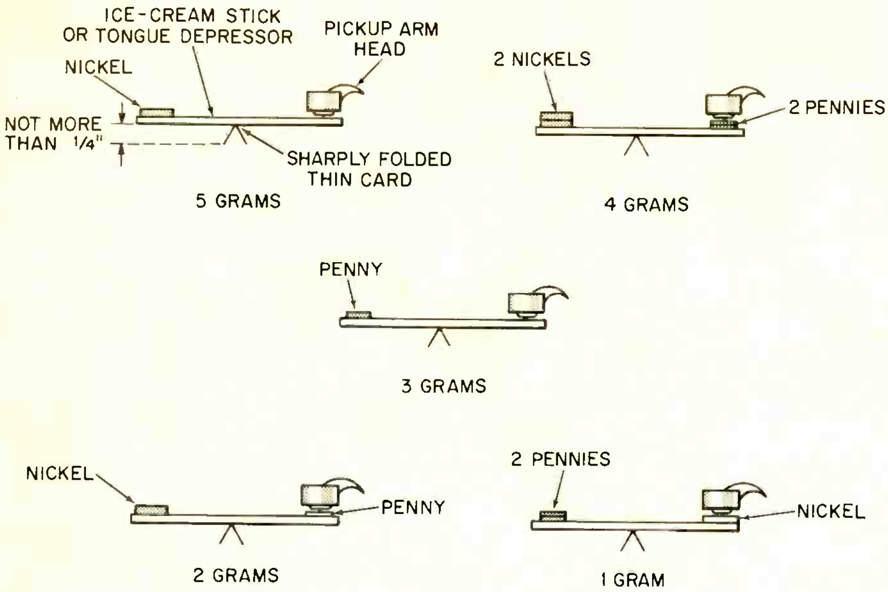


Pickup arm, turntable, stylus and cartridge are vital to hi-fi. Here's how to check and adjust them

STYLUS FORCE GAUGE improvised from a few coins and Popsicle stick.

by PETER SUTHEIM

A TURNTABLE HAS POSSIBLY THE SIMplest job in the whole record-playing system: to turn the record around. But it must do that at a constant and accurate speed (within 0.2% or better) of the nominal speed and with an absolute minimum of vibration, which would be heard in the speakers as rumble. These requirements mean that all running surfaces must be smooth and clean. Where the drive to the turntable platter depends on friction—as between a rubber-tired idler and the inner rim of the platter, or on a belt between pulleys, the surface must also be free of oils, including skin oils. The flutter, wow and rumble performance of the turntable depend heavily on the condition of the rubber or cloth materials used in tires or belts. Worn, cracked, glazed or sticky belts and idlers should be replaced. Go very easy on lubrication here. Be careful not to get oil onto any rubber or rubberized cloth materials—especially not on drive surfaces. If some oil does get on, wipe it off immediately with a clean, dry rag and then clean off the residue with alcohol (isopropyl or shellac thinner is ok) or ethyl chloride, or some other greaseless solvent. A small drop of oil on the shafts of idler wheels or pulleys is not likely to be harmful, as long as the manufacturer's instructions don't expressly say otherwise. Use sewing-machine or household oil for delicate parts, SAE 10 or equivalent for motors or heavier parts. In the absence of instructions, if the motor itself has oil tubes or holes, feed it a few drops into each opening. If it doesn't, don't worry about it; chances are it's designed not to require oiling. Where surfaces to be oiled are exposed, clean off old oil and accumulated dust and grit with a clean dry rag before reoiling. If the surfaces are badly gunked up, use a solvent to help clean them (alcohol, benzene, odorless paint thinner, ethyl chloride, etc.).

To check the performance of a turntable, you need nothing more than a stroboscopic disc and a watch (a stop-watch is helpful but not necessary). A strobe disc or card is available from many audio dealerships and mail-order houses; some turntables even have them built in. When the turntable is turning and the strobe disc is viewed by 60-Hz fluorescent or neon light, the pattern of lines on the disc will appear to stand still, *if* the turntable speed is accurate and constant. If the lines appear to rotate in the same direction as the turntable, the turntable is running fast; if they appear to move in the opposite direction, the turntable is slow. If the movement is irregular, or seems to pulsate, the speed is not constant, and you may hear wow or flutter if the variation is great enough.

To measure speed error, establish a fixed reference point. For example, bend a piece of stiff wire into a pointer and tape it to some stationary part of the turntable. Put a record on the turntable, drop the strobe disc over it and then set the tone arm down on the outer edge of the record. Start the turntable, giving it a few seconds to come up to speed, and then begin counting the number of lines that appear to pass the reference point in one minute. Approximately 14 to 15 lines per minute at 33⅓ rpm represents a speed error of 0.2%, which is acceptable for all but the most critical needs. In fact, if yours is not the most musical ear, you may not be disturbed even by an error as great as 0.5% (about 35 lines per minute).

The test is not valid for many turntables unless you are actually playing a record with the stylus force set to its normal value. The friction between the stylus and the walls of the record groove can exert a surprising drag on the turntable's rotation. This drag is greatest at the outer grooves. (The slowing effect of the stylus friction bears little correlation to the brute power of the motor. One of the best turntables in this respect is one driven by a little synchronous motor hardly more powerful than a clock motor, while some heavy "transcription" turntables with massive induction motors slow down noticeably when the stylus is set on the record.)

If your turntable has a continuously variable speed adjustment, you can use this strobe check to normal the speed control, so that precise 33⅓-rpm speed is set exactly at the index mark of the speed control. Check the manufacturer's instructions about how to do that.

If your turntable has only fixed speeds, a speed error of a few tenths of a percent is probably due to wear or slippage, and can perhaps be cured by replacing drive parts. In turntables with 2-pole or 4-pole induction motors (rather than synchronous motors), speed error can be caused by excessively low or high line voltage.

A thrusting or jerking motion of the strobe lines will probably be heard as wow and indicates unevenly worn drive surfaces or slippage of some sort. Careful cleaning, judicious oiling, or replacement, should clear up such troubles. You should bear in mind, though, that some turntables may have design defects, and certain speed errors or fluctuations may be inherent. If you can't *hear* wow or flutter when listening to piano music, don't worry about what your strobe check turns up.

The next thing to check is the pickup arm or, more properly, the pickup arm/cartridge system. It must move very freely in horizontal and vertical planes, and it must be properly balanced and adjusted for the correct stylus force.

In any good modern pickup arm, the pivot friction should be so low that it can't be measured with any devices you're likely to have around the shop. But if the tonearm sticks or skips frequently on different records, you can be sure something is wrong.

Set the stylus force to zero, if you can. The arm should float freely and remain where you move it. If it drifts constantly toward or away from the center of the turntable, or up or down, it is not properly balanced, or the turntable is not level, or the cartridge wires are tugging at the arm. If it sticks, there is pivot friction or the wires are hung up on something or are too stiff. Assuming that the pickup arm was properly designed, high pivot-friction is probably a sign that it has been dropped or otherwise abused. A good arm is built with the precision of a watch. Unless you know what you are doing and have a delicate sense of touch, you may not be able to do much. Lubrication seldom helps in a good arm, though it may in cheaper ones.

When you are satisfied that the arm moves freely, run through the balancing procedure, if there is provision for such an operation in your unit. Adjust the counterweight till the arm balances horizontally. If you can't balance the arm within the range of adjustment, your cartridge is probably unusually heavy. Simply fasten a nickel or a quarter to the counterweight and try again. Now adjust the stylus force to the value recommended for the cartridge you are using. If you don't have specific information, 2 to 3 grams is a good place to begin. Manufacturer's calibrations are usually within 10% or ¼ gram, close enough.

If your arm has no calibrated stylus-force scale, use any accessory stylus-force gage, or improvise one (Fig. 1). A U.S. penny makes a good 3-gram weight, and U.S. nickel a 5-gram weight.

While there are cartridges that will track most records at 1 gram of stylus force or less, it's well to remember that too low a stylus force wears records at least as much as one that's higher than necessary, because of skipping and scuffing at high stylus

PIONEER PL-41D broadcast-type turntable is belt driven.

THIS SONY TURNTABLE is servo-controlled.

THORENS TD-125 transcription turntable has transistor-governed synchronous motor.

velocities. Too little force can also introduce audible distortion.

An excellent way to establish the lowest practical stylus force for your arm and cartridge is to use a test record such as the one made by *Stereo Review*, or the Shure "Audio Obstacle Course." These records provide music or tone-modulated grooves at stepwise increasing levels; if distortion is audible on any but the highest-level (highest stylus-velocity) bands, you should increase the stylus force as much as necessary to eliminate the distortion. This approach is much better than blindly setting the stylus force at the lowest value given in the manufacturer's literature, which is often optimistic.

We've been assuming so far that you know your stylus is in good condition. If it has logged more than a few hundred hours' playing time, or if you suspect it for any reason, you should check it with a high-powered magnifier or a pocket microscope. Look for chipped-out places or flat spots. A good, new diamond stylus should be smoothly rounded and polished. (An elliptical-cross-section stylus will not, of course, be evenly rounded, but all surfaces should still be smooth.) Since a badly worn stylus can ruin a record in one playing, replace the stylus if you have any doubts.

It is also helpful to clean the stylus. If you play records in dusty air, some fluff will accumulate on the stylus during every playing. Touching the fluff with a fingertip should dislodge it immediately. In heavily polluted air, such as in industrial areas or where a lot of smoking takes place, the area around the stylus tip will in a few weeks or months become encased in crud. Dissolved that off with a small, soft-bristled brush and some alcohol.

NORELCO MODEL 202 electronic turntable has 3 speeds controlled by electronic circuitry.

SONY SOLID-STATE TURNTABLE has dc motor with variable-voltage control from an ac generator.

Finally, when you insert the new stylus, or reinsert the old one, see that it looks centered in its channel. Then place a small pocket mirror on the turntable and set the pickup arm down on it. The stylus point and its reflection should form a straight line. If they don't, the arm or cartridge may be incorrectly mounted, or the stylus cantilever may have become bent or twisted. This can cause distortion and accelerate record wear.

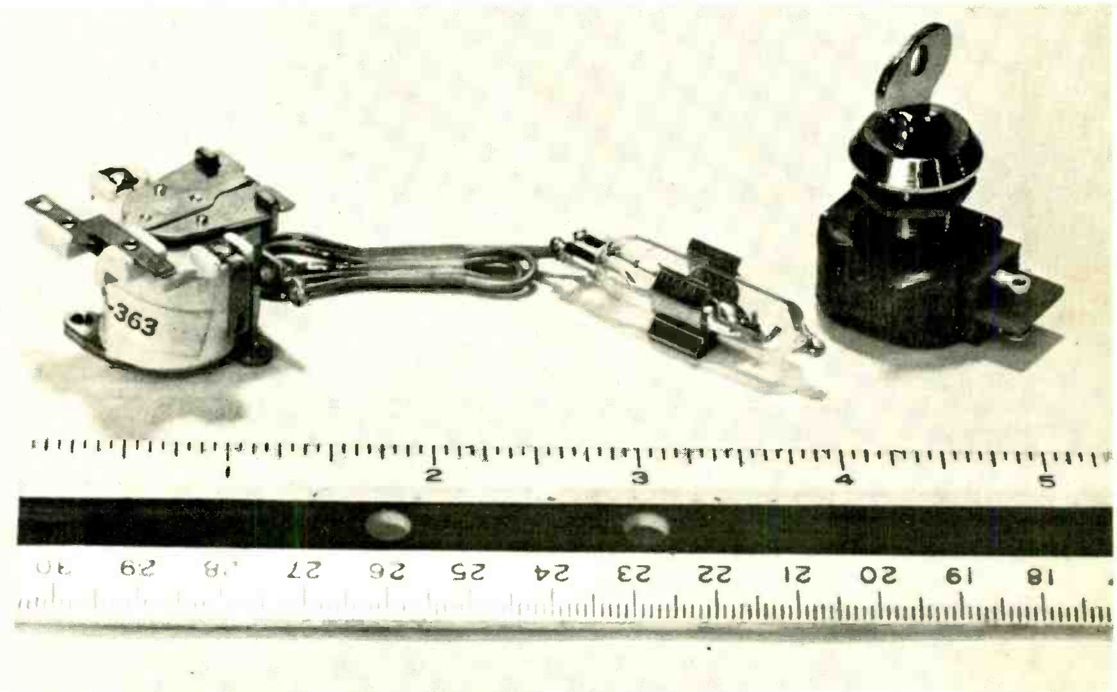
Most manufactured record changers and other turntable/arm combinations incorporate at least a moderately effective shock mounting. When arm and turntable are purchased separately, however—especially when the turntable has no special provision for mounting an arm—the installation is often very susceptible to vibration and mechanical shock. For shock mounting to be at all effective, and to keep rumble to a minimum, the mounting board for the turntable and arm must be rigid, in one piece and as massive as possible. (Many professional turntables use ¼-inch steel plate or heavy castings.) The springs, shock mounts, foam rubber or whatever else you use as the compliance part of your shock-mounting system should be chosen so the mounting board (with the turntable and everything else on it) can bounce once or twice when bumped down with a finger. If the mounting board is rigid and heavy enough, you may not need springs or rubber. Try to install the turntable in something solid, someplace where the floor doesn't give when walked upon. And, for most turntables and arms, the installation must be level. A bubble level from any hardware store will help you get the mounting board perfectly horizontal.

Keep dust and peanut butter and jelly sandwiches off your records and turntable. Really dirty records and turntables mats can be safely washed with cool water and a little mild soap. Don't scrub records—do the washing with just your hands. Take rings off your fingers first, though.

If you're troubled by pops, clicks, buzz or hum in your system when you play records, try grounding the pickup arm or the entire turntable assembly to the amplifier chassis or to a water-pipe ground. Sometimes hum can be reduced by "lifting" the shield connection on the pickup cable for one channel or both, and using a separate wire from turntable chassis to amplifier chassis instead. And sometimes not. Hum is a funny thing, and you may have to experiment here.

Radio-frequency interference, from a nearby ham, CB or broadcast transmitter, can often be reduced through simialr experimentation. Try cleaning and polishing all friction connections (phono plugs, slip-on cartridge clips and such), or, as a last resort, altering the lengths of the connecting cables. (A piece of wire a few feet long, grounded at one end, can make a dandy accidental CB receiving antenna).

A loud "pop" when the turntable motor shuts itself off can usually be reduced by connecting a capacitor (0.1 μF, 600 volts) across the automatic shutoff contacts (also across any offending manually-operated switches.) **R-E**



Build A $5 Vehicle Alarm System

Protect motorcycles, boats and maybe even bicycles against theft with this simple, but effective alarm

by HOWARD PHILLIPS

THIS THEFT ALARM IS DESIGNED for use on motorcycles, or boats with 6- or 12-volt ignition systems having either positive or negative grounds. It is inexpensive; all new parts may be purchased for less than $5. It is easy to build since there are only three new parts, only one circuit change to the existing horn circuit is required, components do not have to be mounted on a chassis box, and no electrical test gear is needed. Finally, it is reliable in that only mechanically rugged parts are used, only low-voltage power is needed, semiconductor devices are not required, and there are no electrical adjustments to make.

During the past few years, there have appeared in print numerous anti-theft/anti-intruder/theft alarm construction projects for automobiles, trucks, motorcycles, and boats. It is instructive to review the operating principles of the alarm systems which have been proposed so that the simple, inexpensive alarm system described in this article can be appreciated. Essentially all burglar detection systems employ one of the following methods of intruder detection:

light beam systems using photocell light detectors.
sound detectors
body capacitance proximity detectors
magnetic-type proximity detectors
motion detectors.

Light detectors, sound detectors, and body capacitance detectors all require several semiconductor devices in complex electronic circuits which consume power and require threshold adjustments. Also, these systems can be triggered falsely and sometimes circumvented.

Magnetic-type proximity detectors tend to be less versatile than one may desire, since ingenious geometry-dependent triggering schemes must be devised to account for the fact that a burglar may not be carrying magnetic material.

The one thing that is absolutely required for any theft to occur is that something must be moved. For this reason, a motion detector may be considered as a fundamental, almost foolproof, sensing device. One of the most reliable motion detectors is the simple mercury switch, whose principle of operation is illustrated in Fig. 1. A slight tip of the switch sends the drop of mercury from one end of the glass envelope to the other end. The switch is ON when the switch is tipped so the drop of liquid mercury metal short circuits the two electrodes.

About the circuit

Like most other vehicle alarm systems, this circuit uses the motorcycle, or boat horn to sound the alarm. A typical horn circuit is illustrated in Fig. 2. Most horn circuits use a normally-open momentary contact switch in the horn ground lead. The only significant change required, is that one of the horn terminals must be connected directly to the battery, even when the ignition switch is off. One reason for this change is to allow the horn to be sounded using the normal horn switch, so that curious "button pushers" will make their presence known when tampering with motorcycles or boats. The complete changes to the electrical system are illustrated in Fig. 3.

Fig. 4 shows the modified circuit after installation of the theft alarm. When the ignition switch is off, the alarm circuit is automatically armed. The alarm requires no battery power until the mercury switch is triggered. With S3 off, the horn will sound any time there is motion sufficient to tip the mercury switch. The key switch, S2, permits the alarm circuit to be disarmed when desired, so that the vehicle may be left with a mechanic or parking attendant. The key may be removed from S2 in either the on or off position.

The relay automatically disarms the alarm when the ignition switch is on. With S3 on, the only battery power used is that required for the relay coil (less than 1/100th the power required for typical size land vehicle and boat headlamps).

Component mounting

All components are small, and the locations of RY1 and S2 are not critical. These components may be mounted under the dashboard of boats, or in the headlamp of a motorcycle.

The mercury switches are supplied with mounting clips. Securing the mounting clip requires only a single screw. The mercury switches may be positioned as desired for the maximum protection. More than one mercury switch may be used if desired. All mercury switches should be wired in parallel with S1. For boat installations, S1 should be mounted on the under side of the boat engine cover, and the normal rocking motion of a boat must be taken into account.

The mercury switch should be mounted in the headlamp of a motorcycle. If S1 is mounted properly, the alarm will remain silent when the bike is leaning on its kickstand with the front wheel turned to the stop point, but the alarm will sound if the bike is righted or the front wheel is turned.

Options

Several modifications may be made to the circuit of Fig. 4, depending upon the protective features which are required. The possibility of using more than one mercury switch has already been discussed (there is no limit to the number of mercury switches which may be wired in parallel with S1).

Some users may insist on direct manual control of the arming function. Removing the relay and connecting one terminal of S1 directly to ground will not permit the alarm to be disarmed automatically when the ignition switch is turned on.

If desired, key switch S2, may be replaced with a less expensive toggle switch, which can be mounted in an inconspicuous location.

This motion-detector theft alarm circuit can be installed on any small or lightweight vehicle having a battery ignition system. This alarm system is **not** suitable for automobiles and trucks. Some automobile and truck horns draw as much as 25–30 amperes and the mercury switch would be damaged the first time the alarm is sounded. It can be used with 6- or 12-volt ignition systems having either a positive or a negative ground. When the system is operating (engine off), no battery power is consumed until the alarm is triggered. Even when the engine is running, the power consumed is negligible. Only three new components are required. All new parts may be purchased for approximately $5. The alarm circuit may be automatically disarmed when the ignition switch is on, so that normal vehicle motion will not trigger the alarm. The circuit can be manually controlled by a key switch so that the alarm may be disarmed when the vehicle is left with a mechanic or parking attendant. **R-E**

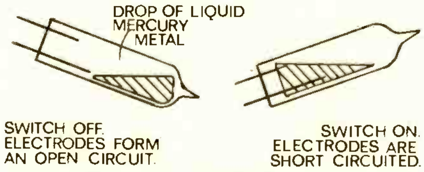


FIG. 1—MERCURY SWITCH ACTION. The switch is turned on by a slight tip of the switch that sends the drop of mercury to the end containing the electrodes.

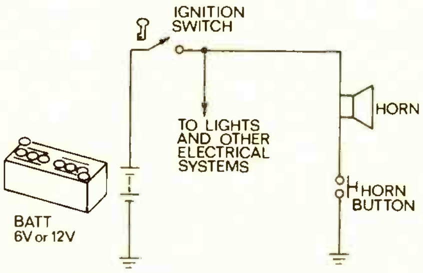


Fig. 2—HORN CIRCUIT before modifications to install the alarm are made.

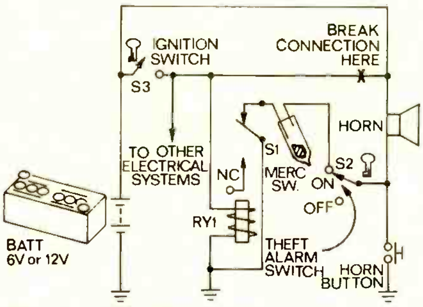


FIG. 3—HORN CIRCUIT WITH ALARM added.

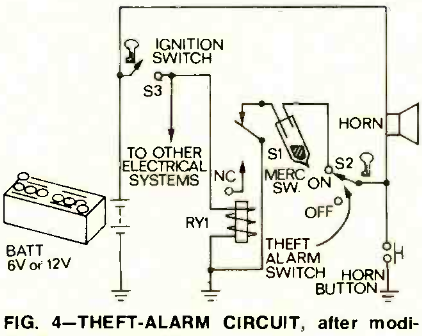


FIG. 4—THEFT-ALARM CIRCUIT, after modifications to existing horn circuit.

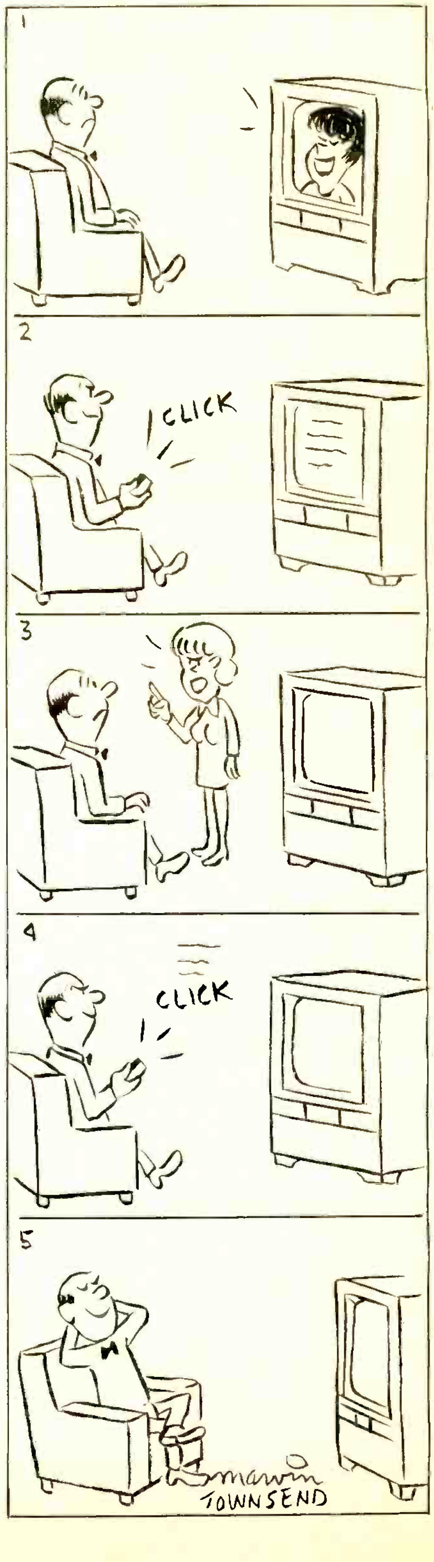
PARTS LIST

RY1—**For 12-volt ignition systems:** RBM MS40-904 miniature spdt dc relay. Contact rating 2 amps, coil voltage 12 volts. Stock No. 19A1703* **For 6-volt ignition systems:** RBM MS40-901 miniature spdt dc relay. Contact rating 2 amps, coil voltage 6 volts. Stock No. 19A1701*

S1—2-amp mercury switch. Stock No. 18A1425*

S2—A-H lock switch with key. Spst, 3-amp contacts. Stock No. 19A7083*

*Burnstein-Applebee, 3199 Mercier St., Kansas City, Mo. 64111



new squelch for CB receiver

Solid-state circuit replaces electromechanical relay

by G. NEAL

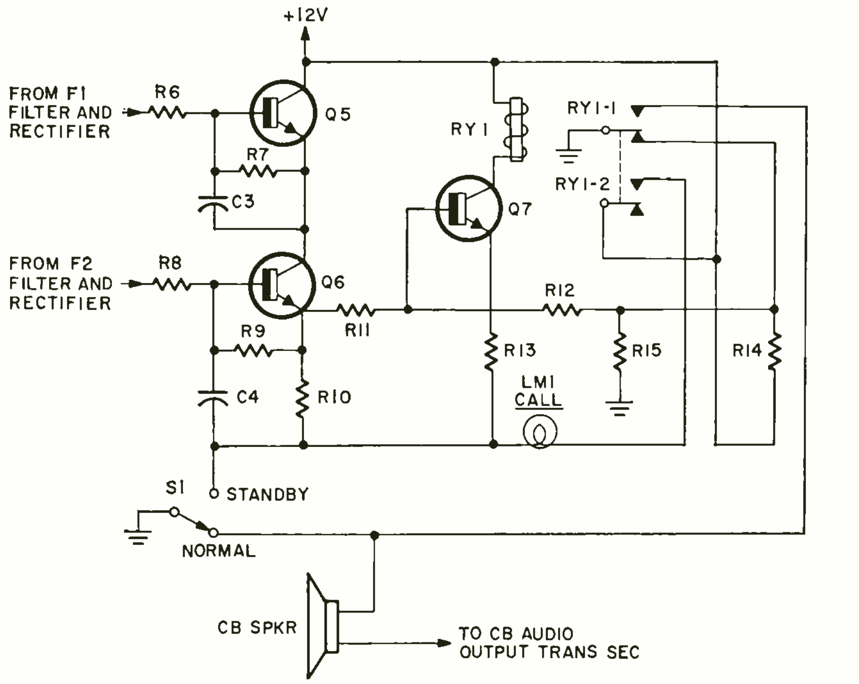


FIG. 1—CONVENTIONAL RELAY-CONTROL squelch circuit used in many CB receivers.

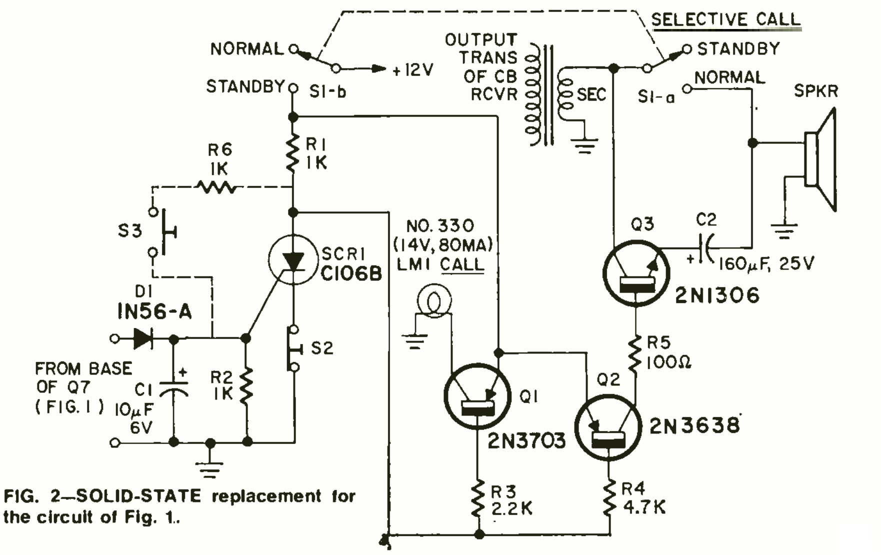


FIG. 2—SOLID-STATE replacement for the circuit of Fig. 1.

Manufacturers of CB equipment have made extensive use of semiconductors in their circuits. One area in which they have not done so, however, is the squelch relay in their selective calling systems.

Usually, a pair of tones (F1 and F2) is transmitted simultaneously from the calling unit and when received is fed through sharp audio filters and rectifiers producing two dc voltages. These are used to bias two series-connected transistors into conduction which in turn operate a dc amplifier with a relay in its collector circuit as shown in Fig. 1.

Relay RY1 is turned on in this case by Q7 (assume S1 in STANDBY position). The relay becomes self-holding as soon as it operates since current is now supplied to the base of Q7 to keep it conducting.

In addition the RY1-1 contacts complete the speaker return and thus remove the squelch.

The sole function of the RY1-2 contacts is to turn on CALL light.

The circuit has the quite considerable merit of simplicity but why not go all the way with semiconductors and eliminate RY1 and its eventual contact problems?

The circuit in Fig. 2 was developed for this purpose. The following changes must be made to the circuit in Fig. 1, in order to convert the solid-state squelch. Q7 may or may not be removed as desired but R12 must be removed and the connection broken to one side of the coil of RY1. An explanation of the circuit in Fig. 2 follows.

The gate of SCR1 is fed from the base of Q7. When the correct combination of tones is received the SCR is turned on. The CALL is then turned on through Q1 and the speaker is connected to the secondary of the output transformer by means of Q2 and Q3.

Push-button switch S2 is used to reapply the squelch and turn off LM1. The operation of Q3 is quite novel since it does not appear to have any collector voltage applied to it: therefore it must be operated as two back-to-back diodes, one of which is biased into conduction by current supplied by Q2. However, no combination of available diodes used in place of Q3 gave satisfactory results. Clipping and other distortion of the waveform across the voice coil were noted when these substitutions were attempted. In fact, no other type of transistor than the 2N1306 gave useful results. Many other types, both silicon and germanium, were tried but without success.

Up to 5 volts p-p may be applied to the speaker without noticeable distortion with a loss of only 0.7 dB across Q3 and C2. Diode D1 is used to raise the threshold required to turn on SCR1 and so reduce the chance of false triggering by short bursts of noise.

If you want to operate the transceiver without employing the selective-calling feature, S1 may be switched to NORMAL.

In place of installing a separate dpdt switch for S1, two poles of the STANDBY-NORMAL switch already present on many selective-call units may be used if desired. An alternative scheme to by-pass the selective-calling system would be to install S3 and resistor R6 as shown (dotted lines on sketch). Pushing S3 briefly would remove the squelch and turn on LM1. Operating S2 would return the system to the standby condition.

All the parts to make the above improvements are available at modest cost from most radio supply houses. They may be mounted on a small circuit board mounted inside the cabinet of some of the larger base-station sets or in a small metal box and tucked away under the instrument panel in a mobile installation. **R-E**

COLOR I.F. Alignment Techniques

With a post-marker sweep generator color i.f. alignment is a cinch. Here's how you can do it.

by ROBERT L. GOODMAN

DO YOU EVER REALLY HAVE TO RE-ALIGN A COLOR TV RE-ceiver? Yes, you can bet you will have to. When the new tubes (or transistors) are installed, or other components and coils are replaced in the tuner, i.f. stages, or color section, realignment may be called for. As an example see Fig. 1-a, the correct overall video i.f. scope waveform response curve. Now, all of the i.f. tubes were replaced with new (known to be good) ones. Now look what happened to the response curve (Fig. 1-b). Quite a change.

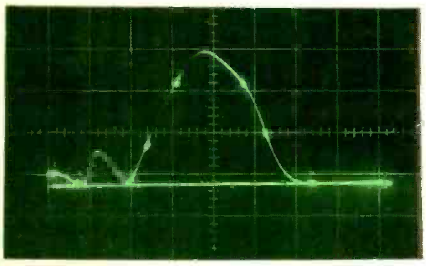


FIG. 1-a—THE I.F. response curve when the set first came into the shop.

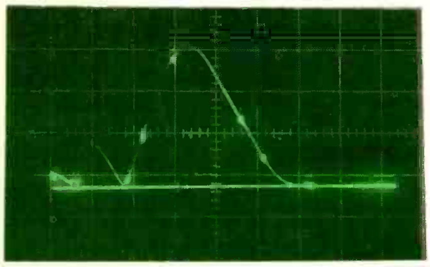


FIG. 1-b—THE I.F. response curve after all tubes in the i.f. strip had been replaced with known good tubes.

I have seen some new sets, just unpacked, that needed alignment. Also, component aging in older receivers is just cause for re-alignment. However, in my many years of TV electronics service the biggest alignment problem, or cause for re-alignment, comes from what I call "diddle stick drift."

Why the need for sweep alignment? If a color receiver is out of alignment you could have no color, poor picture quality (smeared black-and-white or color video) beat interference in the picture, poor or distorted sound and low audio or buzz in the sound reproduction. These are just a few of the many problems that can be caused by misaligned circuits. As tubes and other components age in the set they will cause the alignment to drift off.

Incorrect rf or i.f. alignment can cause troubles in addition to poor picture quality. Misalignment can produce instable sync, inadequate blanking, excessive noise in the picture, regeneration, and interference. The major picture components and the blanking—sync pulses, represent relatively low frequencies, but the sharp edges on these pulses require excellent high-frequency response too.

Please remember that incorrect alignment is not always the main reason for poor rf–i.f. signal response. Other causes include off-value damping resistors—across tuned circuits—open plate, screen, and grid-return by-pass capacitors. Also open coupling capacitors, off-value coupling components, and regeneration, affect the rf–i.f. response. Improper or excessive bias on one or more of the rf–i.f. stages may cause a poor response. This condition could be caused by a leaky coupling capacitor, or a defeat in the agc circuits. Excessive input signal strength may bias the stages too much and also affect the frequency response.

Let's keep in mind that many troubles that can originate in rf, oscillator, converter, i.f. amplifier, second detector and color band/pass stages can be located quickly and easily with the use of good alignment equipment. It is a wise technician indeed, who checks the overall alignment response curve for every color TV chassis that crosses his service bench.

Without good alignment equipment a technician might fumble and grumble around for many hours before locating the reasons for the poor quality picture reception.

Post-injected marker vs sweep-marker

In conventional alignment equipment an AM generator signal is mixed with a sweep frequency and fed through the TV's i.f. amplifier. This causes a beat-frequency to be formed by the difference between the two frequencies. The nearer they are in frequency, the lower the frequency of the beat signal. A low-pass filter must be used between the receiver and the scope to eliminate all but the very low frequencies to get a narrow marker pip. Because both sweep and marker signals are fed through the receiver to be observed by the scope, a strong marker may distort the sweep curve. And the amplitude of the marker depends on the amplitudes of both the sweep and marker signals—thus the marker varies according to its position on the curve. Hence much manipulation is needed to avoid erroneous results.

The post-injected markers are created by a beat-frequency process (some are also crystal controlled) and these signal samples are used. This post-marker is mixed with the sweep curve signal and both fed into the vertical amplifier of the oscilloscope. This is the "birdie" type of marker (see Fig. 2). If you wish an intensity-modulated marker, feed the post-marker signal in the cathode of the scope's CRT. I find this a very desirable method.

The sweep signal only passes through the receiver. The marker is added later. This is why it's called post-injected markers. With the post-injection method it is possible to produce markers without the aid of a TV receiver as shown in Fig. 3. If you don't want certain markers, just

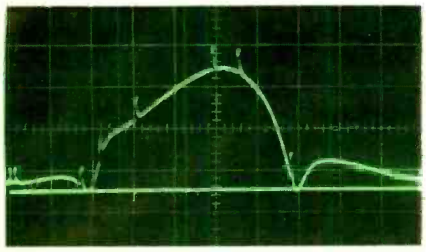


FIG. 2—BIRDIE TYPE of marker on the response curve.

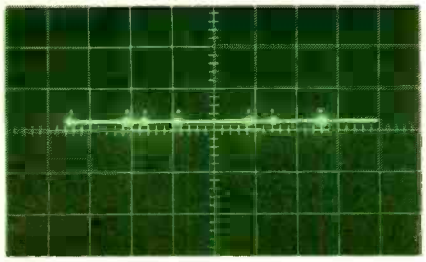


FIG. 3—WITH POST injection you can generate markers without the TV set producing a response curve.

switch them off or turn down the marker gain control. To generate the marker signals a sample of the swept-oscillator voltage is supplied to a set of crystals. The sample voltage has enough amplitude to allow the crystal to "ring" or oscillate, at its natural frequency. The resulting oscillator voltage is then detected, amplified, and shaped to provide the proper output marker "pip" display on the scope.

Trap alignment and adjustments

Before doing an overall alignment it is best to adjust the input and output traps first. These are indicated as L1 and T5 on the schematic for a Zenith 25MC36 chassis as shown in (Fig. 4). Feed the sweep signal into the third i.f. stage and with the scope connected to test point C1 adjust the 41.25-MHz trap. The scope trace in (Fig. 5-a) illustrates incorrect trap setting. The bright 41.25 marker pip should be located in the notch. **Caution**—*terminate the ground of the sweep generator cable very close to where you inject the i.f. signal or you may not obtain a proper curve.* Fig. 5-b shows a properly adjusted 41.25-MHz trap scope trace.

Next feed the sweep signal into the tuner converter plate coil and tune the 41.25-MHz input trap for minimum amplitude. Also go back and touch-up the output 41.25-MHz trap.

The reason for this is because of the two 41.25-MHz input and output trap coils. Should you try and adjust both

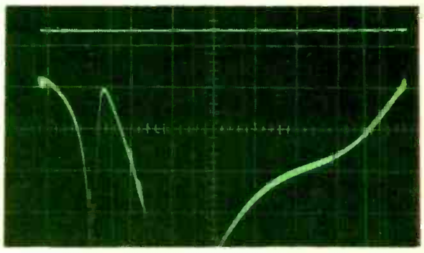


FIG. 5-a—INCORRECT trap setting is obvious in this response curve.

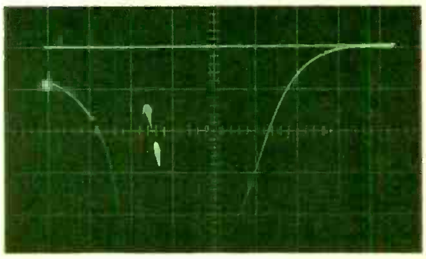


FIG. 5-b—PROPERLY adjusted 41.25 trap as seen on scope.

coils by feeding a sweep signal into the i.f. input, one trap will actually mask the action of the other trap and you will get nowhere fast. Fig. 6 is the correct waveform for both input and output 41.25-MHz traps. This is an expanded trace, and intensity marker pips are being used. Note the bright spots for markers.

Television trap alignment normally includes adjusting sound traps and adjacent-channel traps. Adjust the sound and adjacent-channel trap to the frequencies specified by the manufacturer. When adjusting the traps, the i.f. circuits should operate near maximum gain. Therefore, keep the sweep-generator output as low as possible and still produce an adequate scope response curve. Here's how it should be done.

1. Set the 41.25-MHz marker switch to the ON posi-

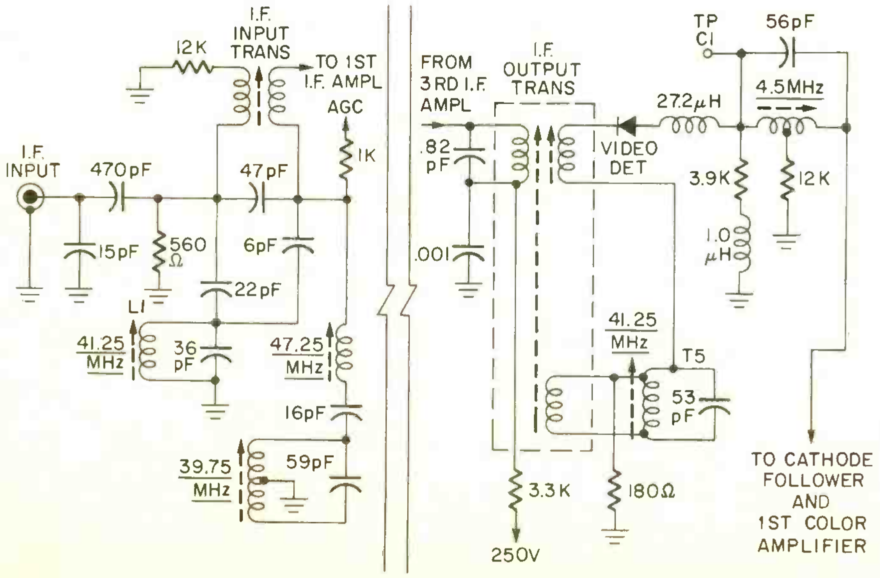


FIG. 4—PARTIAL CIRCUIT of Zenith 25MC36 chassis shows i.f. strip input and output traps.

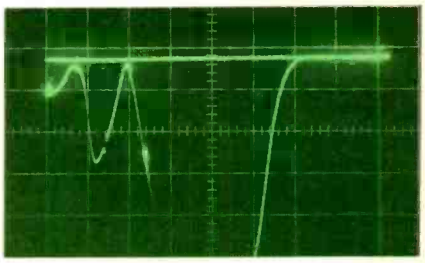


FIG. 6—CORRECT WAVEFORM for both input and output 41.25-MHz traps.

tion. Adjust the sound trap for minimum amplitude of the scope pattern. If necessary, reduce the i.f. bias to increase the i.f. gain. *Note:* As the i.f. gain is increased the trap adjustment becomes more critical. Again adjust the sound trap for minimum amplitude of the scope pattern.

2. Repeat the preceding steps until the sound trap is properly aligned. Fig. 7-a shows the correct scope display for a properly aligned sound trap. Now flip the 41.25-MHz marker switch OFF.

3. Turn on the 47.25-MHz marker switch, then follow the same procedure to align the adjacent-channel sound trap. If the set has one, adjust the 39.75-MHz adjacent picture trap. Align it to the manufacturer's specs. Fig. 7-b is a typical response curve. The response curve in Fig. 8 indicates that the 41.25-MHz sound trap is out of adjustment. Notice that the 41.25-MHz marker pip does not fall into the notch.

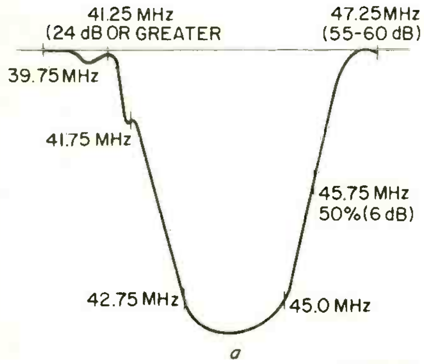


FIG. 7-a—CORRECT scope display for properly aligned sound trap.

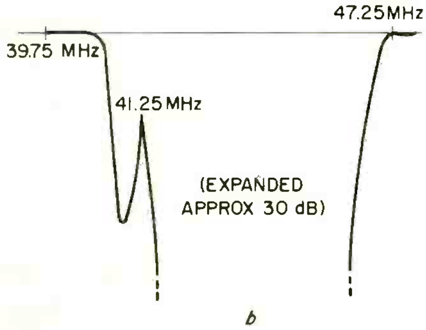


FIG. 7-b—TYPICAL response curve for 39.75-MHz adjacent-channel trap.

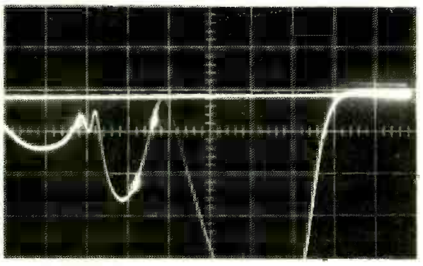


FIG. 8—41.25-MHz sound trap is out of adjustment if it produces this waveform.

4. Recheck the overall i.f. alignment for proper marker placement and bandwidth. *Note:* If you align the i.f. circuits of a black-and-white TV set to the same bandwidth as the i.f. stages of a color receiver, the picture may be distorted due to the greater bandwidth and the lack of sufficient trapping of the 4.5-MHz sound signals.

Video i.f. and afc response curves

The lower limit of the color i.f. bandpass is 41.75-MHz. Most generators have a crystal marker for this frequency. A look at the response curve in Fig. 9 shows that the location for 42.17-MHz (color carrier, 3.58-MHz removed from the 45.75-MHz picture carrier) is not so important as the skirt or slope of the response curve on the color carrier side.

On the Zenith color TV production line the 41.75-MHz marker is used instead of the color carrier marker, because variations may exist at the skirt or slope, due to sound trap attenuation. It is important that the low limit of color bandpass 41.75-MHz be on the order of 20% to assure proper color operation from the chroma circuitry.

Accurate alignment of the 45.75-MHz a.f.c. circuit can be done easily (note curve in Fig. 10). The bandpass can be precisely adjusted. The "intensity" marker at 45.75-MHz will be very sharp, as opposed to an AM birdie marker display. Bandpass alignment of the i.f. requires several frequency markers. For this reason seven multiple-marker displays are provided on modern generators. The three trap frequencies—plus markers to shape the i.f. bandpass, are all available with separate switches and may be displayed in any combination.

FIG. 9—THIS CURVE shows the location for 42.17-MHz color carrier, 3.58-MHz removed from 45.75-MHz picture carrier.

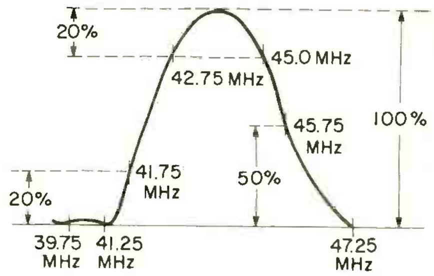
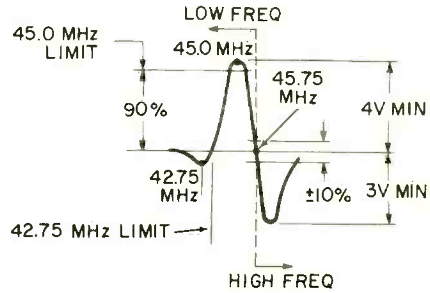


FIG. 10—45.75-MHz afc circuit should produce this curve when properly adjusted.



Precautions during alignment

1. Remove the horizontal oscillator and sweep output tube to prevent horizontal pulses or spikes from appearing to the scope pattern.

2. Remove the vertical oscillator tube to prevent vertical pulses from appearing. Now connect a resistor load from B+ to ground as specified by the service information. This will provide the proper load for it to maintain the correct value of the B+ voltage.

3. Use only the rf cables supplied with the generator. Be sure the rf cable is terminated in its proper impedance. Keep the leads from the terminated cable as short as possible at point of connection to the receiver under test.

4. Check for ground loops between instruments. This is easily determined by touching each piece of equipment while observing the scope trace. If the trace moves or changes shape, check all ground connections. It may be necessary to ground all cables at one common point.

5. Do not dress the sweep generator output leads, nor the demodulation input cable leads, over the i.f. circuits, i.f. transformers, or tubes. This practice can cause detuning or oscillation in the section under test.

6. Use a bias box and apply voltages as specified by the set maker data. More accurate trap adjustments can be achieved by reducing i.f. bias. But be careful not to overload the i.f. circuits with too much rf signal from the generator.

7. Adjust the scope's vertical gain control near to its most sensitive position and keep the sweep generator output as low as possible. This will prevent overloading the i.f. amplifiers, which may produce an improper response curve and result in misalignment.

Before alignment begins, allow all alignment and receiver equipment to reach normal operating temperature.

Now that all of the traps are correctly set we can proceed to make the overall i.f. alignment adjustments.

1. Refer to Fig. 11 and connect the oscilloscope and post-marker generator to the TV chassis. Make sure all leads are as short as possible. If bias voltage is called for, connect the bias leads to the proper point on the TV chassis. Connect a voltmeter across the bias box terminals and set the bias voltage as specified by the manufacturer. Either a positive or negative bias may be applied by reversing the leads from the bias box.

2. Adjust the scope's vertical attenuator or gain control to near maximum sensitivity. Set the sweep generator frequency and sweep (usually about 1-MHz wider than the overall receiver i.f. bandwidth). Center the trace on the scope's CRT.

3. Turn on the required marker switches and adjust the marker gain control for the proper amplitude. The markers should be just large enough to be seen clearly. The width of the marker increases slightly as its amplitude is increased. *Note:* If the i.f. circuits are way out of adjustment, you may have to inject the signal into the last i.f. stage, then work toward the input stage. The sweep generator rf output will have to be increased when the signal is fed into the last i.f. stage because there will be very little gain in the last stage. The rf output *must* be decreased as the signal input is moved back toward the input of the i.f. strip. After the stage-by-stage adjustments have been made, an overall i.f. check is in order. Always follow the alignment procedures as detailed in the service information.

Shown in Fig. 12 is a normal i.f. response curve for a color set with proper size intensity markers. Note in Fig. 13 an i.f. curve shown with excessive "birdie type" marker pip amplitude.

Should you wish, horizontal markers can be produced (Fig. 14) when the marker information is added to the horizontal sweep of the scope in place of the conventional method of adding the markers to the vertical input of the oscilloscope. The markers only are shown in Fig. 3 with the generator gain set at zero. Some TV set manufacturers specify marker positions as so many "dB down," or as a percentage of full trace size. To accurately align an i.f. system or tuner when the service information specifies that the markers should be down "so many dB," you must be able to determine where these points are located on the pattern. Not all scopes will produce a linear vertical deflection. However, with the calibrated triggered oscilloscope this procedure is quite easy.

Always use the recommended agc bias voltage (as

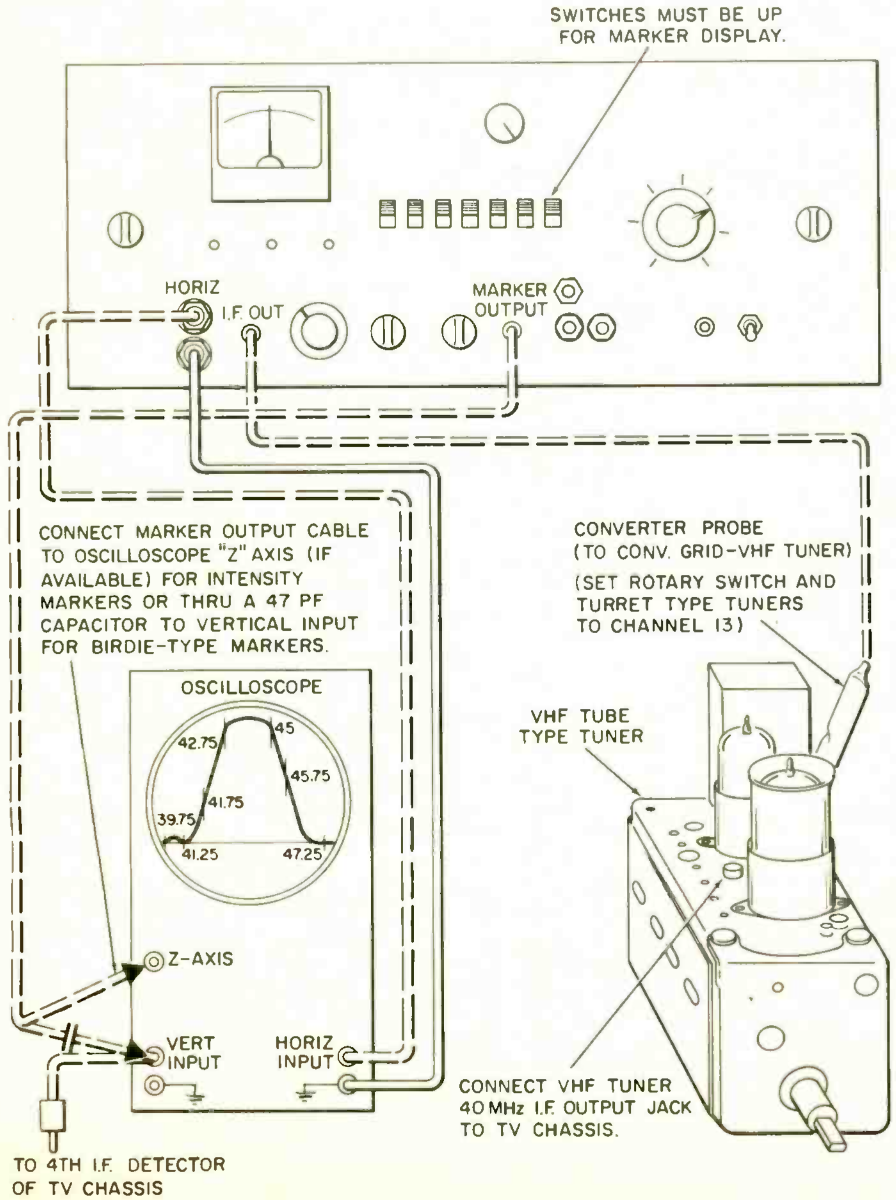


FIG. 11—HOW TO CONNECT scope and post-marker generator to the TV chassis for alignment adjustments.

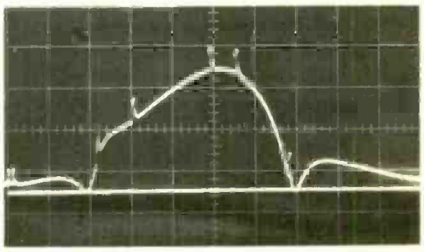


FIG. 12—NORMAL I.F. response curve for color set with proper size intensity markers.

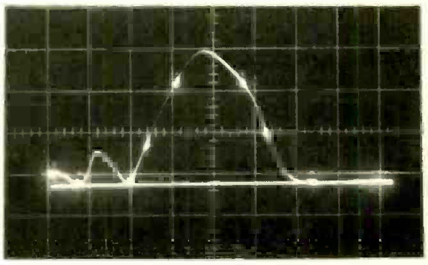


FIG. 13—I.F. CURVE HAS EXCESSIVE birdie-type marker pips.

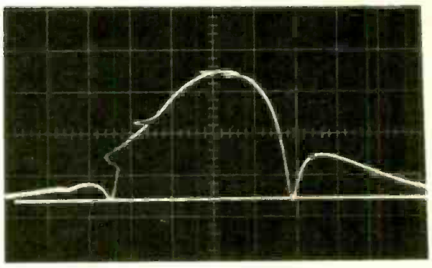


FIG. 14—MARKERS CAN BE ADDED to horizontal sweep instead of conventional vertical connection.

specified in the service information) when making any i.f. alignment adjustments. This fixed bias is a selected mid-point voltage or the TV receivers average signal opeating range. **Service tip:** Observe the alignment curve on your scope while varying the agc bias voltage. This may well give you a clue to possible i.f. circuit troubles. Note that different bias settings will change the shape of the response curve. In Fig. 15 a distorted i.f. response curve was caused by a positive 5 volts being applied to the agc line. Note loss of gain and incorrect curve. While in Fig. 16 an incorrect

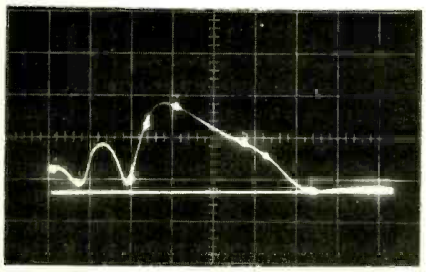


FIG. 15—DISTORTED I.F. curve is caused by positive 5 volts applied to agc line.

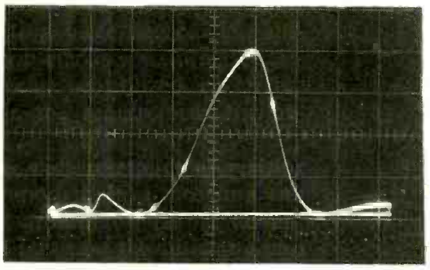


FIG. 16—INCORRECT CURVE with too much i.f. gain caused this misshaped waveform.

curve with too much i.f. gain caused this very mishaped waveform when a negative 3 volts was applied to the agc line. This is why it is very important to set the agc bias voltage according to the manufacturers specifications before an overall i.f. sweep alignment is performed.

On some of the newer model solid-state TV sets you have a built-in bias supply. One example is the Zenith color chassis with a transistor i.f. amplifier. Fig. 17 shows this set's agc delay circuit. **Service tip:** Just pull out the agc amplifier transistor Q202 and adjust the agc delay control for the proper bias voltage. Note that you have a variable voltage divider from chassis ground to the 24-volt supply. This will give you a good swing in bias voltage deflection range. Check the service manual and be sure to use the correct agc bias setting.

Solid-state i.f. amplifiers

The transistor i.f. is a very broad-tuned (wide bandwidth) system while the tube i.f. circuits are staggered tuned design. This calls for a difference in alignment procedures also. The solid-state i.f. amplifier must have a sophisticated and more efficient trapping circuit system.

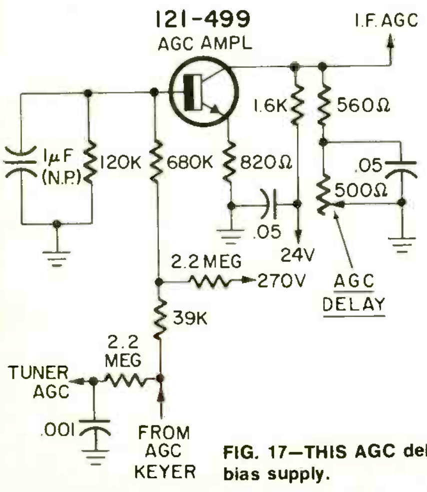


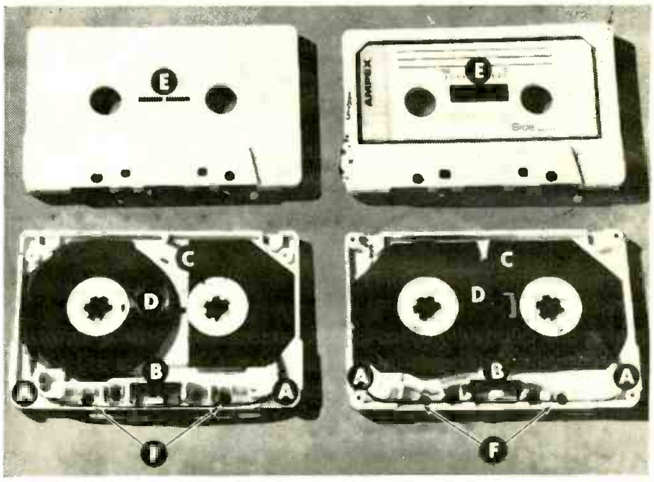
FIG. 17—THIS AGC delay circuit has a built-in bias supply.

The transistor is a low-impedance device (which shunts i.f. transformer and trap coils) and this gives the solid-state i.f. stages an automatic wide band-pass capability. So that the object of a transistor i.f. amplifier is not to build up amplification in certain portions of the band pass, but to eliminate some of the broad bandpass. This then points out the great importance of the trapping designed into these stages and the proper need for alignment or adjustment settings. Each stage of a transistor i.f. is tuned for the complete band-pass. So you cannot stagger tune this i.f. system and obtain proper picture details. **Caution:** *It is possible to stagger tune the transistor i.f. stages but the picture and color information will be poor.* **R-E**

BUYER'S GUIDE FOR TAPE CASSETTES

A wide range of cassettes are available, ranging in quality from poor to excellent. And, because cassettes are sealed, few people see the critical inner mechanisms that determine the performance quality of the cassette. This makes shopping for cassettes a bewildering experience for many cassette recorder owners.

Here are some definite guideposts which can help you select serviceable cassettes, and some advice on questions to ask your tape salesman before you make your purchase.



A) Is the tape guided around stationary posts as on the cassette at the left, or is it guided by rotating posts anchored by lubricated metal pins, as on the cassette at the right?

B) Is tape pressure against the heads accomplished by a sponge which becomes rigid and inflexible after a few uses (photo at left); or by a metal spring which assures constant tape-to-head contact for long periods of use (photo at right)?

C) & D) Is the tape pressure pad in sections, causing uneven winding of tape on the hubs (left)? Or does the cassette have a one-piece pressure pad for a smooth tape pack (right)?

E) Can you view the tape through unguarded slots in the cassette shell (left)? Or through a large plastic-protected window which keeps out dust and other foreign particles (right)?

F) Does the tape itself provide good recording and playback characteristics?

By asking these questions, the wise consumer can select the cassette that will give him his money's worth in quality performance and long life. **R-E**

Build a Scope Camera for $45

A low-cost Polaroid camera, a close-up lens and adapter ring, some light sheet metal and an hour or so is all you will need.

by JACK DARR
SERVICE EDITOR

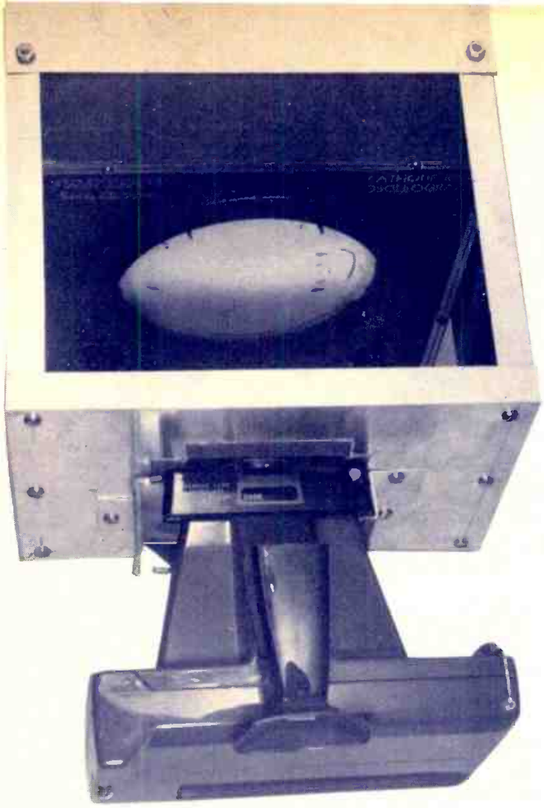


FIG. 2—CAMERA IS MOUNTED on sheet-metal bracket on scope case.

A COMMERCIAL OSCILLOSCOPE CAMERA is nice. It's also expensive, from $400.00 on up to $1200.00 or more. They use the instant-developing Polaroid film. You can make your own Polaroid scope camera for a lot less. All you need is one of the new "Colorpack II" Polaroid cameras, an auxiliary lens, and two pieces of sheet metal. With this you can take excellent waveform pictures. Fig. 1 shows some samples.

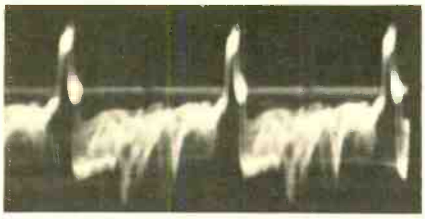


FIG. 1—SAMPLE SCOPE SHOTS made with Colorpak II camera. Slight horizontal jitter is due to the scope, not to the camera.

No modifications are made on the camera itself. It has an electric eye controlled shutter—but for this use, the electric-eye does *NOT* work! Not enough light. So the cell holds the camera shutter open when the button is pushed, like the "bulb" position on a standard shutter. You time the shot by counting seconds. Sounds very inaccurate, but it works! With the ultra-fast 3000 speed Polaroid film, a 1-second exposure is plenty. You'll be surprised how easy it is to get the right exposure, with a bit of practice.

Fig. 2 shows the camera mounted on a Precision ES-500A scope. You'll need a "closeup lens" to enable the camera to focus on the CRT screen at such a short distance. The lens in the Polaroid Print Copier is fine. You'll also need an adapter ring or filter-holder, to mount this lens on the camera. These are available in most camera shops. Fig. 3 shows the one I used, a "Tiffen Adapter Ring, Stock No. 38SQ-6" (If you happen to have one of the small plastic magnifying lenses given away at Magnavox Service meetings, you can use it, but you have to Scotch-tape it on which isn't too reliable!)

FIG. 3—CAMERA with lens adapter ring mounted on front panel of bracket.

The mounting bracket has been considerably simplified since my "pilot model" was made. With perfect 20–20 hindsight, I realized that I could have made it out of only two pieces of sheet metal, as shown in Fig. 4. I used 20-gauge aluminum, because it's easy to work. Any kind of suitable sheet metal can be used.

Make a full-sized layout as in Fig. 4. The 8.5" dimension of the top must be the same as the width of *your* scope-cabinet plus about 1/16 inch. My scope is 8.5" wide. The 'A' flanges are bent at right angles for stiffening the sides, and the 'B' flanges are bent in to provide a mounting for the front

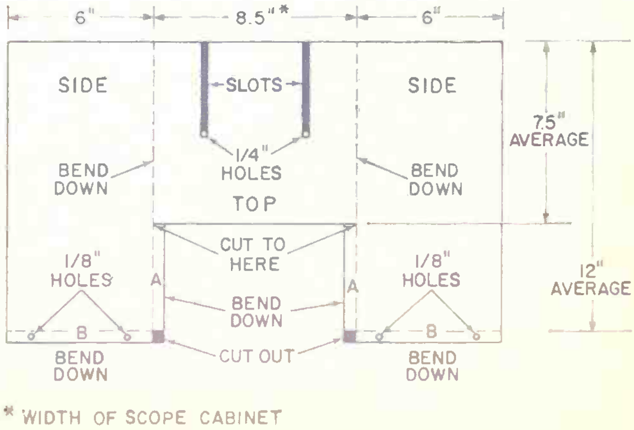


FIG.4—SHEET METAL LAYOUT for top and sides of mounting bracket.

panel. Don't bend it yet.

Check the top of your scope cabinet. Mine had a handle bolted on. I took it off, and had two bolt-holes I could use! If yours doesn't, take the scope out of the case, and drill two holes about 2" apart, and about 4 inches from the front. Put two 1" #8 pan-head bolts in these, with lock-washers under the heads, from inside. On the top, put another lockwasher, and a nut. Tighten the nut firmly, then slip two flat washers and a wingnut on each. These go into the slots in the top half of the bracket.

Measure the distance apart, then drill two 1/4 inch holes in the top section, using the same spacing. Now, with a pair of small tin-shears, cut from the back edge to each hole to make the slots. Lay this piece aside for a moment and make the front panel.

Fig. 5 shows the layout for this piece. Remember the 8.5" dimension *must* be the same as the width of *your* scope cabinet, as in Fig. 4. The 6-inch height may have to be changed also, depending on how your scope is built. This would also have to be changed on the side pieces of the big bracket, of course.

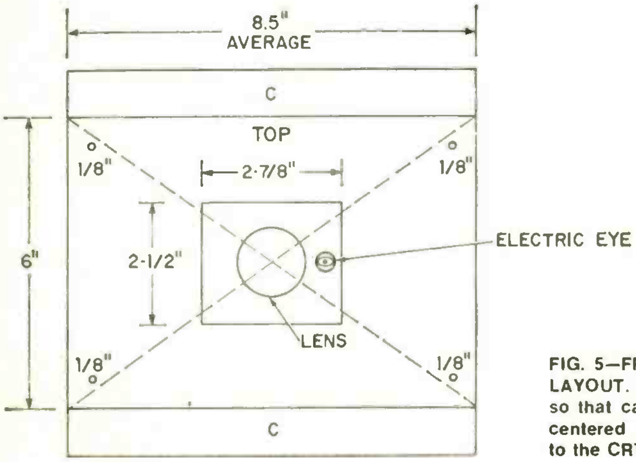


FIG. 5—FRONT PANEL LAYOUT. Cut opening so that camera lens is centered with respect to the CRT screen.

Before bending the top section, lay the edges of the front panel on the "B" flanges, and drill the boltholes, through both pieces at the same time. (This way they'll match!) Fig. 6 is an inside view of the front panel with the camera mounted. (More hindsight. The bolted-on flanges at top and bottom were added after the pilot was built for extra stiffness.)

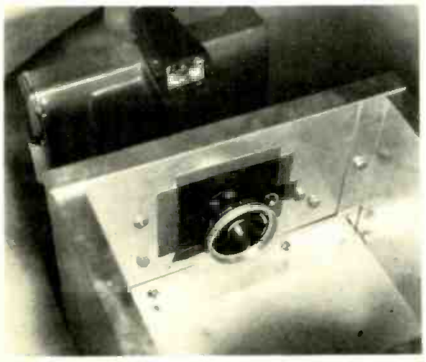


FIG. 6—INSIDE VIEW of camera mounted on front panel, assembled to bracket.

Cut a rectangular hole in the front panel so the shoulders of the camera-case butt against the panel. This hole will actually be off-center. The "wide side" must be on the left looking at it from the back of the camera, to clear the electric-eye opening.

Fit the camera into the hole, then make up two small angle-brackets of the scrap from the sheet metal. One of these fits on either side of the camera to hold it firmly against the panel. The right hand bracket will be 2" long, and from 5/8" to 3/4" deep. The short flange can be about 3/16", and the bolt-flange about an inch. Fig. 7 shows the layout for these and Fig. 8 shows how they're mounted to hold the camera. The left side bracket must be smaller, to clear the flashcube socket.

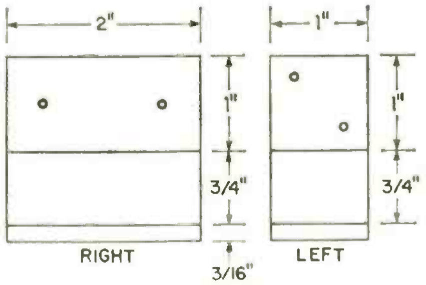


FIG. 7—CLAMP BRACKETS for holding camera to front panel of scope.

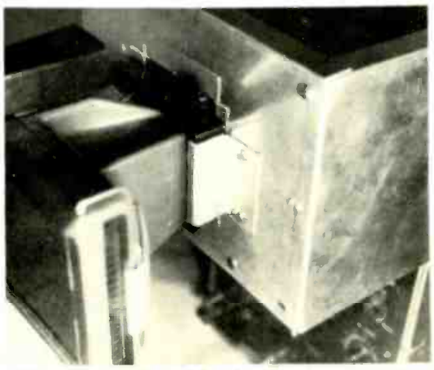


FIG. 8—OTHER SIDE shows clamp bracket holding camera to front panel of scope.

These can be made with a "hand-brake" or bent in a vise. Drill the bolt-holes in the bracket and the panel, and mount the camera temporarily, to see if it's held firmly. If it's a bit loose add another bracket on the top at the left side, about 1/2" wide. If you line these brackets with cloth-backed adhesive tape they'll hold better, and won't scratch the camera. If they're just a bit loose, add pads of rubber tape, etc., under the short leg.

Now, put the Copier lens into the adapter ring. The adapter screws apart. If you get the lens in backward, the adapter won't hold it tightly. Just take it out and turn it over. You can't tell which way is which, so try it.

Push the adapter ring over the camera lens. Since there's a good bit of delicate plastic around here, don't use too much muscle. Push it on perfectly straight until it's seated as shown in the closeups. Next, bolt the front panel to the side brackets and mount the camera.

To mount the unit on the scope cabinet, slide the slots over the two bolts you put in the top of the case. Set these so that the center of the lens is about 3-3/4" from the center of the CRT screen. (Hint: measure and cut a piece of stiff cardboard to this length and use this as a gauge. It's hard to get a ruler in this small space!) By the way, the scope should have been put back in the cabinet before the camera is mounted! Now we're about ready to go.

Focussing

Open the back of the camera. Slip an empty film-pack, which has been fitted with a piece of ground-glass, into it. Fig. 9 shows how this is done. The ground-glass must be at exactly the same place the film will be, of course. Set the "stop," which is a little gubbins on top of the camera looking like a slide-switch, to the "75" position.

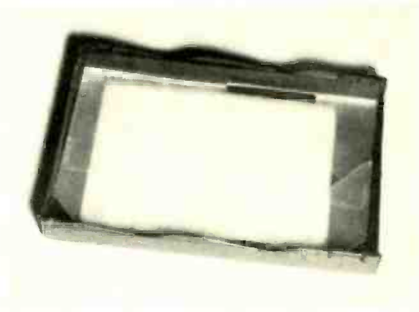


FIG. 9—EMPTY FILM PACK, with ground-glass mounted where film was. Use it for focussing.

The 75 position is for color film. However, the 3000 position is much smaller (Seems to be about f18 or f20. Polaroid won't give out information about lens speeds and stops, but this is close) I use the "75" position for focussing, for otherwise I wouldn't get enough light to see the image. If the image is sharply focused on the "75" position, "stopping down" to the 3,000 position will make it even sharper.

Hook the scope to something that will make a waveform—TV set, af signal generator, etc. Adjust the waveform for normal brightness and set the scope focus very carefully. Set the "Sync" control for the steadiest pattern.

Turn out all of the lights, open the back of the camera, and hold the shutter button down. You'll see the waveform, inverted, on the ground glass. Slide the camera back and forth on the case until you get the sharpest image. Tighten the bolts. Now, see if you can sharpen it up a little more by turning the lens-ring on the camera. The electric-eye adjustment should be set all the way clockwise, to "Darkest." This holds the shutter open.

Take the focus glass out of the camera and load it. Read the instruction book to make sure that all of the little tabs and flippers come out in the right place. Now, you're ready to make the first test shot.

Be sure that the waveform on the scope is perfectly focussed and steady. Don't set the brightness too high. With the fantastic speed of the 3000 speed film, too much light will make the picture blurry. Be sure that the slide is set to "3,000" and not "75." Hold the back of the camera with your left hand, to steady it and push the button with your right thumb. Remember your "count" of seconds. Try to make the first one about one second.

Pull the tabs, etc., and let the picture develop for about 15 seconds. Don't overdevelop. This often causes blurring. Check the picture. If it's a little weak, lines of the waveform not clear and white, increase the scope brightness a little and shoot again. By juggling camera exposure and CRT brightness it won't take long to get the hang of it.

The waveforms shown were made with a "blue tube" in the scope (—CP11 phosphor, made especially for photographic uses). However, this film is very sensitive in the green, and the same camera has been used on scopes with the standard —CP1 (green) phosphor with good results.

This camera is mounted permanently on the scope. If you want to gussie it up a little, you can add a long piano-type hinge to one side of the bracket, so it can be swung to the side to expose the scope screen. The two bolts on the other side of the front panel can be taken out or wing-nuts used on them.

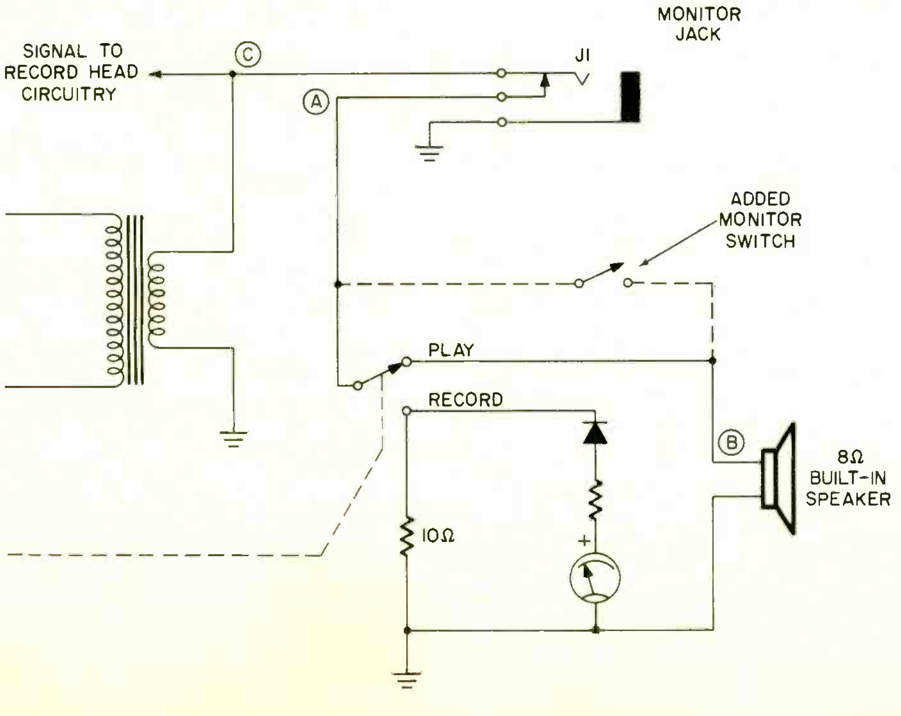
Happy shooting!

PARTS LIST

1. Polaroid "Colorpack II" camera, Allied Radio 10 A 5903 S. $29.95
2. "Print Copier," for Colorpack II, Allied Radio Stock No. 10 A 5126 S. $7.95
3. Tiffen Adapter Ring, Stock No. 38SQ-6, or equivalent. $3.00
4. Sheet metal, 20-gauge aluminum, about $1.50 at local sheet-metal shop, including making the bends.

speaker monitor for your tape recorder

When dubbing tapes on your recorder or recording from radio or phono, you should hear what's being recorded. Why not use recorder's built-in speaker?

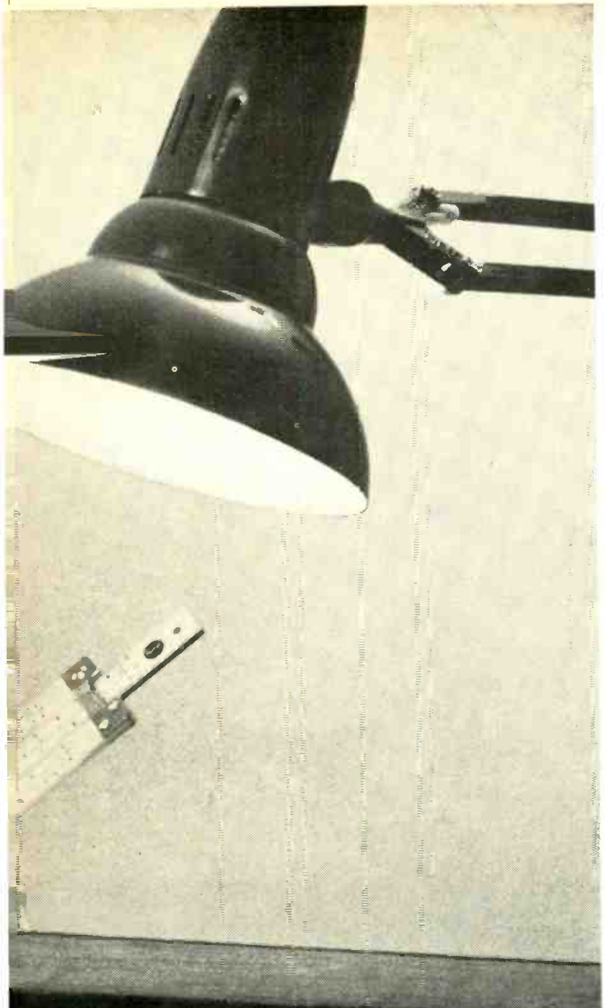


MONITOR JACK WIRING in a typical tape recorder. Dotted lines show how monitor switch cuts in speaker for monitoring or PA.

by FRED BLECHMAN

Do you ever use your tape recorder to make recordings from another recorder, or from your phonograph or radio? Would you like to sometimes use your tape recorder as a low-power PA system? If so, you'll be interested in a simple change that can be made to most modern inexpensive tape recorders that will provide you with a switch to use your built-in speaker as a recording monitor.

A monitor lets you hear what is being recorded on the tape while it's being recorded. This is sometimes a necessity when recording from the speaker jack of a radio or another tape recorder, since doing so usually disables the source speaker. Monitoring allows you to control the volume and know when to turn off the



recorder at the end of a selection. While this can be done with an earphone or an external speaker on many recorders, a built-in speaker monitor is more convenient, but usually found only in more expensive machines. Also, by using a microphone with a speaker monitor, you have a small PA system for small or medium-size meetings, parties and gatherings.

There are two basic methods for monitoring a recording: (1) a separate pickup head and amplifier or (2) feeding the already-amplified recording signal to an earphone or speaker. Most modern recorders (and many older ones) already come equipped with a jack to plug in a monitoring earphone or speaker. Changing these machines to monitor through the built-in speaker involves only wiring in a 10¢ switch in the right place!

If your recorder has a jack that can be used for monitoring (usually marked EARPHONE or EXT SPKR or MONITOR), you can easily add the switch to provide monitoring through the built-in speaker. To verify this, plug an earphone or speaker into this jack and listen for a monitoring signal while you're recording. If you have no such jack, there is still a good chance you can add this modification.

The diagram shows how a monitoring jack (J1) is typically wired in a tape recorder. In the PLAY position, the RECORD-PLAY switch feeds the recording to the built-in speaker. In the record mode, the signal is fed to a dummy-load resistor (10 ohms) and the recording level meter through a rectifier and dropping resistor. When an earphone or speaker is plugged into J1, the built-in speaker, the meter and the record-play switch are bypassed. By adding the new MONITOR switch (shown dotted in the schematic), you can put the built-in speaker back in the circuit at will.

To add the MONITOR switch, disassemble the recorder to the extent necessary to permit access to the earphone jack and the speaker terminals. Mount a miniature spst slide or toggle switch in a location that can be operated easily when the machine is put back together. The photos show typical installations.

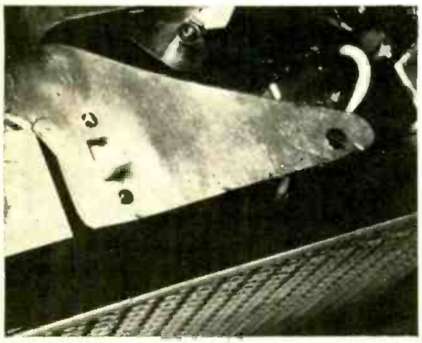
The wiring is simple once you find points "A" and "B" shown in the diagrams. To find point A, visually identify the terminal that is disconnected when a plug is inserted in J1. To determine point B, you can connect one end of a wire temporarily to point "A" and touch the other end of this wire to one of the speaker terminals while the recorder is playing. If there is no change in sound, you are on point B; if the sound is reduced, you are on the grounded side of the speaker. If you have an ohmmeter, locate point A by inserting a plug in J1 and finding which terminal of J1 shows approximately 8 ohms to ground. Point B is, of course, the speaker terminal that shows approximately 8 ohms to ground.

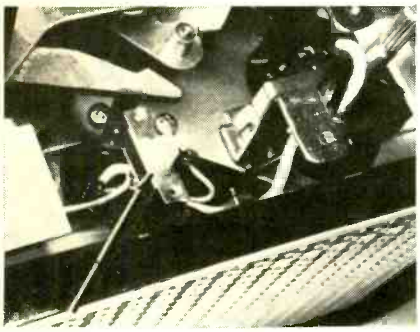
Once you've located points A and B just wire the switch between these points. If your machine doesn't have a monitoring jack, J1, find Point C by inspection of the wiring, and use this as if it were point A.

To check out the modification, plug a microphone into the recorder with the volume control set at minimum and the machine in the record mode. Speak into the microphone, slowly advancing the volume control. If the new monitoring switch is closed, you'll start hearing your own voice through the built-in speaker and, as the volume is increased or as the microphone is brought nearer the speaker, you'll get audio feedback howl. Switch the monitoring switch off and the sound should stop. When using the modified recorder as a low-power PA system, you can avoid feedback by minimizing the speaker output getting back to the microphone; stand further away from the speaker and aim the speaker so sound doesn't bounce back to the microphone from a nearby wall.

If your recorder has a recording level meter or light, it will have reduced sensitivity when the monitor switch is on, since some signal is also being fed to the built-in speaker.

Try this simple change on your recorder, and see how it simplifies making "dubs" of other tapes. It's inexpensive, it's easy, and it's useful.





SWITCH MOUNTING AND LOCATION depends on the layout of the recorder. Photos show typical mountings and panel treatments.

It stays that way until he apologizes for that crack about our hourly service charge!

all about inductors

Inductors are a basic electronic circuit element. Here, in detail, is a complete picture of how they work and what they can and can't do

by **FARL JACOB WATERS**

"LODESTONES" OR MAGNETS WERE among the many things that mystified early man. In due time it was noted that there was a resemblance between the magnets attraction to other stones and the effect of static electricity. Then in 1819 Oersted, the Danish physicist, discovered that an electrical current through a conductor produces a magnetic field. Fig. 1-a illustrates the development of a magnetic field by a current I and causing the compass needle to swing to a position perpendicular to the conductor (Fig. 1-b and c). Taking the opposite approach Faraday, the English physicist, determined that cutting a magnetic field with a conductor causes an electrical current to flow. Movement of the conductor in Fig. 1-d up and down through the magnetic field produces a current as indicated by a deflection of the galvanometer needle. By definition *electromagnetism* is that field of magnetic forces produced by an electrical current through a conductor. *Electromagnetic induction* is the production of an emf (voltage) and the resulting current by a moving conductor through a magnetic field or by moving a magnet near a conductor. Voltage induced by electromagnetic induction is the result of the conductor cutting the "lines" of magnetic force existing about the magnet.

With an alternating current the magnetic field is constantly increasing or decreasing as the lines of magnetic force alternately expand out into space and then contract. As this expanding and contracting of the magnetic lines of force occurs, those lines are 'cut' by the wire conductor and a voltage is *self-induced*. Therefore, *self-induction* is the induction of a voltage into that conductor carrying the current causing the magnetic field. A conductor's ability to produce a self-induced voltage is its *inductance*. Concentration of the magnetic field by coiling the conductor, as shown by Fig. 2, increases the inductance. Such a coil of conducting wire is, therefore, referred to as an *inductor*.

Inductance is much like mechanical inertia which tends to hold a body at its present state of motion. That is; a body (or object) that is at rest will tend to remain at rest while the body that is moving will tend to continue its movement. The force that tends to keep the body in motion or at rest is *inertia*. When the current through an inductor begins to decrease the lines of magnetic force begin to contract or collapse about its conductors and produces a self-induced voltage. That self-induced voltage has a polarity opposing the decrease in current. In other words, the self-induced voltage tends to keep the current flowing at its initial rate and direction. So an inductor opposes any change in the magnitude or direction of current. Direct current does not change magnitude or direction and is not effected by an inductor. Opposition to alternating current presented by an inductor is, like the bounce of a ball, a reaction or *reactance* to the originating action. With an alternating current varying as the trignometric sine wave, the inductor's reactance X_L is *directly proportional* to the frequency f and the inductance L.

Inductive reactance, $X_L = 6.28fL$
where f is the alternating current frequency in hertz.

L is the inductance in henries.

By opposing change in the rate of current flow the inductive reactance also

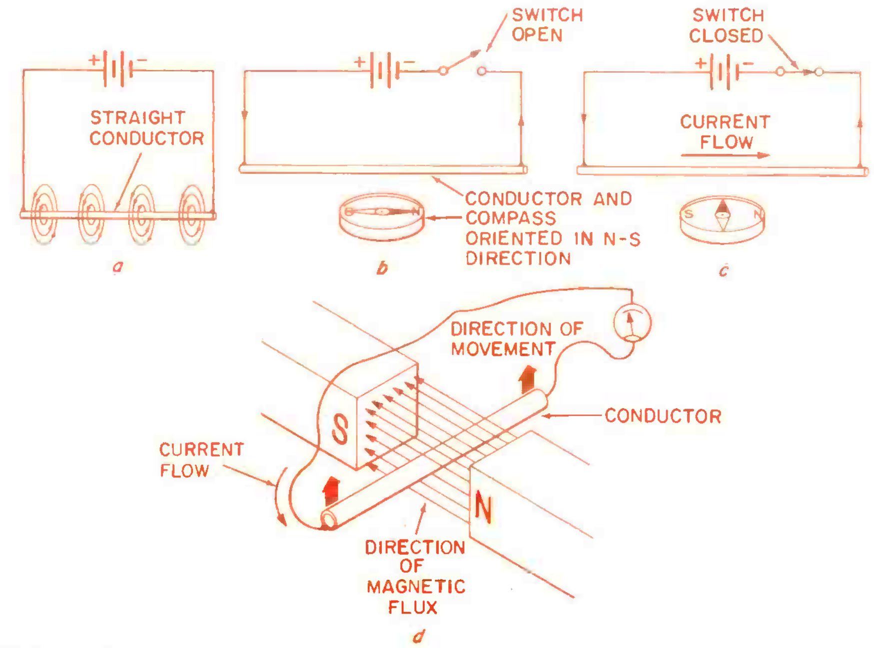


FIG. 1—OERSTED'S EXPERIMENTS showed that a magnetic field (a) exists around a current-carrying conductor. The conductor was placed above a compass (b) aligned N-S. Closing the switch (c) causes compass needle to swing at right angles to the conductor. Needle swings 90 degrees in opposite direction if current flow is reversed or the compass is placed above the conductor. FARADAY EXPERIMENTS (d) demonstrated that current flows in a circuit when a conductor is moved through a magnetic field.

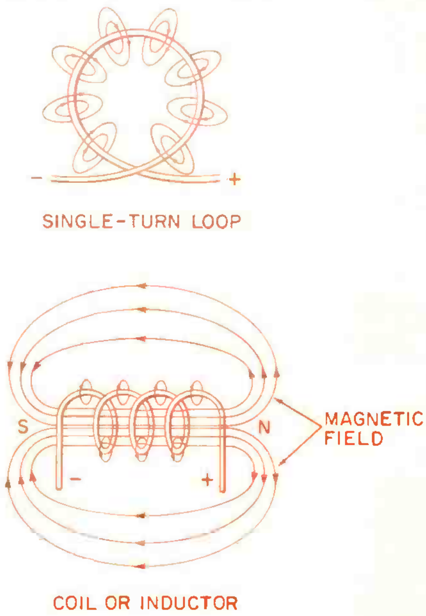


FIG. 2—MAGNETIC FIELD around a current-carrying conductor is concentrated by coiling the wire into a single- or multiple-turn inductor. The inductance increases as the number of turns increases.

causes the maximum values of alternating current to occur ¼ cycle (90 electrical degrees) later than the voltage maximum values. That is; alternating current through an inductor *lags* the alternating voltage by ¼ cycle to provide a phase shift between the voltage and the current. And while the inductor limits the alternating current and develops a voltage drop like a resistor; the inductor does not expend energy. Energy used to develop the magnetic field about an inductor is returned to the electrical circuit as that magnetic field collapses to induce an added voltage.

Inductor Uses

To reduce or eliminate the alternating current passing into a portion of a circuit, inductors are often used. Referred to as filtering, this reduction or elimination of alternating current is often accomplished by a circuit similar to that in Fig. 3. Inductor L represents a

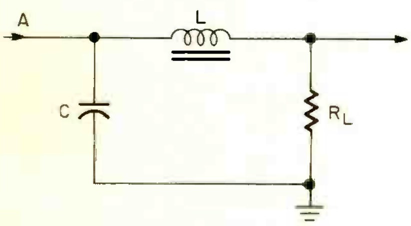


FIG. 3—FILTER CHOKE, L, passes dc and opposes flow of ac from rectifier-type power supply. Capacitor C shunts ac component to ground so it doesn't reach R_L.

rather large opposition to the passage of alternating current while the capacitor C passes alternating current readily. Thus, if both direct current and alternating current are present at point A the direct current would pass readily through inductor L and into the load R_L while the alternating current would be bypassed through capacitor C. Rectifier diodes in a power supply have direct-current and alternating-current components. Accordingly, the rectifying power supply uses an inductor and capacitor in a filter as shown by Fig. 3. Similar circuits are found in audio-, video- and radio-frequency circuits—the output of a transmitter may contain a filter circuit to eliminate spurious frequencies.

Inductors may also be used to reduce the level of an alternating voltage. The cost as well as the phase shift produced makes the use of an inductor for this purpose very impractical in most situations. However; unlike the resistor often used for this purpose, the inductor will not dissipate energy or take power from the circuit.

Broadcast stations often use two or more antennas to establish a desired radiation pattern. This requires that each antenna be fed with a portion of the transmitter's power. One method of dividing that power, or voltage, without a portion of that power being absorbed is by using two or more inductors as shown by Fig. 4. Division of the input voltage E_t is in direct proportion to the inductor values. That is; if inductor L1 has a value of 100 mH and inductor L2 is 50 mH, voltage E1 across inductor L1 will be twice voltage E2 across inductor L2.

$$E1/E2 = L1/L2$$
$$\text{and } E1 + E2 = E_t$$

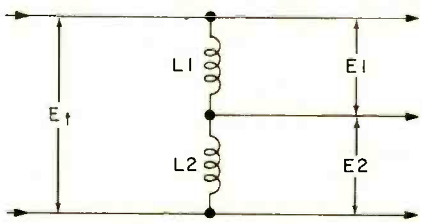


FIG. 4—INDUCTIVE PHASING NETWORK adjusts directivity pattern of BC antenna.

In some early electronics texts, notations can be found with regard to an impedance coupled amplifier. Such amplifier circuits used a large inductor instead of the usual coupling resistor in audio voltage amplification. With this inductive load there was considerably less voltage drop and the supply voltage did not need to be as great. But there were also a great number of disadvantages to such a circuit. A later form of this impedance-coupled amplifier circuit uses the mutual inductance between two windings rather than a coupling capacitor, Fig. 5. This will be

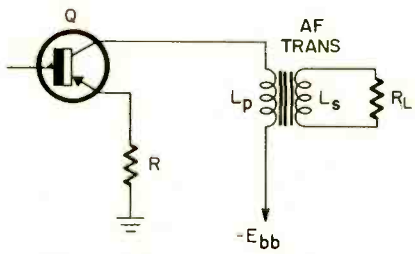


FIG. 5—AUDIO TRANSFORMER is the most efficient method of matching a transistor or tube to another or to load R_L.

recognized as being a *transformer-coupled* amplifier circuit. Basically the transformer consists of two inductors spaced close enough together that the magnetic field of one induces a voltage into the other. For audio frequencies the inductors of a transformer have cores of laminated iron (usually a common core for both windings) while cores of air or of some combination of air and powdered-iron are used for transformers operating at radio frequencies. Regardless of whether it is a single inductor or the mutually coupled inductors of a transformer, the inductor of an impedance-coupled amplifier circuit develops an alternating voltage for the circuit's output.

In series with a capacitor C in Fig. 6 the inductor L develops very little self-induced voltage that opposes the

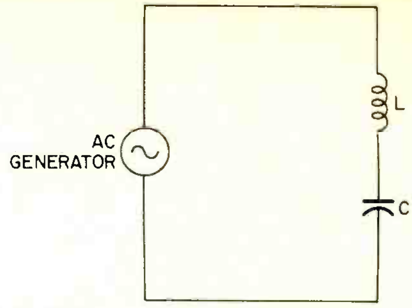


FIG. 6—SERIES-RESONANT CIRCUIT has L and C in series across ac generator.

current flow. In effect capacitor C discharges in opposition to the self-induced voltage of inductor L with the net result that the reactance of the inductor X_L tends to cancel the reactance of the capacitor X_C. At one frequency the two reactances, X_L and X_C, become equal and their net reactance is zero.

$$X_L = X_C$$
$$\text{or } 6.28fL = \frac{1}{6.28fC}$$

With this situation the circuit is said to resonate and the frequency is its *resonant frequency.*

$$\text{Resonant frequency, } f = \frac{1}{6.28\sqrt{LC}}$$

where f is the resonant frequency in hertz

L is the inductance in henries

C is the capacitance in farads.

Conversely, the action of capacitor C tends to reinforce that of inductor L in the parallel circuit of Fig. 7. Thus; the parallel-resonant circuit, Fig. 7, acts much like a filled 'tank' at its resonant

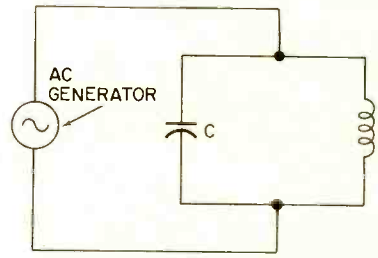


FIG. 7—PARALLEL RESONANCE exists when an inductor and capacitor are in parallel across an ac signal source.

frequency. A filled 'tank' circuit will not accept additional resonating current and represents a very high impedance. This high impedance of the parallel resonant circuit is completely opposite the low impedance of the series resonant circuit.

At the resonant frequency the alternating current through the series-resonant circuit is opposed only by the resistance R within the windings of inductor L as shown in Fig. 8.

$$I = E'/R$$

where I is the current

E' is the applied voltage

R is the inductor resistance.

This current also passes through inductor L, and its inductive reactance X_L, and develops the voltage E_L.

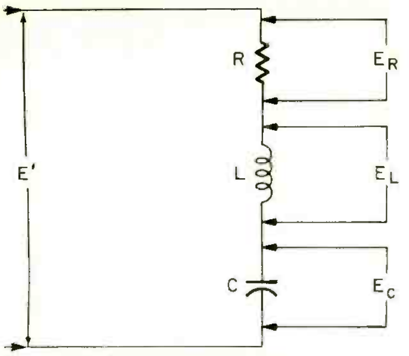


FIG. 8—INDUCTOR RESISTANCE is only limiting factor on current circulating through a series-resonant circuit. Voltages across C and L can each be many times the input signal voltage E'.

$$E_L = IX_L$$

Therefore, 1.0 volt applied to the circuit will produce a current of 1.0 ampere through a resistance R of 1.0 ohm. But that 1.0 ampere will also develop a voltage E_L or IX_L of 100 volts across inductor L if X_L has a value of 100 ohms. So the voltage developed across the inductive reactance, or the capacitive reactance, E_C within a series resonant circuit can be many times the applied voltage E'. And if the parallel-resonant circuit is shown with voltage E' developed across resistance R, it can be shown that the same condition exists.

Q factor

In any resonant circuit, the ratio between the voltage developed across the inductor, E_L, and the applied voltage E' is referred to as the circuit's *Q factor.*

$$Q = E_L/E' = IX_L/IR = X_L/R$$

Where resistance R was 1.0 ohm and X_L was 100 ohms the circuit's Q would be 100. But since the capacitor C of the resonant circuit has very little resistance, the circuit's Q is often referred to as being the inductor's Q. The Q factor also determines the selectivity of a resonant circuit and may also be referred to as a *figure of merit.*

Determination of the Q uses the high-frequency resistance which differs considerably from the direct-current resistance. In addition to the lines of magnetic force surrounding a wire conductor there are also lines *within* the conductor. The greatest concentration of these magnetic lines is at the conductor's center. And the self-inductance is also greater at the center of the conductor. Therefore; the conductor's center is very reactive to high-frequency current causing that current to flow within the outer portions.

This is often referred to as *skin effect* since it, in effect reduces the cross-sectional area and greatly increases the resistance of the wire conductor. High-frequency resistance is the result of the inductive reactance within the conductor but should not be confused with being a reactance. As the number of and the closeness of an inductor's windings (turns) increase its high-frequency resistance also increases. For example; a multi-layered inductor using No. 14 double-cotton-covered wire has a high-frequency resistance of about 0.2 ohm but spacing the turns closer together by using No. 18 enameled wire increases the high-frequency resistance considerably.

A resonant circuit is commonly concerned with selectivity and bandwidth. It must pass (or oppose) the resonant frequency as well as any desirable sidebands while discriminating against any undesired frequencies. A resonant circuit used in the reception of standard AM broadcast signals must pass the carrier frequency plus the 10-kHz sidebands containing the sound. In Fig. 9,

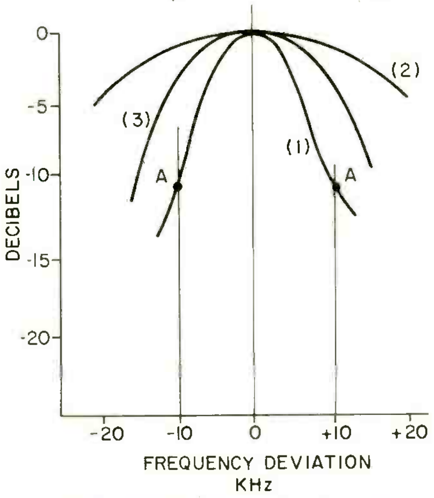


FIG. 9—RESPONSE CURVES of high-, medium- and low-Q L-C resonant circuits.

curve (1) shows the response of a parallel-resonant circuit having a very high Q factor. This very high Q circuit will readily pass the carrier frequency but the sideband frequencies, at A and A', will be reduced too much. Curve (2), with a very low Q circuit, goes to the other extreme and would pass much of the sideband frequencies associated with an adjacent-channel station. Sideband frequencies would be reduced by the medium Q circuit represented by curve (3) but that reduction could probably be tolerated. Thus, the Q of a resonant circuit determines its selectivity and its bandwidth.

Inductor values

Self-induced voltage is related to the inductance L and to the rate of change in the density of magnetic lines of force. Putting this into mathematical form—

Self-induce voltage, $E = -L\Delta\phi/\Delta t$
where L is the inductance
$\Delta\phi/\Delta t$ is the change in density of magnetic lines per unit of time.

But the magnetic flux ϕ (density of magnetic lines) is related directly with the current I and the term $\Delta\phi/\Delta t$ may be replaced by $\Delta I/\Delta t$.

Self-induced voltage, $E = -L\Delta I/\Delta t$

and inductance, $L = \dfrac{-E}{\Delta I/\Delta t}$

Then if the change in current $\Delta I/\Delta t$ is 1.0 ampere per second and produces an induced voltage E of 1.0 volt; the inductance is 1.0 henry (named for Joseph Henry, American, 1797-1878). Except for those inductors used in the filtering portions of larger rectifying power supplies, the henry is too large a unit. Most inductors are rated in millihenries (mH), 1 mH equaling 0.001 henry and in microhenries (μH), 1 μH equaling 0.000001 henry.

The antenna coil, which may also serve as the antenna, of the standard broadcast AM receiver commonly has a value 250 μH. In contrast, for an FM (88 – 108 MHz) receiver the antenna coil has a value of about 20 μH. Many of the other inductors in AM or FM receivers are primaries and secondaries of i.f. transformers with values also in the microhenry range. An inductor of several hundred millihenries is found in discriminator circuits of FM receivers to block the rf while returning the dc to the secondary center-tap. But this rf choke inductor is commonly included within the discriminator package. Some better engineered receivers, as well as Hi-Fi equipment, may have filter inductors of a henry or more in the output of the power-supply circuit.

With the frequencies encountered in television receivers, the tuner inductors, and the i.f. inductors (transformers) etc. have values both larger and smaller than corresponding inductors within the FM receiver. The ultra-high frequency tuner (470 to 890 MHz) has inductors that are a single turn or less. Television receivers also use fixed and variable inductors as peaking coils, synchronizing controls, deflection yokes, traps, etc. with a fairly wide range of values. Deflection yokes, for example, actually consist of two windings with inductance values from 3.5 to 50 mH while horizontal linearity and width controls having minimum values as low as 0.5 mH and maximum values as high as 60 mH.

While it is usually possible to find a replacement for any inductor, it is not common to find a long list of values as we do with resistors and capacitors. Equipment manufacturers usually build (or have built) inductors to fit each circuit design. That is; one manufacturer may find it advantageous to use an antenna coil of 240 μH while another may use a 300 μH antenna coil. Fortunately replacement is not often necessary but the standard replacement antenna coil of 250 μH can usually be made to function properly. While deflection yokes may be somewhat more critical in value any difference can usually be corrected with various physical and control adjustments.

Inductor types

In modern electronic equipment the variable or adjustable inductor is probably the most frequently used. Much of this popularity comes from the fact that one standard production model can be adjusted to a fairly wide range of values. Variable inductors of the past were cumbersome arrangements of switches, adjustable coupling, etc. Presently nearly all variable inductors are like that shown in Fig. 10 with a powdered-iron core that is movable in and out of the cardboard form. As this powdered-iron core is moved further into the windings the lines of magnetic force become more concentrated and increase the inductance. Threads formed on the powdered-iron core make the adjustment continuous and extremely accurate as well as permanent. Other forms of variable inductors do not have this steady and continuous movement and are often difficult to set on a desired value. Powdered-iron core inductors are used as antenna coils (often also serve as the antenna), oscillator coils, primary and secondary windings of i.f. transformers, TV linearity controls, etc.

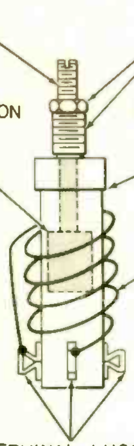


FIG. 10—NEARLY ALL VARIABLE INDUCTORS have a powered-iron core that can be moved in and out of the cardboard coil form.

Fixed inductors may have either air or iron for cores. Fig. 11 shows an inductor with a laminated iron core having an inductance of several henries. This laminated iron core extends through the center of the multiple-layer windings as well as around the sides. Naturally such inductors are very heavy and are, therefore, used only in more expensive equipment to filter the alternating component from the output of a rectifying power supply. Air-cored inductors may have cardboard or other non-magnetic forms to support the windings, as shown by Fig. 12. Or if the windings use heavy gauged wire it may not be necessary to have a form. With values ranging up to several hundred millihenries, the air-cored inductor finds usage as radio-frequency chokes, antenna coils, primaries and secondaries of some i.f. transformers, etc.

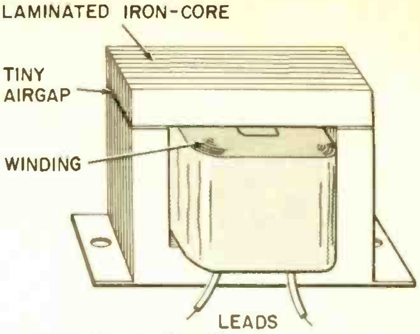


FIG. 11—IRON-CORE INDUCTOR. DC through winding magnetizes core and reduces the effective inductance. Air gap reduces the initial inductance but minimizes inductance changes with current.

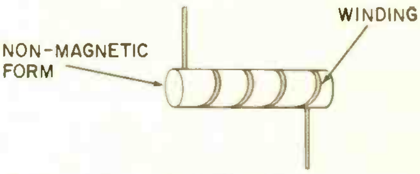


FIG. 12—AIR-CORE INDUCTORS are generally used as rf chokes and in vhf and uhf tuning networks.

A late innovation with air-cored and powdered-iron cored inductors for use at radio frequencies and in pulse circuitry is encapsulation within a plastic form. Such encapsulation provides for maximum mechanical protection so that the winding cannot be disturbed by normal handling. The inductor is, therefore, protected from changes in value and can be wired into a circuit. **R-E**

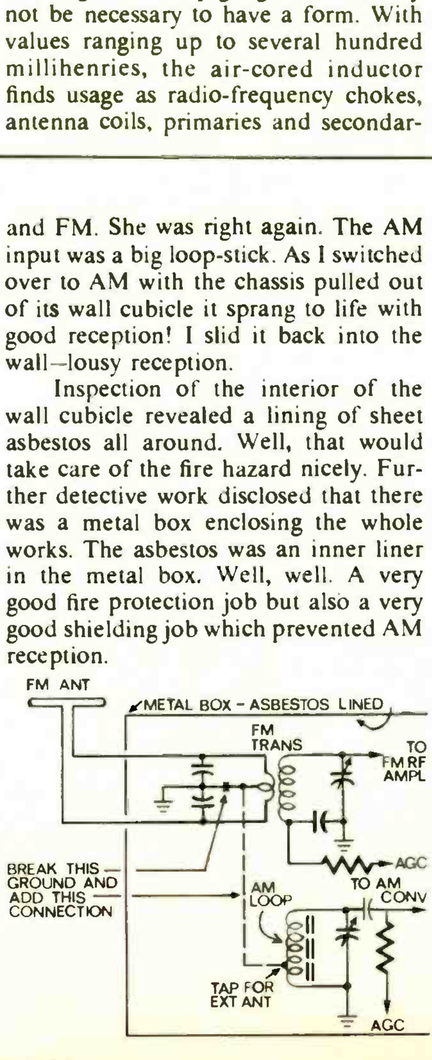
The Case of a Custom Job Too Well Done

by JOHN T. BAILEY

Over the phone she said that her custom built-in radio works fine on FM but the AM never did work as well as she had expected. Would I take a look at it? When I got there I found she was right. The AM sounded as if there was very little signal input. The agc was letting a lot of noise through which confirmed this. As I was pondering how to get into this beautiful built-in-the-wall unit she explained that she had hired a "craftsman" to install an FM antenna with the lead-in buried in the wall. She understood that the AM part didn't need an outside antenna—it had something called a loop, she thought. The craftsman had built the set into the wall and then the entire room was paneled in wood. Oh yes—she had insisted on a safe installation. She didn't want a fire to start in the wall and burn the house down. And she made it clear that I could not rip out the wood paneling to install an AM antenna.

After some study I managed to pull the chassis. It was an expensive job and should have worked well on both AM and FM. She was right again. The AM input was a big loop-stick. As I switched over to AM with the chassis pulled out of its wall cubicle it sprang to life with good reception! I slid it back into the wall—lousy reception.

Inspection of the interior of the wall cubicle revealed a lining of sheet asbestos all around. Well, that would take care of the fire hazard nicely. Further detective work disclosed that there was a metal box enclosing the whole works. The asbestos was an inner liner in the metal box. Well, well. A very good fire protection job but also a very good shielding job which prevented AM reception.



What to do! She wouldn't let me rip out the fire protection or touch the wood paneling in order to run in an external AM antenna.

Fortunately, the service manual was found in the cubicle—very thoughtful of the craftsman. Looking at the FM and the AM inputs, it occurred to me that, with very little work, an AM input could be taken off the FM input transformer primary without degrading the FM performance noticeably.

As shown in the diagram, the FM input transformer primary was center tapped to chassis and each antenna input terminal was bypassed to chassis with a small capacitor. So I merely clipped the center-tap from the chassis connection and connected the center tap to the external antenna tap on the AM loop. With this alteration the FM lead-in became an external AM antenna and, on FM, there was no apparent change in reception. The FM primary still was center-tapped to chassis by virtue of the two input capacitors. A small bypass capacitor which I tried across the loopstick tap to chassis in an effort to further ground the FM center tap wasn't worth the effort and was not left in. **R-E**

Design for STEREO

by MANNIE HOROWITZ

how to design your own solid-state audio amplifier

Power dissipation ratings are vital to all amplifier designs—especially to the low-efficiency class-A circuits discussed in this article.

DATA SHEETS SPECIFYING FETS OR bipolar transistors present two groups of information. One group provides the designer with the electrical characteristics such as beta and leakage current for the bipolar device and transconductance and pinch-off voltage for the FET. These, as well as other characteristics, were used in previous articles detailing the designs of various circuits.

The second group presents information concerning the limits of the transistor. Each transistor has limitations within which it can operate without breaking down. These ratings indicate, for example, the maximum base, emitter and collector currents that may be permitted to flow through the device. It discloses the maximum voltages that the designer may place across various junctions or combinations of junctions without causing the transistor to break down. The voltage allowed across any junction may vary with voltages applied at other junctions of the device, as well as with temperature. Limits are also set to the operating and storage temperatures in which the transistor may find itself, as well as to the amount of power it may dissipate.

The maximum ratings were ignored in previous amplifier discussions because these boundaries are seldom exceeded in small-signal preamplifier stages. It is essential to take these limits into consideration when choosing a transistor for any application. Economical power amplifier design cannot be completed without taking full cognizance of the permissible confines of transistor operation.

Many of the limits apply to both FET and bipolar devices. At this writing, the JFET is used almost exclusively as a small-signal device although there is some work in process on power field-effect transistors. This discussion of power devices and amplifiers will be limited to arrangements using bipolar transistors only. Much of the discussion will likewise apply to power JFETs should they become commercially available.

Real power is developed across a device when current flows through the device while a voltage exists across it. Heat is generated in the device due to the power. Should the transistor be the device in question, the amount of power it is permitted to dissipate depends upon the maximum temperature the junction may reach without inflicting damage upon or without destroying the transistor. It also depends upon the ability of the finished package to convey generated heat from the junctions to the surrounding and cooler air.

The power transistor comes in many different types of packages. The three most common ones are the TO-5, TO-66 and TO-3 shown in Fig. 1. The larger TO-3 devices can usually dissipate more power than the transistors in the small TO-5 package. Transistors in TO-3 cases, as well as those in the smaller sized TO-66 cases, can be conveniently mounted on a large metal surface to facilitate the removal of heat from the junctions.

FIG. 1—POWER TRANSISTORS come in several case sizes and types. The three most popular case types are shown.

The amount of power a transistor can dissipate is related to the ambient temperature or to the temperature of the case. A curve shown this relationship for the popular 2N3055 transistor mounted in a TO-3 case, is shown in Fig. 2. Up to 25°C, the dissipation is limited to 115 watts. The permissible dissipation drops when the case temperature exceeds 25°C until zero watts may be dissipated at the upper thermal limit of the transistor at 200°C. Should the design, for example, require that 55 watts be dissipated by the transistor, the case temperature must not exceed 115°C. Power limiting information should be plotted on the collector characteristic curves display of the device.

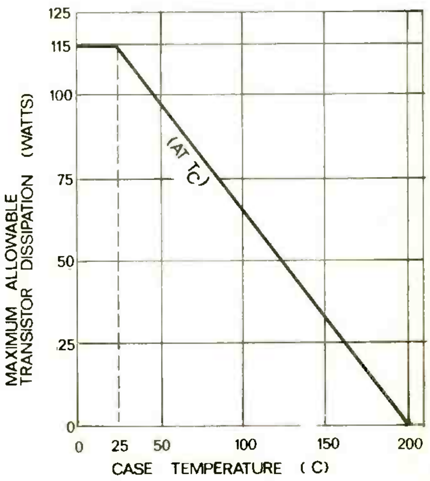


FIG. 2—POWER DISSIPATION curves showing maximum dissipation for the 2N3055 transistor for various case temperatures.

The characteristic curves are supplied by the manufacturer of the transistor. Points on the power limiting curve can be calculated using the Ohm's law equation, $I_C = P_{CEM}/V_{CE}$, where I_C is the collector current, P_{CEM} is the maximum power that can be dissipated by the transistor at the stated case temperature, and V_{CE} is the collector-to-emitter voltage.

For V_{CE} = 0 volts, I_C = 55 watts/0 volts = infinite amperes

V_{CE} = 5 volts, I_C = 55 watts/5 volts = 11 amperes

V_{CE} = 10 volts, I_C = 55 watts/10 volts = 5.5 amperes

V_{CE} = 20 volts, I_C = 55 watts/20 volts = 2.75 amperes

V_{CE} = 40 volts, I_C = 55 watts/40 volts = 1.38 amperes

$V_{CE} = 60$ volts, $I_C = 55$ watts/60 volts $= 0.92$ amperes

Plot these points on the collector characteristic curves and connect them with a smooth line as in Fig. 3. The circuit

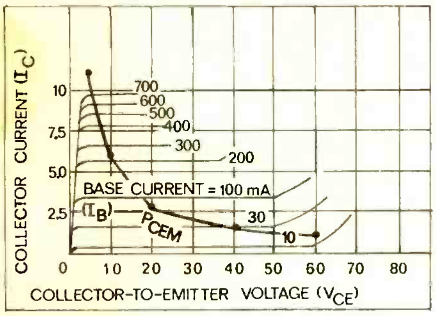


FIG. 3—COLLECTOR CHARACTERISTICS and curve showing power limits. Always operate below the P_{CEM} curve.

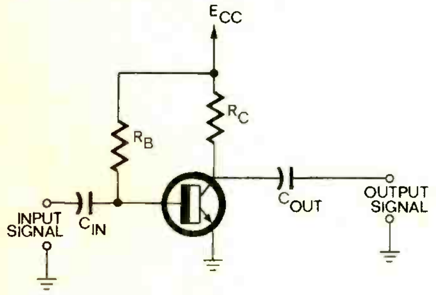
must be designed so that the transistor will operate within the limits set by the curve. Operation above the P_{CEM} curve may cause the device to overheat and be destroyed due to thermal factors.

(It should be noted that although the P_{CEM} curve is superimposed on the collector characteristics, it is independent of these curves. Wherever possible and in the interest of clarity, the actual collector curves will be omitted from the drawings.)

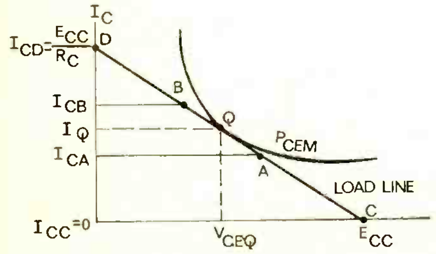
The power amplifier

A class A amplifier is biased so that the collector current flows through the entire cycle. The output is limited to only the leakage and saturation characteristics of the transistor.

Class A power amplifiers can be differentiated from class A signal voltage amplifiers by the magnitude of the output signal swing. This can be illustrated using the circuit in Fig. 4-a and its load line (Fig. 4-b).



(a)



(b)

FIG. 4—CLASS-A AMPLIFIER (a) with load line and maximum power dissipation curves (b). Note that the P_{CEM} curve touches load line only at its center.

You may recall, the dc equation of the output collector circuit of the transistor is

$$E_{CC} = I_C R_C + V_{CE}$$

where V_{CE} is the voltage across the device. As was the case with the small-signal circuits, the equation defines the load line. One point on the load line is when $V_{CE} = 0$ and $I_C = E_{CC}/R_C$. A second point when $I_C = 0$ is $V_{CE} = E_{CC}$. Plot the two points and connect them with a straight line. All coincident collector-to-emitter voltage and collector current relations that may be assumed by the transistor, must lie on this line.

Assume the transistor is idling at point Q on the load line. The bias current is I_Q while the collector to emitter voltage is V_{CEQ}. In the absence of a signal, the transistor current and voltage are at I_Q and V_{CEQ} respectively. A small signal may cause the output current to swing from I_{CA} to I_{CB} or from A and B along the load line while with a large signal at the output, the collector current may swing the limits from 0 to I_C or from C to D on the load line. In the former case, the amplifier may be designed using the small-signal equivalent circuits discussed in a previous article. Amplifier stages which must accommodate the larger swing, should be designed using the power amplifier considerations detailed here. There is, however, no definite point of demarkation where the signal amplifier stops and the power amplifier begins.

It is obvious from Fig. 4-b that the collector current swing is limited to a minimum of 0 amperes and a maximum of E_{CC}/R_C amperes. Likewise, the collector voltage cannot drop below 0 volts or increase above E_{CC} volts. Other factors limiting the swing may be observed from the exaggerated collector characteristic curves in Fig. 5 and the load line on this drawing.

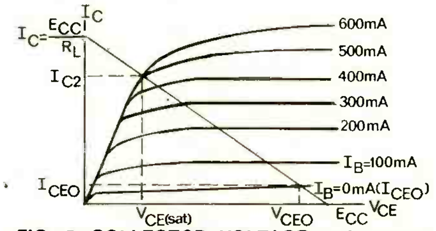


FIG. 5—COLLECTOR VOLTAGE and current-swing limits. V_{CE} in audio use is about $3V_{CE(sat)}$. You may simply subtract a few volts to compensate for V_{CEO}.

At the left, all curves seem to eminate from a reasonably straight line which starts at the vertex. This line is *not* coincident with the I_C axis. In this low collector-to-emitter voltage region, the transistor behaves as a resistor about equal to $V_{CE}(sat)/I_{CZ}$, known as the saturation resistance. $V_{CE}(sat)$, the saturation voltage, is specified at a specific collector current. In the drawing it is shown at the point of intersection of the characteristic curves and the load line. The voltage will differ with the saturation voltage at other collector currents. It may likewise not agree with the transistor data supplied by the manufacturer for he may specify $V_{CE}(sat)$ at a different collector current than the I_{CX} in the drawing. However, the saturation voltage shown is the significant saturation voltage in this particular application. There is no amplification of any signal that may swing to the left of the saturation resistance curve.

At the right, the load line is limited by the $I_B = 0$ collector curve. The output current many not travel below this curve. Considering both limits, the actual maximum collector current swing is $I_{CZ}—I_{CEO}$ and the voltage swing is $V_{CEO}—V_{CE}(sat)$. In the initial design work, these limits may be ignored. They may, however, be very significant in the final design stages.

In Fig. 4-b, the load line just touches the P_{CEM} curve at one point Q. (Although Q has been used previously as the quiescent operating point, here it is assumed to be a point of contact between the P_{CEM} curve and the load line. The actual idling condition may be chosen at Q or at any other point along the load line.) This is the center of the load line. Significantly, if the load line touches the P_{CEM} curve at any one point, the point of contact is always at the center of the load line.

Should a sinusoidal signal be applied to the input of the transistor, after amplification it will travel along the load line at the output, as shown in Fig. 6. Here it is assumed that Q is the qui-

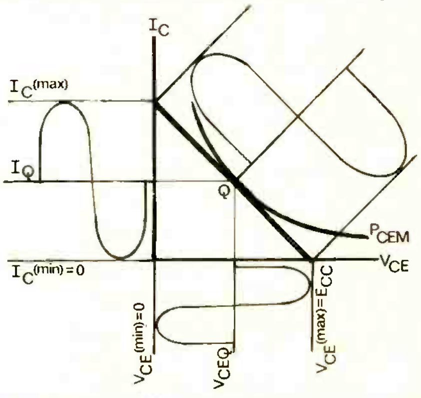


FIG. 6—SINEWAVE OUTPUT. The swing is at maximum, ignoring limitations in Fig. 5.

escent bias point at the center of the load line. The transistor will dissipate the maximum power when it is idling at Q or during the instant in the cyclic variations when the current is I_Q and the collector-to-emitter voltage is at V_{CEQ}. Since I_Q is equal to I_C(max)/2 and V_{CEQ} is $E_{CC}/2$, the maximum power dissipated at any instant in the cycle is

$$P_C\,(\max) = \frac{I_C\,(\max)\,E_{CC}}{4} \quad (1)$$

$$= \frac{I_C\,(\max)^2\,R_C}{4} = \frac{E_{CC}^2}{4R_C}$$

where R_C, the load resistor in Fig. 4-a, is equal to $E_{CC}/I_C(max)$.

If the load line just touches the maximum dissipation curve, $P_C(max)$ is also equal to the maximum permissible dissipation of the transistor. The product of $I_C(max)/2$ and $E_{CC}/2$ on the load line, is always the point in the cycle when the transistor dissipates the maximum power, independent of whether it is the actual quiescent point or whether or not the load line touches the P_{CEM} curve.

As discussed in an earlier article, the rms voltage of a sine wave is $E_p/-\sqrt{2}$ where E_p is the peak voltage. It is also equal to $E_{p-p}/2-\sqrt{2}$ if we let E_{p-p} equal the peak-to-peak voltage. It follows that the rms current is $I_{p-p}/2-\sqrt{2}$. In Fig. 6, the peak-to-peak voltage across the load resistor is E_{CC} so that the rms output voltage is $E_{CC}/2-\sqrt{2}$. Similarly, the rms current across R_C is $I_C(max)/2-\sqrt{2}$. The signal power, P_{RC} developed across the load is the product of the rms current and voltage or

$$P_{R_C} = \frac{E_{CC}\ I_C\ (max)}{8} = \frac{E_{CC}^2}{8R_C} = \frac{I_C\ (max)\ R_C}{8} \qquad (2)$$

Comparing equation 1 with equation 2, it should be noted that the transistor can deliver only ½ the maximum power it can dissipate safely.

Assuming a perfect sinusoidal output, the average power dissipated by the transistor is equal to the maximum instantaneous power as stated in Equation 1, or $E_{CC}^2/4R_C$. As the average or quiescent voltage across the load resistor is $E_{CC}/2$, the power dissipated across R_C is $E_{CC}^2/4R_C$. Ignoring the power dissipated by the input circuit, the supply must furnish power equal to the sum of that dissipated by the transistor and that dissipated across the resistor load, or $E_{CC}^2/2R_C$.

The percent efficiency of the circuit, defined as 100 multiplied by the ratio of the maximum ac power that can be delivered to the load to the power that must be provided by the supply, is 25%. To improve this, the wasted power across the load resistor must be minimized or entirely eliminated.

A circuit with an output transformer can be used to minimize the dc resistance in the collector circuit diminishing the magnitude of d-c power the supply must provide. In Fig. 7, an output transformer is shown between the transistor and the load. The load resistor, R_L, is reflected into the primary circuit multiplied by the square of the turns ratio of the transformer. If N_p is the number of turns in the primary winding and N_s is the number of turns in the secondary, the reflected ac load into the primary is $R_L' = R_L(N_p/N_s)^2$.

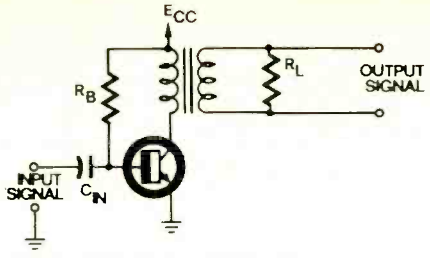


FIG. 7—OUTPUT TRANSFORMER reduces dc resistance in the collector circuit.

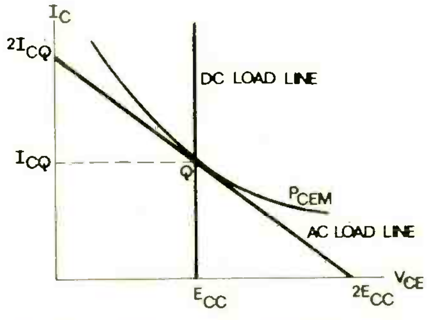


FIG. 8—AC AND DC LOAD LINES for class-A amplifier with transformer output. Zero resistance is assumed for the power supply and output transformer.

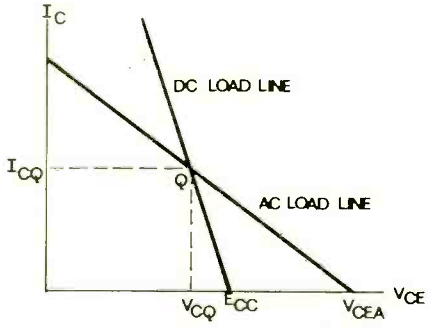


FIG. 9—PLOT OF LOAD LINES when collector circuit has dc resistance.

Two load lines—dc and ac—must be drawn (see Fig. 8). Assume zero resistance in the windings. Using the collector relationship $E_{CC} = I_C R_C + V_{CE}$ stated above, one point on the d-c load line is at $I_C = 0$ and $V_{CE} = E_{CC}$ while the second point is at $V_{CE} = 0$ and $I_C = \infty$. This is a vertical line from E_{CC}. Choose a quiescent point at Q where the dc load line crosses the P_{CEM} hyperbola. Draw an ac load line so that it passes through Q and is at a tangent to the P_{CEM} curve. The a-c load line must then pass through two other points as well, namely through $2E_{CC}$ on the horizontal axis and through $2I_{CQ}$ on the collector current vertical axis.

Assume a sine wave across the load causes the collector voltage to swing from 0 to $2E_{CC}$ volts while the collector current swings from $2I_{CQ}$ to 0 amperes. The power developed across the load is

$$P_{R_L}' = \frac{4\ E_{CC}\ I_{CQ}}{8} = \frac{E_{CC}\ I_{CQ}}{2} \qquad (3)$$

The maximum power that can be dissipated by the transistor is

$$P_{CEM} = P_C(max) = E_{CC} I_{CQ} \qquad (4)$$

There are three major advantages in using an output transformer. First, the circuit efficiency is almost doubled to 50% as the dc supply must provide power for the transistor only. Little power is dissipated by the low dc resistance in the primary winding. Next, the transformer can be used to make a low impedance load, R_L, such as a loudspeaker, appear as a higher impedance in the primary winding where it is most desirable. Finally, it isolates the speaker from the collector current of the transistor. It is undesirable to let dc flow through the speaker coil for it would limit the full travel of the cone.

In most cases, the dc resistance in the collector circuit cannot be ignored. Should the resistance of the primary winding of the transistor be significant, the dc load line will no longer be perfectly vertical. It will be at an angle with the horizontal axis as in Fig. 9. The dc load line can be found using the methods applied to Fig. 4.

The ac load line can be determined using the following logic. The quiescent point on the dc load line is Q. This is also one point on the ac load line. Two points are necessary to define any line. If we let R_L' be the total resistance in the collector circuit (the reflected resistance through the transformer plus all resistance in the ac portion of the collector circuit), the second point, V_{CEA}, can be determined from the equation

$$R_L' = \frac{V_{CEA} - V_{CQ}}{I_{CQ}} \qquad (5)$$

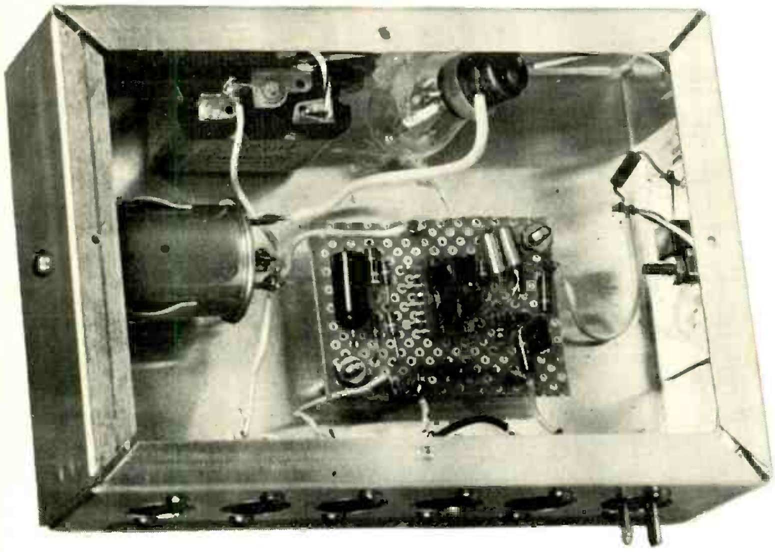
This concludes the discussion on class-A power amplifier fundamentals. But, before going on to class-AB and B amplifiers, we are going to design a practical class-A power amplifier. Watch for it in the next installment. **R-E**

HOT CHASSIS

I'm working on a Setchell-Carlson C105 TV chassis. The thing is hot! Even with the switch turned off it bites. I reversed the ac plug and it still bit me. —H.F., Brooklyn, N.Y.

This TV has a power transformer and it shouldn't bite, no matter which way the line plug is inserted. You have some kind of short or leakage from the transformer primary circuit to chassis. This must be cleared.

The schematic shows two line-bypass capacitors, one from each side of the ac input to chassis. One of these could be shorted. Quick-check, just clip them loose and recheck for hot-chassis. If this doesn't clear it up, you could have a short from the primary winding of the transformer to the core. Disconnect both primary leads, and check from them to the chassis. This should be a completely open circuit, of course. If it is shorted, replace the power transformer.



Use any kind of normally-open or normally-closed sensors with this combination burglar and fire alarm

Build A Multi-sensor Alarm

by C. R. LEWART

THE DEVICE DESCRIBED HERE IS A simple and inexpensive burglar and/or fire alarm circuit that has many features found only in high-priced systems. The circuit as designed uses simple normally open switches as sensors. However, more sophisticated types, heat or smoke sensors could also be used.

The purpose of the circuit is to sound a horn at ½-second intervals to produce a highly annoying **BEEP-BEEP** sound whenever one of the parallel wired sensor switches is activated. An auxiliary output can be used for continuous alarms such as bells, sirens, lights, etc.

Cost of the components in addition to a 12-volt automobile horn and a 12-volt rechargeable storage battery is approximately $10. The battery I used was a non-spillable lead acid 12-volt battery with 10 ampere-hour capacity. This battery (B72-12), made by YUASA Battery (America) Incorporated, 16530 South Figuroa Street, Gardena, Calif. 90247, weighs eight pounds, comes with a 120-volt recharger, a carrying case, and costs $14.50.

The circuit uses programmed unijunction transistors (PUT) to provide a delay between the time the main switch is turned on and the circuit is armed and also between the time a sensing switch is closed and the alarm goes off. This feature allows the use of one of the protected exits without sounding the alarm.

Construction hints

Wiring of the circuit is not critical. The photographs show the layout I used. Relays, jacks, and a silicon controlled rectifier (SCR3) are mounted directly in a 7 by 9 by 2 inch aluminum box. The remaining components are mounted on a 2 by 3 inch rectangular perf board. SCR1, SCR2, Q1 and Q2 are all plugged into a dual-in-line integrated circuit socket.

How it works

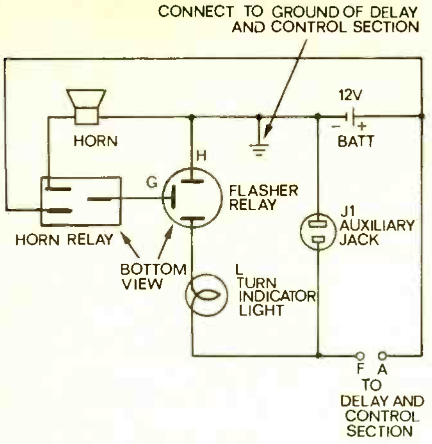
The circuit consists of two sections: 1. The horn actuator. It uses automotive components (Fig. 1). 2. The delay and control section (Fig. 2), using solid state devices.

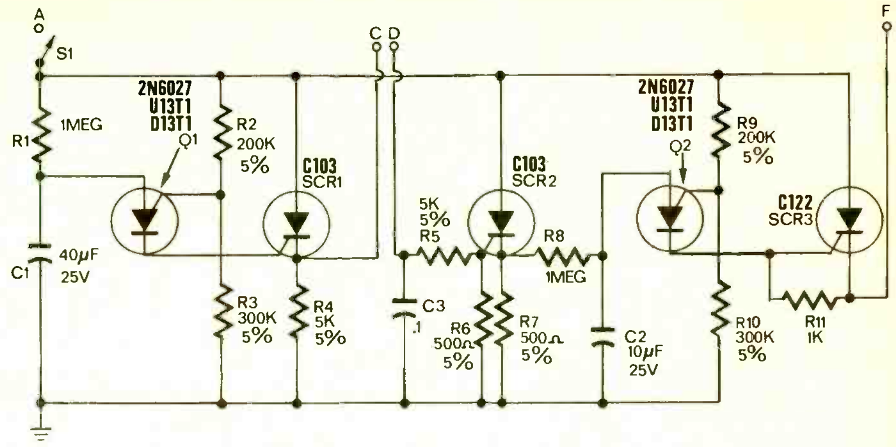
Let's look at the horn actuator section first. If points **A** and **B** are shorted, (through the delay and control section) the flasher relay will close and open the switch between **G** and **H** at approximately ½-second intervals. The flasher relay will, in turn, actuate the horn relay at the same rate sounding the horn. Shorting points **A** and **F** also puts the battery voltage V_B on auxiliary jack J1 which can be connected to a bell, siren, lights, etc. This section of the circuit can be tested independently of the delay and control section by shorting **A** and **F**.

The delay and control section of the circuit provides latching action when one of the alarm sensing switches is momentarily closed.* This section also provides a delay between the time the main switch is closed and the circuit is armed so that a protected door can be used within a minute after the main switch, S1, is closed. A shorter delay of about 15 seconds is also provided between closing of one of the alarm sensing switches and sounding the alarm.

When switch S1 is closed, capacitor C1 starts to charge with a time constant C1R1. Upon reaching the firing voltage of $\left(\frac{V_B \times R3}{R2 + R3}\right) + 0.6)$ volts, which takes approximately one minute, the programmed unijunction transistor Q1 discharges C1 and turns silicon controlled rectifier SCR1 on. The circuit is now armed, and a voltage of approximately (V_B − 1) volts appears across R4. All door, window, and other alarm sensing switches are wired in parallel across points **C** and **D**.* A momentary closing of one of these switches will turn silicon controlled rectifier SCR2 on and latch it. The voltage across resistor R7 then charges capacitor C2 with its

*The circuit can also be operated with all sensing switches normally closed. For this kind of operation, put a short between **C** and **D** and wire all switches in series. Also remove resistor R6, it is no longer necessary. Change the value of R5 to 10,000 ohms.





PARTS LIST (Fig. 1)

Horn—12-volt automobile unit
Horn relay—Sorensen HR20 or equal
Flasher relay—Sears 28KR55107 or equal
L1—Turn indicator lamp, 12 volts
J1—Auxiliary jack
BATT—12 volts (see text)

PARTS LIST (Fig. 2)

R1, R8—1 megohms, ½ watt
R2, R9—200,000 ohms, 5%, ½ watt
R3, R10—300,000 ohms, 5%, ½ watt
R3, R10—300,000 phms, 5%, ½ watt
R4, R5—5000 ohms, 5%, ½ watt
R6, R7—500 ohms, 5%, ½ watt
R11—1000 ohms, ½ watt
C1—40 μF, 25 V, electrolytic
C2—10 μF, 25 V, electrolytic
C3—0.1 μF, ceramic
Q1, Q2—2N6027 or D13T1 or U13T1
SCR1, SCR2—C103*
SCR3—C122*
S1—spst
*Any letter suffix is ok

time constant of C2R8. Upon reaching the firing voltage (which takes about 15 seconds), programmed unijunction transistor Q2 discharges capacitor C2 and turns silicon controlled rectifier SCR3 on. SCR3 then provides an effective short between points **A** and **F**.

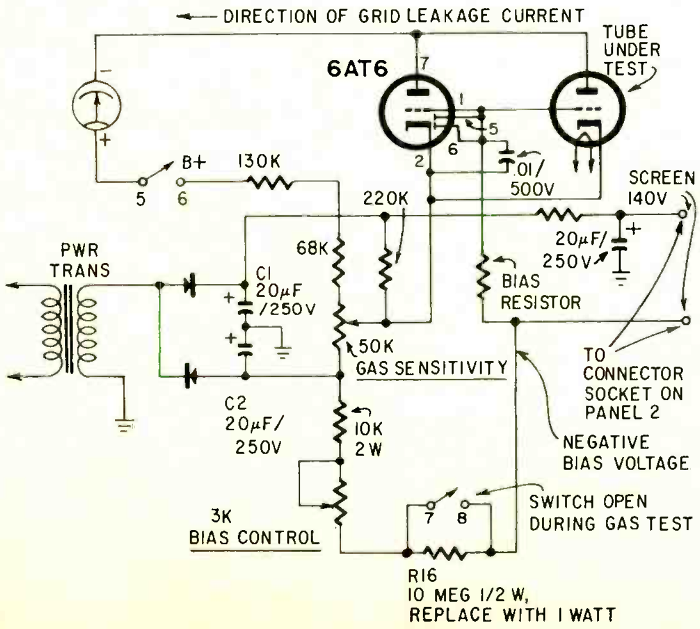
If you intend to use this alarms system drop the editors a note and, if possible, inclose a photo of the unit you build. We're sure other readers would like to see your work. **R-E**

Service Notes

B & K 250 TUBE TESTERS

If the tester indicates grid leakage even when there is no tube in the test socket, this may be due to the 10-meg resistor (R16) in the grid section of the 6AT6 tube. The ½-watt resistor has a tendency to open and cause this difficulty. A 1-watt replacement cleared up the trouble.

The diagram shows a partial circuit of the tester. Normally, cutoff bias is applied to the 6AT6 through the 10-meg resistor. If the resistor opens, electrons reach the plate and the meter produces a false reading indicating grid leakage.—*Roger McDonald*

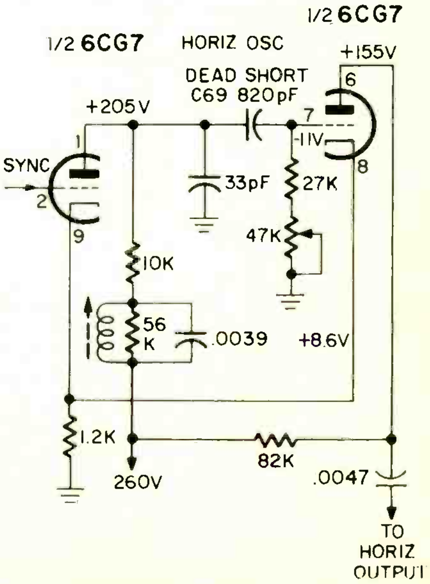


NO HIGH VOLTAGE, NO RASTER

Shortly after an Admiral portable 19UB8 chassis was turned on the plate of the horizontal output tube became red hot. Replacement of the 6DQ6, 6CG7, and damper tubes did not solve the no-high-voltage, no-raster problem.

A voltage check upon the grip of the 6DQ6 indicated no drive voltage and should be a −36 volts. Then voltage checks were made upon the 6CG7, horizontal oscillator tube, and only a +25 volts was found on the plate terminal. The schematic indicated a +205 volts at this point. Pin seven, was +25 V and should be −11V.

We checked the resistance of C69 and found a high leakage reading. Replacement of the 820 pF coupling capacitor restored the high voltage and raster.—*David Mark*



Inside Linear IC's

transistor arrays and you

There are many IC transistor arrays available today. Here's a look at how they tick and what you can do with them

by WALTER G. JUNG

FUNDAMENTAL TO ANY DISCUSSION OF what goes on inside integrated circuits is the idea of component matching. Efficient use of IC's takes advantage of this asset, while minimizing weak points. Circuit design on a chip level is an entirely different ball game from what has been familiar to us in using discrete transistor circuits. But by no means does this say that working with IC concepts can't be fun. True, the ground rules are different, but once these are understood, the sky is the limit.

This month we're going to go right down to the substrate of an IC and explore what makes it tick. And the ideas we'll talk about are ones you can use, not just as an aid to general understanding of monolithic integrated circuits, but as a real-life usable tool through the availability of IC *transistor arrays*. With the use of the unique and special nature of IC transistor characteristics you can build circuits which would be impossible to duplicate with garden-variety discretes.

The characteristics peculiar to IC processing have both its good and bad points. The good points are the closely matched parameters, the very close temperature tracking (due to intimate physical proximity) and the relatively low cost of additional transistors. Monolithic transistors present a number of problem areas. But for the most part, the design challenges which these areas represent has been successfully met. Let's look at a few of these and see how they are being overcome. First we'll list the problems, then look at the solutions to them.

1. Lack of inductors and transformers.
2. Lack of large values of capacitance.
3. Wide component tolerances.
4. Poor quality pnp's.
5. Limited dissipation and voltage ratings.
6. Parasitic effects.

Solutions

1. Neither inductors nor transformers can be integrated, but their performance can be simulated by IC's. The function of an inductor can be replaced by active filter techniques using blocks of gain (available inexpensively in IC's due to the low cost of a high number of active parts). Transformer action can be simulated to a degree by push-pull complementary amplifiers using an all-transistor approach.

2. Capacitors are available within a chip in values to about 200 pF, but are generally undesirable because they take up excessive space (and so reduce the number of circuits available per area). Direct-coupled stages can eliminate the necessity for capacitors to a large degree. The differential amplifier is a natural IC element, and can be utilized effectively to eliminate the requirement for capacitors.

3. The wide tolerance of resistor values common to IC processing can be worked around by taking advantage of the fact that the resistor *ratios* will be close even though the absolute values may vary ±25%. This is true because a pair of identical resistors a few thousandths of an inch apart on a chip will match one another very well, within ±3%. So we can minimize this problem by using designs which depend upon resistor ratios and are uncritical as to their exact value.

4. The poor quality pnp transistors associated with IC's are due to incompatible process requirements with the npn technology. There are ways to work around these difficulties however. The low-beta lateral pnp can be combined with a conventional npn transistor to make a so-called "composite pnp". In addition, newer developments in fabrication techniques are now promising high-quality pnp units which are npn-process compatible and offer but little compromise in performance.

5. The voltage and power capabilities of IC transistors are generally limited although specialized applications extend the range of power dissipation up to several watts. Npn voltage ratings are limited to about 50 volts maximum with some IC's rated at considerably less. Generally, pnp's have much higher breakdown voltages, up to 80 volts.

6. The parasitic effects of monolithic transistors is due to the junction isolation used, and must be considered in using the devices. The effects are both active and passive; resistors exhibit distributed capacitance and parasitic pnp action as do the npn transistors. These parasitic pnp's (due to the P-N junction isolations) must be back-biased to prevent interference with normal circuit operation. Figure 1 illustrates a cross-sectional view of

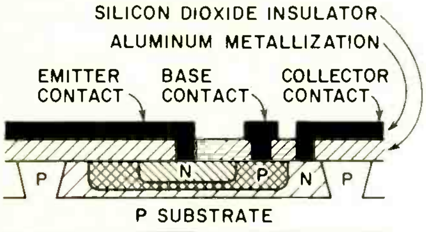


FIG. 1—CROSS-SECTION view of a monolithic npn transistor. High-conductivity metallic paths are used between the various elements and case terminals.

an npn monolithic transistor which is junction-isolated. The collector of this transistor, consisting of "N" material, forms a junction with the "P" substrate. This junction must be *back biased* for the npn to function normally, this is why *the substrate is always the most negative point in an IC.*

Note also in addition to the desired npn device with the base, emitter and collector leads there is a pnp unit formed by the base, collector and substrate. This is the *parasitic pnp,* il-

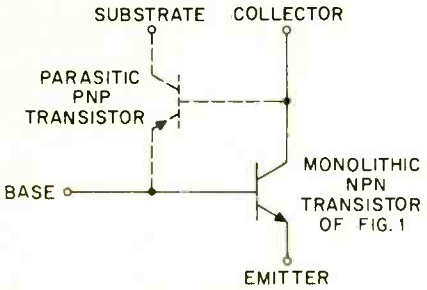


FIG. 2—PARASITIC TRANSISTOR (pnp) developed during formation of a npn monolithic device. The collector-base junction of the npn must always be cut off to prevent the parasitic pnp from conducting.

lustrated schematically in Fig. 2. The collector-base junction of the npn should not be allowed to conduct, otherwise this pnp may turn on and try to take over. This is prevented in normal circumstances by keeping a positive bias on the npn collector.

Now all of this could sound downright discouraging, but it really shouldn't. Look at what has been done to date with IC's and you'll be convinced that there certainly are ways around these problems, and effective solutions do exist. In addition the state of the IC art is far from a static thing. New improvements are being announced at a fantastic rate, and what is stated as gospel today could be obsolete tomorrow. But there is plenty of time to use what is available, so let's now look at some IC's we can use ourselves as design tools.

IC arrays—typical characteristics

The CA3018 IC transistor array (discussed briefly in the June issue) is to the IC transistor-array family what the 709 is to the op-amp family—the forerunner; very versatile, very popular and now a much copied idea. We're going to use the IC transistor array as a transitional point in going from discrete transistor circuit thinking to IC thinking. This is possible because IC transistor arrays allow you to eat your cake and have it too. If you are accustomed to "discrete thinking" you can painlessly use array transistors just as you would plastic ones—and get the bargain of 3 or 4 more per package. But if you gravitate towards monolithic thinking, you have many more possibilities open to you. Let's now look at some IC transistor specs to familiarize ourselves with our working tools.

IC arrays, although they are available in a wide variety of part numbers and from various vendors, boil down to different variations in interconnections on a standard chip. Looking at a schematic of one this is not obvious, but the specifications tell the story. In essence, you may consider all of the transistors within a given array as being identical in characteristics unless it is otherwise stated on the data sheet. Take the CA3018 and its brother, the CA3046 for instance. The CA3018 is a 4-transistor array and the CA3046 is a 5-transistor

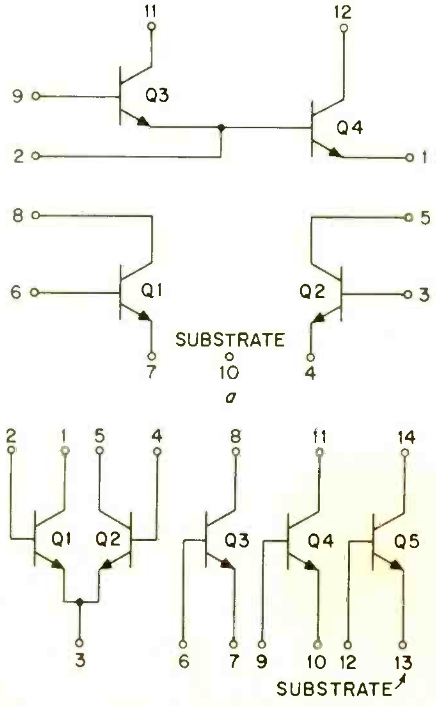


FIG. 3—TRANSISTOR ARRAYS. The CA3018 and CA3018A (a) have two isolated transistors and a Darlington-pair. Three isolated transistors and one differentially connected pair (b) are in the CA3045, CA3046, CA3086, SG3821 and SL3045AK IC's.

device (see Fig. 3). These transistors exhibit (typically an h_{FE} of 100 @ 1 *m*A, breakdown voltages of 24 volts, input offset voltages of less than ½ millivolt, and a beta match between pairs of within 10% (see Fig. 4). You'll also note that Fig. 4 shows the region of maximum h_{FE}, as it peaks around 4 *m*A. The input offset voltage character-

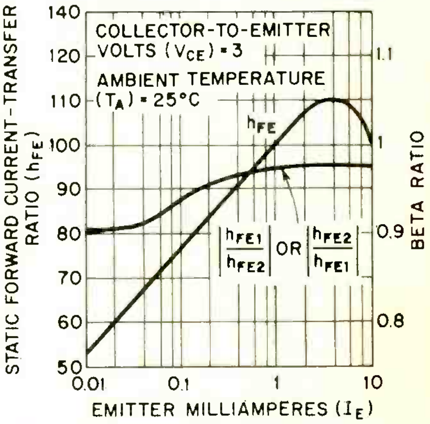


FIG. 4—TRANSISTOR MATCHING is illustrated in these curves showing the static forward current-transfer and beta ratios for Q1 and Q2 in the CA3045.

istics are shown by Fig. 5, where it is seen to be minimum at 1 *m*A or below, rising steeply above this. These two sets of curves show that these array transis-

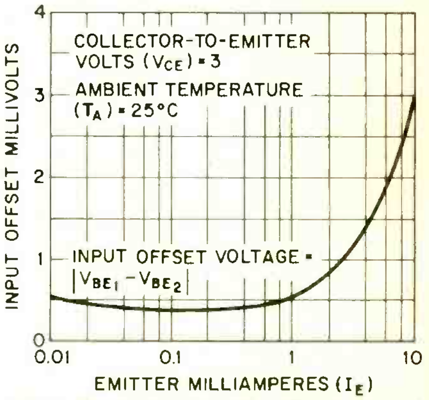
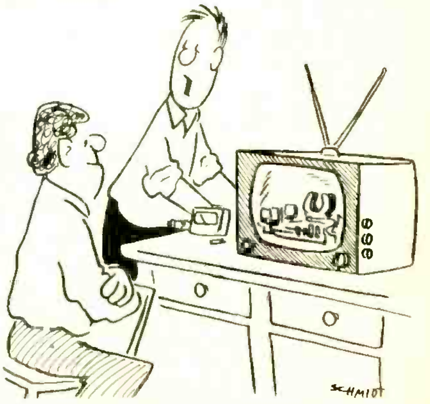


FIG. 5—INPUT OFFSET VOLTAGE for Q1 and Q2 is typical transistor array.

tors have optimum performance below 1 *m*A of emitter current where the best matching predominates and gain is high. **R-E**



No, that's not an education channel Murph, I have the picture tube out.

TECHNICAL TOPICS

Introduction to direct-conversion radio receivers

by **ROBERT F. SCOTT**
SENIOR TECHNICAL EDITOR

IN EARLIER COLUMNS WE DISCUSSED the superheterodyne circuit and have seen how selectivity increases as the intermediate frequency is decreased. Thus, it might seem that the ultimate in selectivity can be obtained by reducing the i.f. to **zero.** We recall that in the superhet, the wanted incoming signal and the signal from the local oscillator are fed into a mixer (converter) and the difference frequency is used as the i.f. The i.f. signal is then rectified to recover the audio information contained in the sidebands.

If we set the oscillator frequency to exactly zero beat with the incoming carrier, we have zero-frequency i.f. and the mixer output consists solely of the beats between the oscillator and the sidebands.

Assume that we want to tune in WWV on 5 MHz while the signal is modulated by a 600-Hz tone. The 5-MHz oscillator signal beats with the carrier and the 4.994- and 5.006-MHz sidebands producing sum and difference frequencies. We'll disregard the sum frequencies and consider only the difference frequencies. The difference between the carrier and the oscillator is **zero** while the difference frequency resulting from the oscillator beating with each sideband is 600 Hz. Since the mixer output that we want to recover is within the **audio** range, there is no need for an i.f. amplifier nor a detector. The mixer output can be fed **directly** to an audio amplifier.

Now, let's see what kind of selectivity we can expect from our imaginary zero frequency i.f. receiver. Suppose that while we are listening to WWV on 5 MHz, shortwave station YVMQ begins broadcasting on 4.990 MHz with 10-kHz sidebands. Our oscillator, tuned to 5-MHz, will produce difference frequencies of 10 kHz, zero and 20 kHz when beating with YVMQ's carrier and upper and lower sidebands, respectively. The beats with the carrier and lower sideband are within the audible range and can interfere with our reception from WWV. However, since we are interested in receiving the 600-Hz tone from WWV, we can eliminate the interference by feeding the audio through a 600-Hz low-pass filter. Thus, we can use an audio filter to provide a degree of selectivity impossible to achieve in a superhet without resorting to complex and expensive mechanical, crystal or ceramic filters. In this system, **selectivity is determined solely by the bandwidth of the audio amplifier.**

Since good selectivity is a prime requisite of a receiver, you are probably wondering why this type of circuitry has not been used. Well, this type of circuit (zero i.f.) has been around for quite a few years in various forms. This reception system is called **direct conversion.**

The most well known direct conversion circuits are the **synchrodyne** and **homodyne.** The synchrodyne uses a local oscillator that is locked in frequency and phase with the incoming signal. In the homodyne system, the injected heterodyning signal is derived **directly from the incoming carrier,** not from a separate oscillator. These and other forms of direct conversion were developed for AM reception and had serious inherent disadvantages that were difficult and expensive to overcome until comparatively recently when new components and techniques were developed. Among the inherent drawbacks are:

Audio images: When using a conventional superhet, we may receive interference from a strong station whose frequency is twice the i.f. away (the image frequency) from the desired station. Image interference is much more severe with direct conversion because, with a zero-frequency i.f., the image frequency is in the af range and stations on adjacent channels can produce beats that fall within the audio passband.

Too, it is possible to receive the desired signal with the local oscillator tuned, not to zero beat with the incoming carrier but to a frequency above the upper sideband or below the lower sideband so as to produce an audio beat.

High distortion: Distortion-free AM reception is possible only when the incoming signal arrives at the mixer completely free from distortion and phase shift and when the oscillator frequency and phase are exactly the same as the incoming carrier.

Spurious whistles. Very loud heterodyne whistles are produced as a signal is being tuned in.

Critical signal level. A high-level

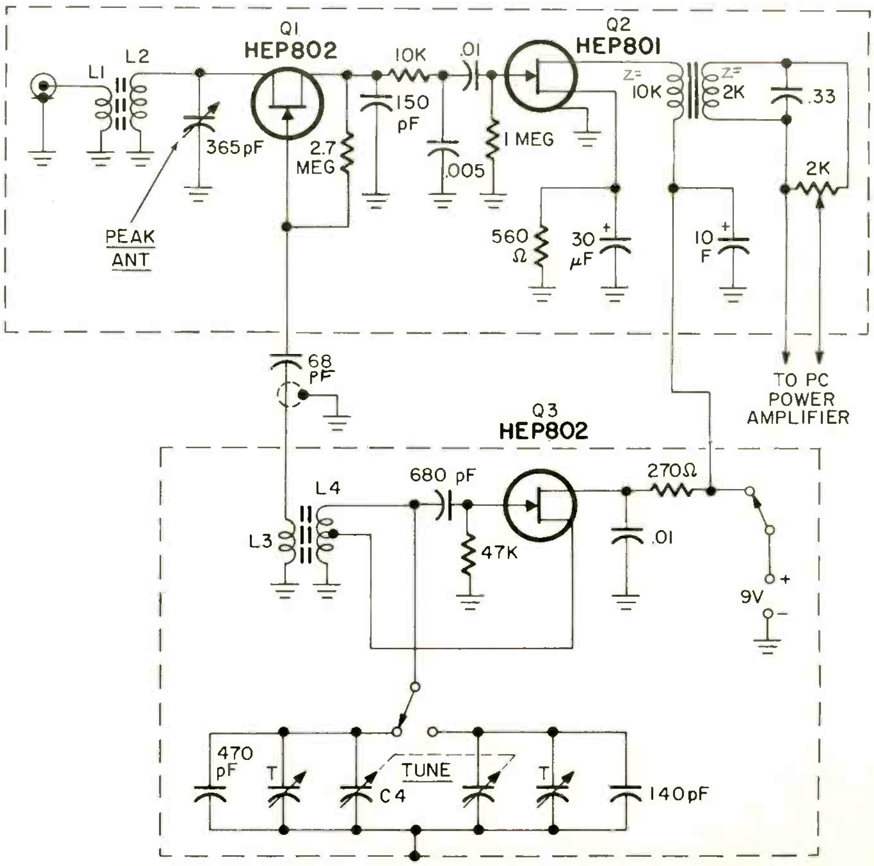


FIG. 2—PARTIAL SCHEMATIC of a direct-conversion receiver for 80 and 40 meters originally appeared in *The Radio Constructor.*

signal is required for reliable oscillator sync while signal level must be kept low to minimize overloading and cross-modulation.

The detector does not produce a dc component proportional to signal strength until the oscillator or injected voltage is correctly synchronized. Thus, there is no simple form of agc or avc available for use in direct-conversion circuits.

Rf amplifiers impractical. Although AM reception requires a strong signal for reliable oscillator sync in a synchrodyne, tubes and transistors are generally nonlinear over a major portion of their operating range and thus tend to cause distortion. Additional distortion can be caused by phase shift inherent in interstage coupling networks.

Direct conversion comes of age

Initially, the various forms of direct conversion were developed for AM reception. If, for some reason, direct conversion should become a must today, techniques developed since its introduction could probably be used to overcome the aforementioned disadvantages.

For example, phasing techniques can probably be adapted to remove audio images just as they are used to suppress an unwanted sideband in SSB transmission.

Simplified phase-lock oscillators made possible by integrated circuits can assure that the injection signal is exactly equal to the incoming signal in frequency and phase. Most of the product detectors and balanced modulators (mixers) can, in a direct-conversion system, process an incoming signal with much less distortion than is inherent in a conventional i.f. amplifier/detector arrangement.

Single-sideband and CW—two common modes of two-way communication today—do not require exact frequency and phase synchronization for satisfactory reception so simple direct-conversion receivers are adequate for receiving CW and SSB.

Squelch circuits operated by the carrier, noise or tones are widely used in FM receivers. Certainly these can be adapted to eliminate the annoying whistle that occurs when the local oscillator is not zero beat with the incoming carrier.

In SSB the carrier is suppressed and so audio-derived agc circuits have been developed to control the gain of rf, i.f. or af circuits. Such circuits can be adapted to direct conversion.

Various engineers have shown that superior performance can be obtained by feeding the rf signal directly into a ring modulator, product detector or similar linear circuit without preamplification. Thus, in direct-conversion receivers, the amplification and preselection often used in superhets is not needed and, in fact, may introduce intolerable distortion ahead of the mixer.

An early practical synchrodyne

Many early experimental synchrodynes used a simple pentagrid converter tube such as a 6BE6 electron-coupled oscillator with the antenna signal fed directly to the signal grid. Generally, the oscillator circuits were designed for good stability but no effort was made for frequency and phase sync except for possible pulling of the oscillator by the tuned antenna circuit. (Perhaps these receivers should have been called direct conversion rather than synchrodynes.)

The circuit in Fig. 1 is one of the first simple experimental synchrodynes in which the local oscillator was locked to the incoming carrier. The circuit was developed by G. A. French and described in *The Radio Constructor* and abstracted in the March 1956 issue of **Radio-Electronics.**

The detector is a balanced bridge fed from a cathode follower with a pot in the grid circuit as a volume control. Preset tuning in the antenna and oscillator circuits minimize tracking problems and completely eliminates the heterodyne whistle that occurs on each station with continuous tuning. A part of the incoming rf signal is tapped off and fed through the sync cathode follower to the cathode of the oscillator to synchronize it with the incoming carrier.

Only two sets of tuning capacitors are shown; others can be added. L1 is a standard broadcast antenna coil. You can use one with a separate primary instead of a tap. The oscillator coil is a broadcast-type rf coil with the primary used for L2 and the secondary for L3. L4 is a winding with enough turns added to develop about 1 volt across the modulator.

To adjust the receiver, tune the antenna coil to a strong local station—use a signal tracer, if necessary. Set the SIGNAL-AMPLITUDE control to maximum and the sync control to minimum. Temporarily short out the 47-ohm cathode resistor and adjust the oscillator tuning capacitor for a low beat note. Remove the shunt from across the 47-ohm resistor and adjust the SYNC control until the oscillator locks-in and modulation is clear. Adjust the SIGNAL AMPLITUDE control and antenna trimmer for the best results.

Fig. 2 is a partial schematic of a direct-conversion receiver for 80 and 40 meters described by Rick Littlefield in *Ham Radio*. Q1 is a simple product detector with the incoming signal applied to its source and the injection signal from oscillator Q2 applied to the gate. The audio signal, developed at the drain, is passed through a low-pass filter to Q3, a low-noise preamplifier. The amplified audio is transformer coupled to a small printed-circuit amplifier.

The antenna coil (L2) for 80 and 40 meters consists of 36 turns of No. 30 enameled wire on a 0.68" toroid form. L1 is 3 or 4 turns on L2. Oscillator coil L4 is 22 turns of No. 22 enameled tapped 5 turns from ground end on 0.68" toroid form. L3 is 5 turns on L4. The oscillator is tuned by a modified two-gang 6.3-123-pF/5.7-78-pF variable capacitor. All rotor plates except six were removed from the large section and all

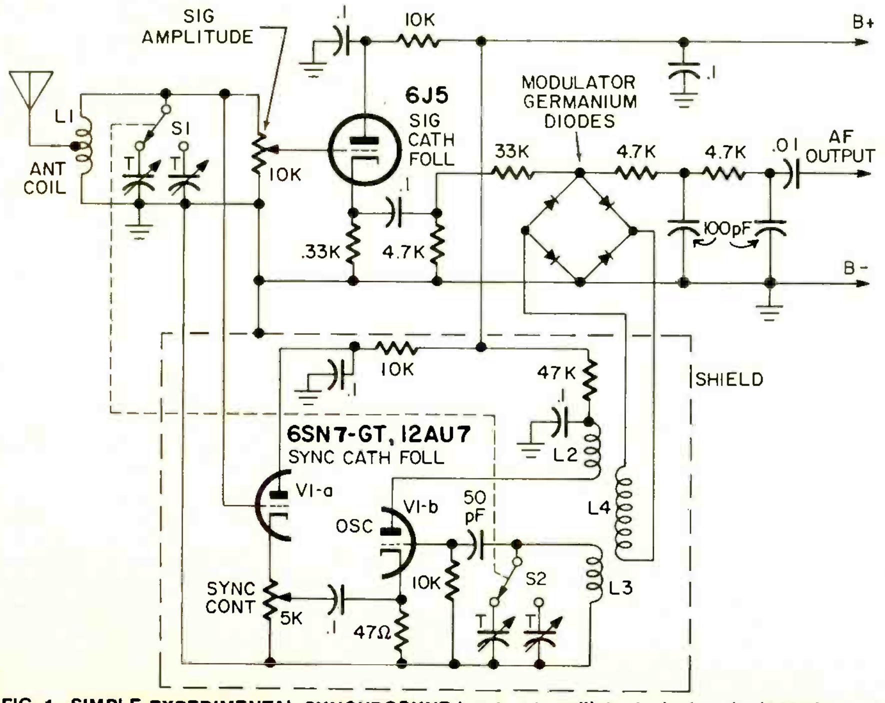
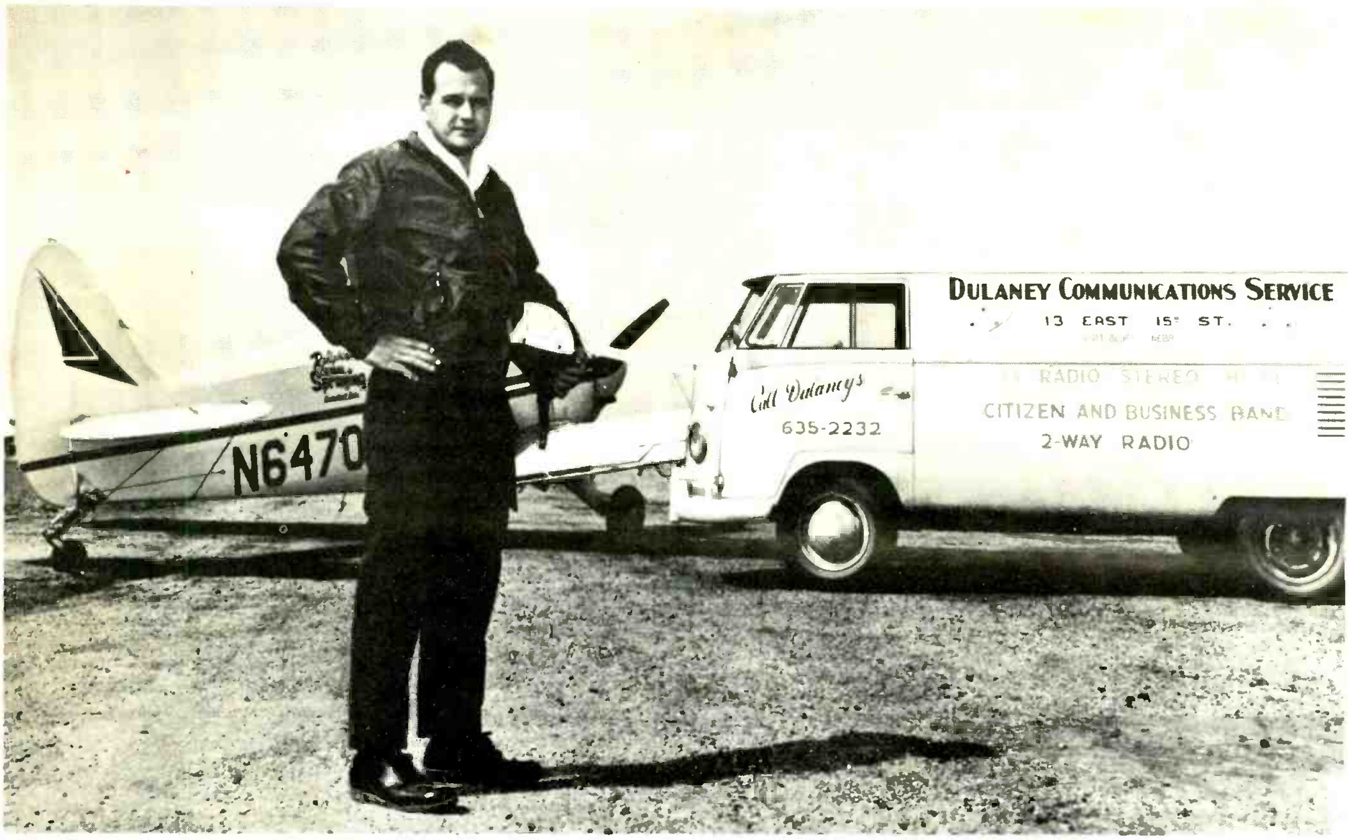


FIG. 1—SIMPLE EXPERIMENTAL SYNCHRODYNE has local oscillator locked to the incoming carrier.

How to get into

One of the hottest money-making fields in electronics today–servicing two-way radios!



HE'S FLYING HIGH. Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. Read here how you can break into this profitable field.

More than 5 million two-way transmitters have skyrocketed the demand for service men and field, system, and R&D engineers. Topnotch licensed experts can earn $12,000 a year or more. You can be your own boss, build your own company. And you don't need a college education to break in.

HOW WOULD YOU LIKE to start collecting your share of the big money being made in electronics today? To start earning $5 to $7 an hour... $200 to $300 a week... $10,000 to $15,000 a year?

Your best bet today, especially if you don't have a college education, is probably in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc. and Citizen's Band uses—and the number is still growing at the rate of 80,000 new transmitters per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Many of them are earning $5,000 to $10,000 a year *more* than the average radio-TV repair man.

Why You'll Earn Top Pay

One reason is that the United States Government doesn't permit anyone to service two-way radio systems unless he is *licensed* by the Federal Communications Commission. And there simply aren't enough licensed electronics experts to go around.

Another reason two-way radio men earn so much more than radio-TV serviceice men is that they are needed more often and more desperately. A home radio or television set may need repair only once every year or two, and there's no real emergency when it does. But a two-way radio user must keep those transmitters operating at all times, and *must* have their frequency modulation and plate power input checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the available licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. A more common arrangement is to be paid a monthly retainer fee by each customer. Although rates vary widely, this fixed charge might be $20 a month for the base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 100 stations, averaging 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

Be Your Own Boss

There are other advantages too. You can become your own boss—work entirely by yourself or gradually build your own fully staffed service company. Instead of being chained to a workbench, machine, or desk all day, you'll move around, see lots of action, rub shoulders with important police and fire officials and business executives who depend on two-way radio for their daily operations. You may even be tapped for a big job working for one of the two-way radio manufacturers in field service, factory quality control, or laboratory research and development.

How To Get Started

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC Exam and get your Commercial FCC License.
2. Then get a job in a two-way radio service shop and "learn the ropes" of the business.
3. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move *out* and start signing up and servicing your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you $5,000. Or you may even be invited to move *up* into a high-prestige salaried job with one of the major manufacturers either in the plant or out in the field.

The first step—mastering the fundamentals of Electronics in your spare time and getting your FCC License—can be easier than you think.

Cleveland Institute of Electronics has been successfully teaching electronics by mail for over thirty years. Right at home, in your spare time, you learn electronics step by step. Our AUTO-PROGRAMMED® lessons and coaching by expert instructors make everything clear and easy, even for men who thought they were "poor learners." You'll learn not only the fundamentals that apply to all electronics design and servicing, but also the specific procedures for installing, troubleshooting, and maintaining two-way mobile equipment.

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By the time you've finished your CIE course, you'll be able to pass the FCC License Exam with ease. Better than nine out of ten CIE-trained men pass the FCC Exam the first time they try, even though two out of three non-CIE men fail. This startling record of achievement makes possible the famous CIE warranty: you'll pass the FCC Exam upon completion of your course or your tuition will be refunded in full.

Ed Dulaney is an outstanding example of the success possible through CIE training. Before he studied with CIE, Dulaney was a crop duster. Today he owns the Dulaney Communications Service, with seven people working for him repairing and manufacturing two-way equipment. Says Dulaney: "I found the CIE training thorough and the lessons easy to understand. No question about it—the CIE course was the best investment I ever made."

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Circle 11 on reader service card

GLOSSARY OF TERMS AS USED OR APPLIED TO DIRECT CONVERSION

AM Reception—The incoming signal is mixed in a *linear* detector with a coherent local oscillator signal that is maintained in proper phase relationship so the upper and lower sidebands reinforce each other. If the oscillator is 90° away from the optimum phase, the sidebands cancel and the detector output is zero.

Audio Image—Similar to image interference in a superhet. The audio image frequency is *twice* the audio bandpass removed from the local oscillator frequency.

CW Reception—Local oscillator must be tuned to one side of the incoming carrier. It is usually tuned to the side having the least interference.

Coherent Detector—A phase-sensitive device whose output is proportional not only to the *amplitude* of the signal being detected but also to its *phase* at the instant of detection. Its output is either negative-going or positive-going, depending on the instantaneous phase relationship between the incoming signal and the reference (local) oscillator.

Coherent Oscillator—An oscillator having the same frequency and a fixed phase relationship with some other signal source. Its output is a signal with definite phase, voltage and current relationships between identical wave elements.

Homodyne Reception—No local oscillator is used. Instead, a portion of the incoming carrier is filtered out and then recombined with the composite broadcast signal in proper phase to demodulate the sidebands.

Product Detector—A linear device in which the output signal's amplitude is proportional to the amplitude of the input signal as long as the input signal's amplitude is much lower than that of the bfo or injection oscillator.

SSB Reception—Only one sideband is transmitted. In direct conversion, the sideband being transmitted (upper or lower) determines on which side of signal the local oscillator must be tuned. In SSB reception, the audio image will be on the wrong side of the re-inserted carrier to be readable and will produce only an annoying interference.

Synchrodyne Reception—For AM reception, the local oscillator is locked in phase with the incoming carrier. The af output of the demodulator has amplitude proportional to the cosine of the phase angle (ϕ) between the incoming signal and the local oscillator. Output is maximum when the phase angle is 90°, cos ϕ is zero and output is zero.

Synchronous Detector—See Coherent Detector.

Two-Phase Synchronous Receiver—Uses two identical synchronous detectors, each followed by low-pass filters and af amplifiers. One synchronous detector is fed a signal from the local oscillator that is in phase with the incoming carrier. The other detector is fed a local oscillator signal that has passed through a 90° phase-shift network. The output of the in-phase detector has maximum aplitude while the output of the 90° out-of-phase (quadrature) detector is zero. This corresponds to the separation of the in-phase (I) and quadrature (Q) sidebands of the 3.58-MHz subcarrier in color TV reception. Thus, in the two-phase synchronous receiver, the in-phase and quadrature detectors may also be called I and Q detectors.

If the local oscillator's phase shifts a few degrees, the I detector output drops in amplitude and the Q detector output rises in proportion to the phase error.

The amplified outputs of the I and Q detectors can be fed through an audio phase discriminator to obtain a dc voltage that can be used as afc to pull the local oscillator back into sync.

In the case of interference; the local oscillator is locked in on the desired carrier and the I output is maximum and the Q output is zero. The interference signal on an adjacent channel causes the I output to contain the components of the desired and unwanted signals. At the same time, the Q output will contain only the interference signal. Since the interference component is the same in both channels, it can be amplified and phase shifted so as to balance out.

but one removed from the smaller section. This results in a maximum capacitance of around 70 pF in the large section and about 15 pF in the small one.

A glossary of terms used in connection with direct-conversion circuitry and a bibliography of material on the subject are included. There will be more on direct conversion in the future. This includes an equipment report on the Ten-Tec RX-10 4-band direct-conversion communications receiver.

Direct conversion bibliography

"The Synchrodyne" by D. G. Tucker and J. Garlick. *Electronic Engineering,* Nov. 1947, p366, Feb. 1948, p49.

"High-Performance Direct-Conversion Receivers" by Pat Hawker, *Radio Communication* Nov. 1970, p760.

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Direct-Conversion Receivers" by Paul Dewhurst. *The Radio Constructor,* March 1971, p479, April 1971, p556.

"Suppressed-Carrier Double Sideband Systems" by G. W. Short. *Wireless World,* May 1961, p243.

"Synchronous Communications" by J. P. Costas. *Proceedings of I.R.E.,* Nov. 1947, p366.

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"How Important Is Detection" by R. C. V. Macario. *Wireless World,* April 1968, p52.

"A Heterodyne Receiver" by Dale Hileman, *Electronics World,* Jan. 1966, p80.

"The D.C. 80-10 Receiver" by Doug DeMaw, *QST,* May 1969, p11.

"Direct Conversion—A Neglected Technique", by Wes Hayward and Dick Bingham. *QST,* Nov. 1968, p15.

"The Synchrodyne" by Ian Pogson, *Radio, Television & Hobbies,* Sept. 1963, p28.

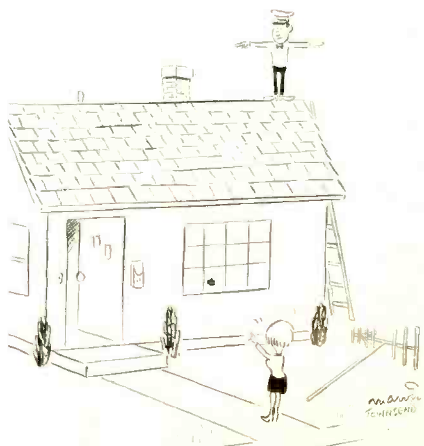
"Synchronous Detectors", by S. George. *Television,* Jan. 1971, p112.

"Supersensitive Communications Systems" by Jim Kyle. *Electronics World.* Feb. 1966, p41.

"Balanced Detector in a T.R.F. Receiver" by James R. White. *QST,* May 1961, p29.

"The Sideband Minituner" by Rick Littlefield, *Ham Radio,* Oct. 1970.

"A Portable Transceiver for 3.5 MHz" by J. E. Hodgkins. *Radio Communication,* Nov. 1970, p757.



"Now let me see how it looks on the other side again."

R-E's Service Clinic

test instrument tricks

Measure component values that are outside your instrument's range

By **JACK DARR**
SERVICE EDITOR

YOU CAN DO A LOT OF THINGS WITH "standard" test equipment. Use your imagination. For example, here are some typical questions, culled from the Clinic mailbag:

"How can I measure the value of a 4,000-μF electrolytic, when my capacitor-checker only goes to 2,000-μF.

Disconnect t, and connect another one in series with it, watching polarity. If the other one is also 4,000-μF the combination is now a 2,000-μF unit and you can read it. If the extra one is say 1,000-μF the resultant capacitance will be somewhere around 500 μF. Capacitors in series, formula: roughly half of the smallest. With this, you can tell whether the big one is open or not, and that's what you want to know (Fig. 1).

Fig. 1

By the way you can use the reverse of this to check a very small capacitor, if it comes out jammed right up to one end of the dial. Connect a known capacitor across the terminals of the cap-checker (take the test-leads off). Balance for the widest eye-opening or meter deflection, which ever yours does. Now connect the unknown across this one, and rebalance the bridge. You can usually read 3- to 4-pF capacitors by the increase in reading needed to restore balance.

Cable breaks

"I've got a long shielded audio cable and it's open! Is there an easy way to find out where the break is?"

Yep. Leave the capacitor-checker turned on! Connect it right across one end of the cable, from inner conductor to shield. Balance the bridge and note the capacitance reading. This is the capacitance between the inner conductor and the shield. Actual reading isn't important.

Now go to the other end of the cable and repeat this test. Most cables break right at one end or the other, at the plugs. If you get a good-sized capacitance reading at one end, and practically nothing at the other, the very low-reading end is where the break is (Fig. 2).

If the two readings are almost the same, the break is somewhere near the

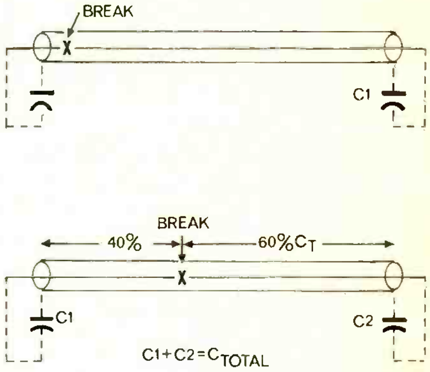


Fig. 2

center of the cable. For example; cable with 1.0-pF capacitance per foot, and 100 ft long. You read 60 pF at one end and 40 pF at the other. The break is 60 feet from the 60-pF end. (Notice how I make those figures come out even?) In actual cables it won't come out so even, of course, but the *percentage* will!

Take the two readings and add them. This is the total capacitance of the cable. Now measure the length, and you'll get the capacitance per foot. Do the mathematics and you'll find out where the break is from either end, in terms of the *percentage* of total length. (Incidentally, this is handy for checking out long rolls of shielded cable, coax, etc., on a reel, without unwinding the whole thing. In fact, you can even use this method between a good wire and a broken one—inside an intercom cable, etc. Read the capacitance between the known-good wire and the broken ends.

"They tell me that the circuit breaker pops at 1.25-A ac. I haven't got an ac ammeter! How can I read it?"

Use a Genuine Simplified Ohm's Law Digital Computer. In other words, connect a good 1.0-ohm resistor in series with the circuit. Then connect an ac voltmeter across the resistor (Fig. 3). Now, each 1.0-volt ac

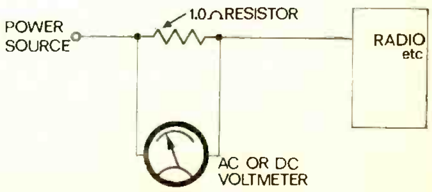


Fig. 3

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, 200 Park Ave. South, New York 10003.

read on the meter indicates 1.0 A of ac current flowing through the resistor. Count it up on your fingers. That's where the "digital computer" comes in.

This same gadget can be used to read milliamperes, in high voltage dc circuits. Just use a good 1,000 ohm resistor. For every milliampere of current flowing through the resistor, you read 1.0 volts Ac or dc; just be sure to use a high-impedance meter.

The same trick will work in low-voltage dc circuits, but you can't use a 1-ohm resistor, especially down around 6 volts or so. One ampere of current will cause a 1.0-volt drop across the resistor, and your set will have only 5.0 volts left! You *can* use this if you have a variable-output dc bench power supply. Just run the voltage up until you read the correct input voltage *at the set*. This will compensate for the metering-resistor drop and everything will be normal.

"How can I read the rf output of a little CB transmitter on my scope? I get nothing, just a line."

That's normal. The average service scope doesn't have much sensitivity at 27.0 MHz! So you're not going to get a heck of a lot of signal through your vertical amplifier. Connect a diode across the direct-probe tip, and then modulate the CB transmitter with some kind of audio signal. For example, feed an audio oscillator to a little speaker; tie the push-to-talk button of the CB transmitter down, and place the mike close to the speaker cone. Then look for the tone-modulating frequency on the scope.

If you have a crystal-demodulator probe with your scope, use it. If the pattern isn't high enough, fasten about 12 to 15 inches of wire to the probe tip and couple it loosely to the transmitter's whip antenna. If you must make tuning adjustments, etc. tune for maximum pattern height. Incidentally, a No. 222 penlight bulb makes a good "dummy antenna" for very small CB transmitters. Won't glow very brightly, but will glow enough to be sure that the thing is putting out rf. Solder the bulb to regular antenna plug used on set. Remove antenna.

There are lots of other ways to use your "common" test equipment, to make special tests. Use your ingenuity! You'll come up with lots of useful ideas. Have fun!

Reader Questions

RED FLICKER

I've got an odd problem in an Admiral 25E6 chassis. Colors flicker at a fast rate; seems to be mostly in the red. Otherwise OK; this is not loss of color-sync or barber-pole. Haven't been able to pin it down.—J.H., Los Angeles, Calif.

There's one way of finding out. Eliminate the other two colors! Turn the Blue and Green screens off, and check it on a pure red picture or pattern. This type of trouble is often due to things like an intermittent solder joint, peaking choke, capacitor or resistor—in the R-Y color-difference amplifier stage, of course.

Another good possibility; check the wiring of the pix tube *socket* for dirty contact, broken wires, etc. "Tap around" in the R-Y amplifier circuit with a pencil, looking for loose contacts.

COLOR PROBLEMS, CH. 13 ONLY

The color is OK on all channels but 13, in this G-E G13 chassis. Sound and picture are off, too; if I tune for one, I lose the other. No color, except when I balance the channel-selector between 12 and 13.—H.J., Fresno, Calif.

From the symptoms, I'd say "Tuner". Everything else is common. If you'll sweep the rf response of Ch. 13 on this tuner, you'll probably find something that looks like a camel-saddle! Single-channel problems with these characteristics are almost always due to tuner troubles, since this is the only thing that is "changed" when you change channels.

BAD ULTOR CONTACT

I get horizontal streaks and flashes in this RCA CTC-17X. Video looks peculiar. The streaks are very thin, and intermittent. The higher the brightness, the worse the streaking. I've checked all of the video tubes, voltages, etc., with no luck. This is a new one. Scope shows nothing unusual in the signal through the video stages.—K.N., Berkley, Mich.

I know what you *might* have. It's rare, fortunately, but I've seen it happen three times (once in my own set)! The *internal connection* from the ultor button on the picture tube may be bad. The internal dag coating may have broken loose from the metal button.

If this happens, the high voltage arcs intermittently from button to coating, and this produces the thin horizontal streaks. Naturally, the higher the beam current (more brightness) the worse the arcing.

Check: clean the bell of the CRT very well, around the button. Fold the rubber cap back, hook up the lead, and turn out the room lights. Watch the ultor connector. If this has happened, you'll be able to see several tiny red arcs from the button to the coating, obviously *inside* the glass! Turn the brightness up and down while you're watching (or have someone else do it. This would take an awfully long arm)! If the arcing *is* inside the tube and increases with an increase in brightness, that's it.

Only cure for this is a new picture tube, I'm afraid. Before you replace it, be sure to check all of the connections in the HV circuit: HV rectifier, socket, wiring, resistors, etc. A burnt series resistor in the HV lead, or an arced-over HV rectifier socket, can imitate it very closely.

NO CONTROL OF BRIGHTNESS

I can set up this RCA CTC-38XL to make a good picture, but the brightness control won't extinguish the raster. (I checked the brightness limiter, too.) The screen controls won't extinguish the beams, either. Everything looks normal; voltages pretty close. In Service position, all I can get is a bright white line, but I can juggle the screen controls on a picture and come out pretty good. Something's still wrong, though.—T.S., Huntington, W.V.

You'll find that your pix tube grids are too far *positive*. If the cathode voltages are close, and vary with the brightness controls, as you say, and the screen voltages are in the ballpark; there's only one thing left. The grid voltages, which are controlled by the color-difference amplifier stages, are so far positive that the cathode voltage cannot cut the beams off.

Needless to say, this will be something common to all three color-difference amplifiers. Check plate resistors, etc.

BLOBS OF COLOR, BUT NO COLOR

This Magnavox T-924 chassis came in for service with a very small picture, which soon disappeared. Checking the power supply, I found the thermistor and varistor in the auto-degausser completely gone; just 4 wires with blobs of metal on the end. After replacing these, and one of the power supply diodes, I got a picture.

However, I have no color. The screen is covered with big blobs of different colors, but they're stationary. Color and tint controls have no effect. What else is wrong here?—N.C., Brooklyn, N.Y.

This kid has been tapped by lightning, and hard! When this happens, the resulting tremendous transient will *magnetize* the picture tube, due to the degaussing coils themselves. It has happened before.

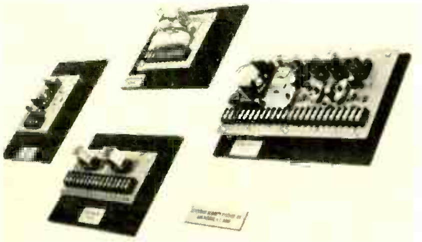
Try this: degauss the tube very thoroughly with a big coil, and I think

(continued on page 91)

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card on page 103 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

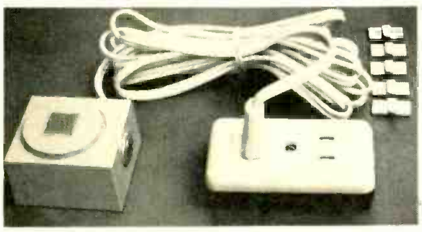
SECURITY SYSTEMS, *models AL-10, AL-20, FM-10, LR-10, RR-10, AR-10, PP-10, SP-10.* Line of interchangeable circuit modules for solid-state electronic security systems such as perimeter, radar, ultrasonic and stress detection types. The modules can be used individually or in



multiples to give warning of forced entry or fire. Each compact module is produced on a printed circuit board with all connections made with screw-type barrier strip for mounting in almost any enclosure.—**Detectron Security Systems, Inc.,** Bay Street, Sag Harbor, N.Y. 11963.

Circle 31 on reader service card

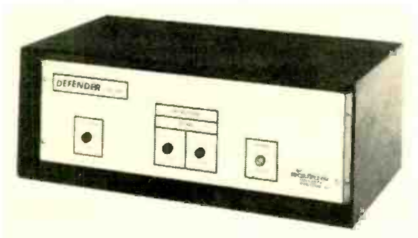
MINIATURE FIRE ALARM, *Mini-Sentry CF-2,* for homes, offices, stores, schools, factories. No nails or holes in walls are required for installation. Place unit on wall near ceiling and plug into 110-117 Vac outlet. The alarm activates the buzzer when ceiling temperature reaches 135°F.



This 3 oz. unit comes complete with 10 foot electrical cord and five adhesive cord holders. $8.95 for one; $8.45 each for two; $8.25 each for four; $8.00 each for six.—**Diamond International Industries,** Dept. F-6, 1045 Airport Blvd., South San Francisco, Calif. 94080.

Circle 32 on reader service card

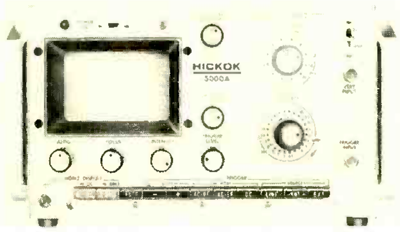
ALARM SYSTEM, *Defender model DS-80.* Designed for the professional security market, the 915-megahertz microwave intrusion alarm system incorporates an inconspicuous antenna sensor and ambient light sensor to monitor relatively large areas. Protects remote locations by adding extra sensors. The command module performs electronic logic analysis to verify human intrusion before activating



alarm; the light sensor does a similar job. Each sensor may be used independently or together to set off alarm.—**Bourns Security Systems, Inc.,** 681 Old Willets Path, Smithtown, N.Y. 11787.

Circle 33 on reader service card

OSCILLOSCOPE, *model 5000A* features 25-MHz bandwidth, stable triggering beyond 50 MHz, vertical bandwidth from dc to 25 MHz (−3 dB point). Built-in vertical delay line provides 50 nanoseconds of display prior to the trigger point on input waveform. The *5000A* has 3% calibrated vertical sensitivities from 10 millivolts to 50



volts per division in 1, 2, 5 sequence. Input impedance is 1 megohm, 30 pF. Sweep delay circuit allows display of any 10-division segment of the 40-division sweep. For field service, research lab, quality control and production testing applications. $595.00.—**Hickok Electrical Instrument Corp.,** 10514 Dupont Ave., Cleveland, Ohio 44108.

Circle 34 on reader service card

FREQUENCY SCALER, *model IB-102.* Used in combination with frequency counter provides measurement capability to 175 MHz, and measures vhf region without vhf counter. Divides input frequencies from 2 MHz to 175 MHz, with the scaled output fed to any frequency counter with a 1 megohm input. Input circuit of *IB-102*

triggers at extremely low signal levels. Front panel sensitivity control and built-in meter allow adjusting the input signal for maximum sensitivity. All solid-state. $99.95 for kit.—**Heath Co.,** Benton Harbor, Mich. 49022.

Circle 35 on reader service card

ANTENNA ROTOR, *model AR-20.* Positive-grip U-bolt clamp for mast mounting,

die-cast upper mast housing, positive braking system, fully automatic control. Set direction, unit will stop automatically

and accurately. Illuminated dial face when system is operating.—**Cornell Dubilier Electronics,** 50 Paris St., Newark, N.J.

Circle 36 on reader service card

REPLACEMENT MULTIPLIERS. Exact replacements for TV high-voltage triplers and quadruplers. Line of four multipliers reduce radiation hazards and cost of flyback transformers. These units eliminate high-voltage rectifier tube and socket, focus rectifier or tube and socket, shunt-regulator tube, and high-voltage cage. The four assemblies meet the specifications of all major set brands. *TVM-026,* $79.95; *TVM-108,* with separate pix tube

anode connector and a 2500 pF, 10 kV capacitor, $43.95; *TVM-153,* with pix tube anode cap and a 27-in. lead, $39.95; *TVM-778,* with anode connector, $39.95.—**International Rectifier Corp.,** 233 Kansas St., El Segundo, Calif. 90245.

Circle 37 on reader service card

FREQUENCY COUNTER, *model 1250.* Portable counter has full range coverage of 5 Hz to 32 MHz, solid-state LED readouts, four ranges with automatic decimal positioning, and a 1-MHz output at TTL levels to use as source for trouble-shooting circuits on a "closed-loop" basis. The counter, designed for bench, field, and industrial applications, has an input imped-

ance of 1 megohm shunted by 30 pF and input sensitivity of 250 mV rms (max. 50 V rms or dc). $395.00.—**Weston Instruments, Inc.,** 614 Frelinghuysen Ave., Newark, N.J. 07114.

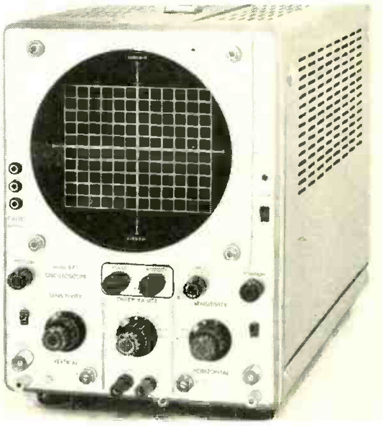
Circle 38 on reader service card

EPOXY GLUE, *Minit-Cure.* Multipurpose epoxy with curing time of less than 60 seconds at 75° F (room temperature). Use to bond metals, woods, plastics, rubber and

glass. For repairs, maintenance, lab work and production. Tensile strength of 2900 psi.—**Tescom Corp., Instrument Div.,** 2633 S.E. 4th St., Minneapolis, Minn. 55414.

Circle 39 on reader service card

OSCILLOSCOPE, *model 572. 7 in.* scope intended for special applications where high legibility is a critical requirement. Contains matched, sensitive d-c amplifiers and balanced attenuators for each axis, permitting phase comparisons and measurements with very small error. 10 cm x 12 cm viewing area on the display tube.



Sensitivity better than 20 mV/cm with bandwidth of about 2 Hz to 600 kHz-3 dB, plus a sweep range of 1 Hz to 100 kHz. Weighs 30 lbs. $589.00.—**Kikusui, c/o Marubeni-Iida (American) Inc.,** 200 Park Ave., New York, N.Y. 10017.

Circle 40 on reader service card

SCANNING RECEIVER, *SCAN 202 HL,* is a multiple-channel monitoring crystal-controlled receiver. Designed for police and citizens to scan all three public safety radio bands, the device can be programmed to tune the field in high band, low band or uhf frequencies, and monitors up to eight specific channels. Handles frequencies from 25 to 512 MHz FM; covers two main public safety bands, 152-164 MHz FM and 30-39 MHz FM. Built for 12-volt dc mobile

operation or 117-volt ac use, the scan comes with power cord, telescoping antenna and built-in speaker. $179.95.—**Pace Div., Pathcom, Inc.,** 24049 South Frampton Ave., Harbor City, Calif. 90710.

Circle 41 on reader service card

MULTITESTER, *model 51-100,* for lab, plant, and service shop. Features 8.5 μA meter-movement for 100,000 ohms-per-volt dc, 10,000 ohms-per-volt ac readings. Has low dc voltage range (0.3 volt) which

is useful for semiconductor circuits. The *51-100* is pocket-size, has band-suspension meter movement; overload protection. Capacitance: 0—0.01, 0.2μF. Decibels: −20 to +58 dB. $30.88.—**Weltron Co.,** 514 E. Peabody St., Durham, N.C. 27702.

Circle 42 on reader service card

4-CHANNEL HEADPHONES, *Quadrafone model K2+2.* This headset is engineered with four separate dynamic driver ele-

ments to reproduce sound from 4-channel amplifiers. The *K2+2* is compatible with conventional stereo amplifiers, as well as 4-channel and augmented 2-channel stereo, and operates from standard stereo phone jacks. Features fluid-filled earcup cushions for isolation of ambient noise and wearing comfort. Frequency response is 10 to 20,000 Hz; total harmonic distortion is 95 dB SPL; impedance 4 to 10 ohms. $85.00 with carrying case.—**Koss Electronics, Inc.,** 4129 N. Port Washington Road, Milwaukee, Wis. 53212.

Circle 43 on reader service card

FM STEREO RECEIVER, *BRC Ferguson model RA-288.* This 90-watt receiver features solid-state circuitry, FET FM front end, electronic tuning and electronically activated tuning indicators, black out front panel, push button switches for mono/stereo mode, phono (mag or ceramic), tape, FM, FM afc. Oiled walnut cabinet included. 100 watts total IHF output; S/N better than 60 dB at phono input;

30 to 20,000 Hz response. Capture ratio 2.7 dB; MPX separation 30 dB. Impedance is 4 to 16 ohms. Operates on 110-120 volts ac, 60 Hz. $220.00.—**Olson Electronics,** 260 South Forge St., Akron, Ohio 44308.

Circle 44 on reader service card

STEREO RECEIVER, *model KR-4140.* This 80-watt (IHF), FET, IC, FM/AM receiver delivers an rms power output of 33 watts per channel at 4 ohms (24 watts per channel at 8 ohms). Frequency response is 20 to 40,000 Hz (± 1.5 dB); power bandwidth is 18 to 30,000 Hz, with distortion less than 0.5% of rated output. The tuner section is

55 dB; IHF selectivity, 1.8 μV; IHF sensitivity, with a capture ratio of 2.5 dB (IHF). $259.95. Optional oiled walnut cabinet, $19.95.—**Kenwood Electronics, Inc.,** Dept. P., 15777 South Broadway, Gardena, Calif. 90248.

Circle 45 on reader service card

GLUE GUN KIT. This automatic gun offers rapid heating, top loading, automatic dispensing and flow control. A built-in light shows when the tool is ready for use and

illuminates the work area. The hot-melt glue and caulk sets in 30 seconds and adheres to wood, plastic, rubber, leather, textiles, concrete, plaster and light metals. Kit comes complete with carrying case, supply of glue and caulk sticks, storage tray, bench stand and manual. $10.95.—**Weller, div. Cooper Industries,** 100 Wellco Road, Easton, Pa. 18042.

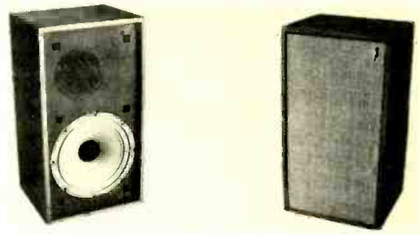
Circle 46 on reader service card

SWEEP MARKER GENERATOR, *model SMG-39.* This precision 'jitter-free' marker generator provides all needed bias and linear sweeping signals for negligible error in alignment of any TV receiver when used with standard oscilloscope. Features VFO

variable marker, 4 bias supplies including –67 volts. All output signals: TV I.F., FM I.F., VSM, chroma, 4.5 MHz and VFO. Cables, probes and leads come with generator.—**Lectrotech, Inc.,** 4529 N. Kedzie Ave., Chicago, Ill. 60625.

Circle 47 on reader service card

HI-FI SPEAKERS, *model 3.* One model in a line of six speaker systems ranging from $30.00 to $198.00, along with six unitary loudspeakers for custom build-ins and do-it-yourself work. The systems feature foam speaker cone suspension; isolation chambers on all direct radiating tweeters and mid-ranges; four-layer woofer voice calls and a computer designed crossover net-



work to provide smoothness and tonal blend. The *model 3* has a frequency range of 36-20,000 Hz, with 8 ohms impedance, 800 Hz crossover, 150± dispersion. $75.00.—**Jensen Sound Laboratories,** 5655 W. 73rd St., Chicago, Ill. 60638.

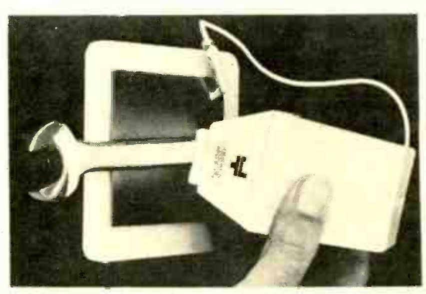
Circle 48 on reader service card

SWEEP GENERATOR, *model ASG-200.* The audio sweep generator provides a source of audio frequency functions: sine, square, triangle, positive sawtooth with variable slope control. Frequency is variable from 0.02 Hz to 20 KHz for all func-

tions. Dial accuracy is within 2%. Power 117 Vac, 50/60 Hz. Output 0 to 20 volts, peak to peak. $84.85 for kit; $108.09 assembled.—**Phase Corp.,** 315A Boston Ave., Medford, Mass. 02155.

Circle 49 on reader service card

METAL-ETCHING INSTRUMENT KIT, *model 17 Marking System,* marks metal tools and equipment. The tool electronically etches marks, names or numbers into flat or round metal surfaces of any thickness, and can be used on office equipment, tools, and parts. It is safe, si-



lent and vibration-free. The unit operates on 117 Vac and will make a permanent mark within 10 seconds. Packaging includes the marking tool, electrical cord, ground plate, electrolyte solution, adapter clip for deep etching, and instructions. Materials supplied will mark up to 2000 items. $24.95.—**Jensen Tools and Alloys,** 4117 North 44th St., Phoenix, Ariz. 85018.

Circle 50 on reader service card

new literature

All Booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free for the asking. Turn to the Reader Service card on page 103 and circle the numbers of the items you want. Then mail the postage-paid card.

SMOKE & HEAT ALARMS, *flyer A-103.* This descriptive flyer explains the need for smoke detection in the home and describes *Smoke Alert models HS-T* and *RR-1.* Complete specifications and installation directions are given.—**Functional Devices, Inc.,** P.O. Box 368, Russiaville, Ind. 46979.

Circle 51 on reader service card

ALARM EQUIPMENT CATALOG, *1971 Space Age Security.* This 64 page catalog describes over 350 intrusion and fire alarm products, many UL listed, of use to alarm installers, dealers, and skilled industrial electronic and electrical technicians who need local alarm systems, parts, and accessories. The items range from "open loop" hardware to the latest ultrasonic, radar, and infrared intrusion detectors, and include fire systems and detectors, remote controls, bells, horns, sirens, lights, telephone dialers, lock specialties, and books. Fully illustrated.—**Mountain West Alarm Supply Co.,** 4215 N. 16th St., Phoenix, Ariz. 85016.

Circle 52 on reader service card

SMALL PARTS CABINETS, *Professional Line Catalog,* shows complete line of small parts storage cabinets, all 22" high, 12" wide and available in 6, 8, 12, 16, 24 and 48-drawer models. Catalog is in full color and demonstrates several examples of stacking and applications. The drawer specifications are shown in line sketches and explain how the drawer can be divided for visibility and inventory control.—**Raaco Corp.,** 370 Ely Ave., South Norwalk, Conn. 06854.

Circle 53 on reader service card

SEMICONDUCTOR CROSS-REFERENCE GUIDE, *1971.* More than 31,000 semiconductor devices are cross-referenced in the catalog. Included are 1N, 2N, 3N, JEDEC, manufacturers' regular and special "house" numbers and many international devices, with particular emphasis on Japanese types.—**Motorola HEP, Semiconductor Products Div.,** 5005 E. McDowell Road, Phoenix, Ariz. 85036.

Circle 54 on reader service card

SWITCH CATALOG, *No. AS-71,* 24 pages of miniature electronic switches and keyboard assemblies. Features six lines of miniature toggles. Each product group described in detail. Electrical specifications, dimension drawings, and prices are shown.—**Alcoswitch, Div. Alco Electronic Products, Inc.,** P.O. Box 1348, Lawrence, Mass. 01842.

Circle 55 on reader service card

TUNER REPLACEMENT GUIDE & PARTS CATALOG, *No. 1,* for service technicians. Lists uhf-vhf-FM tuner parts, channel strips for drum type tuners, spring clips, screws, detent balls, gears, wafers, fine-tuning gear assemblies, coils, plungers, antenna coil replacements with guide. Fully illustrated.—**Precision Tuner Service,** P.O. Box 272, Bloomington, Ind. 47401.

ELECTRONIC PRODUCTS CATALOG, *1971-72.* Completely illustrated listing with prices of the entire line. Features antennas, anode connectors and wire, chemicals, capacitors, color TV components, resistors, transistors, diodes, switches, yokes, etc.—**Oneida Electronic Mfg. Co** 843 N. Cottage St., Meadville, Pa. 16335.

Circle 56 on reader service card

PRECISION TUNER SERVICE MOVES TO NEW PLANT. The management of Precision Tuner Service announces the new address for their West Coast factory and offices. They can now be reached at Precision Tuner Service, P.O. Box 41354 Sacramento, Calif. 95841.

APPLIANCE CLINIC
(continued from page 17)

Millivolt systems

Newer systems, especially on the small home-type heaters, operate on nothing but the minute voltage developed by the thermocouple. For obvious reasons, these are called *millivolt systems*, for that's what you'll read; millivolts! Gas valves are built with specially designed coils, so that they will open on very small currents. One that we checked, an ITT B60, needed only 30 mA dc from the thermocouple!

The valves themselves are specially designed, with a very light diaphragm, usually of a special construction called a bleeder diaphragm. With it, the gas pressure itself actually helps to open and close the valve. The diaphragm is operated by the plunger (core) of the solenoid, and a light spring helps to push the diaphragm closed when the excitation is removed. Like all gas-valves, they are **normally closed.** If power is taken away, they close, to shut off the gas. (Fail-safe!) Since the home gas-lines work at a pressure of only a few *ounces* (4-6 oz is typical) this kind of operation is practical.

The drawing again shows the stock series circuit arrangement. The room thermostat closes when the temperature falls below the set level. The HIGH-TEMPERATURE LIMIT SWITCH is normally closed. If the plenum temperature rises above a certain level, it opens, shutting the system down. (Plenum: the metal box above the main heater which circulates the heated air to the room.)

Any of these units can be checked for proper electrical operation with a standard vom, 20,000 ohms-per-volt or better. If the controls won't start the burner and gas pressure is OK, check the pilot flame. Also, see that the thermocouple body is right in the middle of the flame. If so, and the main burner refuses to light, start checking the electrical circuitry.

Take a millivoltage reading across the output terminals of the thermocouple, on the top of the control unit. Set the vom on an 0-1 volt range (0-1000 millivolts) and look for a minimum reading of about 70-80 mV. Most home-type thermocouples will have an output from this level up to perhaps 150-175 mV. There are high power thermocouples which have outputs up to 800 mV or more, but most home-type stuff will probably be in the 150-mV range.

If you get no output at this point, disconnect the leads from the control unit, and take a reading right across them. The meter can be left on the 1-volt range or switched to the 3- or 30-mA range. Here you should get an output of up to 30 mA if the thermocouple is in good shape.

No reading at all across the thermocouple leads probably indicates a defective thermocouple. Try a new one. (Be sure that the original did have enough heat; that it *is* right in the middle of the pilot flame!) Incidentally, although this is dc, these units **are not polarized.** Leads can be connected either way. If some devices do need polarization, it will be indicated by color-coded leads, red for positive, etc.

If you do get what looks like a normal output from the thermocouple (Still hooked up) but the gas valve won't open, take a voltage reading across the leads to the room thermostat. With such minute currents and voltages, as you can readily see, we can't take any perceptible *resistance* in either switch-contacts or wiring! So if you read more than about 10 mV. across the (presumably) closed contacts of the thermostat, look out! Go to the thermostat itself, take the cover off, and read the contact resistance. If it is very low, short the two leads together, go back to the control unit, disconnect the leads, and see if you get more than 1–2 ohms across the wires. If you do, there is probably a twisted splice somewhere in the wiring! Hunt it down, and solder it.

Contacts on the thermostat itself can be cleaned with a piece of plain paper. As a rule, **never** use emery paper, etc. on contacts in a millivoltage system. If they're so bad that they have too much resistance, replace the thermostat. The same test can be used on the limit switch, which is exactly the same as the thermostat, but works at different temperatures.

Quick checks

One good quick-check for thermostat or limit switch, or wiring troubles is to jumper their contacts on the control unit. If this lets the main burner come on normally, you have located the cause of the trouble. Same old process of elimination used in all electrical and electronic troubleshooting. **DO NOT** leave jumpers in place across safety devices such as limit switches, etc! This is very dangerous.

After the process of elimination, you will have the faulty part pinned down. Replace the defective parts and recheck. The thermostat, limit switch or thermocouple are fairly easy to replace, if directions (always packed with the new unit) are followed. If all of the other things are working, but the main burner refuses to come on, the valve itself is defective.

CAUTION! The valve can sometimes be taken apart and cleaned, or replaced. This job should be handled by a licensed gas-plumber. Do-it-yourselfing here could lead to danger, unless you are an experienced pipefitter, and take every precaution to check out the whole system for gas-leaks! Use soap-bubbles and a small brush. Even at these low pressures, any gas-leakage is potentially very dangerous! However, the electrical parts of the system can be checked by any competent technician, once he knows what the normal reactions are, and this is what we've tried to give you here.

If you are in doubt about your millivoltage reading, whether it actually indicates low output or not, check with your friendly gas-appliance repair man, giving him the make and model-number of the unit. He will be able to tell you just what the normal output of the thermocouple should be. **R-E**

Circle 68 on reader service card

15 new Heath-gift ideas

Meet the second generation AR-15 ...new Heathkit AR-1500!

From the AR-15, hailed at the time of its introduction in 1967 as the most advanced receiver of its kind, comes the AR-1500... with impressive improvements in every critical area! *180 Watts Dynamic Music Power,* 90 watts per channel (8 ohm load); 120 watts dynamic music power per channel under 4 ohm load, with less than 0.1% intermod distortion, less than .25% harmonic distortion. A 14-lb. power transformer and massive output transistor heat sink are mute testimony to the power at your command. Direct coupled output and drive transistors are protected by limiting circuitry that electronically monitors voltage and current. *FM selectivity greater than 90 dB,* better phase linearity, separation, and less distortion are the result of two computer-designed 5-pole LC Filters. An improved 4-gang 6-tuned circuit front end offers better stability, 1.8 uV sensitivity, 1.5 dB capture ratio, and 100 dB image and IF rejection. Four ICs are used, three in the IF and one in the Multiplex. Patented automatic FM squelch is both noise and deviation activated, fully adjustable for sensitivity. *Vastly Superior AM,* an "also ran" with many receivers, has two dual-gate MOSFETS in the RF and Mixer stages, one J-FET in the oscillator, 12-pole LC Filter in the IF, and broad-band detector. Result: better overload characteristics, better AGC action, and no IF alignment. *Greatly simplified kit construction.* Ten plug-in circuit boards, two wiring harnesses and extensive use of pre-cut wiring with installed clip connections make the AR-1500 a kit builder's dream. Built-in test circuitry uses signal meter to make resistance and voltage checks before operation. *Other advanced features* include Black Magic panel lighting that hides dial markings when set is not in use; flywheel tuning; pushbutton function controls; outputs for two separate speaker systems, bi-amplification, oscilloscope monitoring of FM multipath; inputs for phono, tape, tape monitor and aux. sources — all with individual level controls. *Versatile installation* in optional new low-profile walnut cabinet, in a wall, or black-finish dust cover included. Join the "NOW" Generation in audio technology...order your Heathkit AR-1500 today!

Kit AR-1500, less cabinet, 42 lbs. **349.95***
ARA-1500-1, walnut cabinet, 6 lbs. **24.95***

New Heathkit Stereo Cassette Recorder

119^{95}*

Frequency response of ±3 dB, 30-12 kHz, brings your stereo system into the cassette age. Features built-in bias adjustment to accommodate the new chromium dioxide tape; counter; automatic motor shutoff; preassembled and aligned transport mechanism. The AD-110 offers fidelity recording and playback of stereo or mono when used with your stereo system.

Kit AD-110, 10 lbs. **119.95***

New Heathkit Stereo-4 Decoder

29^{95}*

Compatible with your present stereo system and FM receiver, lets you hear all Stereo-4 material currently being broadcast by a number of stations across the country. Additionally, imparts a 4-channel effect to your existing stereo library. Requires second amplifier and 2 speaker systems for installation with conventional stereo system.

Kit AD-2002, 5 lbs. **29.95***

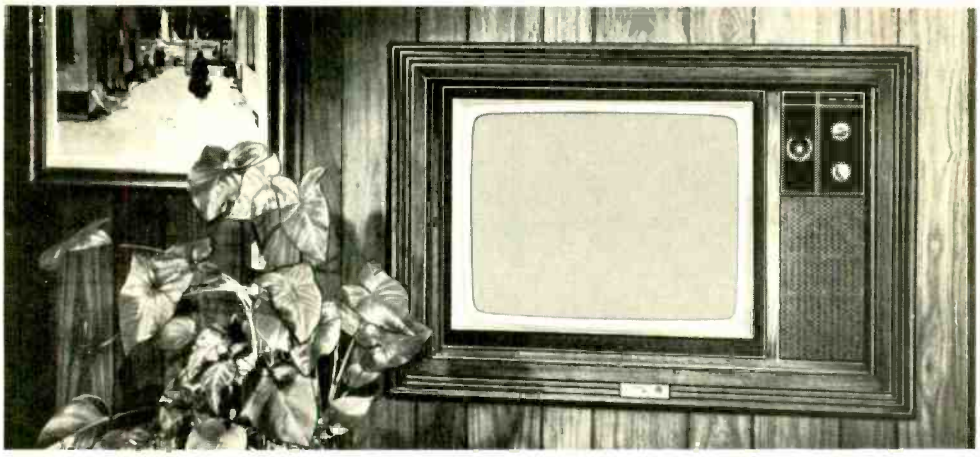
New Heathkit Stereo Phonograph with AM Radio

109^{95}*

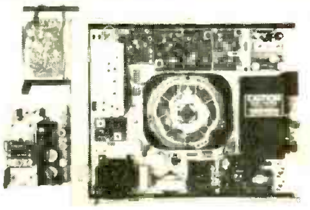
Gets it together in a portable package with a purple plum snakey skin that's as far out as today's sounds. Solid-state 18-watt amplifier, fold-down 4-speed automatic changer and swing-out high compliance speakers. Speakers can be separated up to 5′. A flip of the mode switch and you're into AM radio! 45 spindle adapter included.

Kit GD-111, 50 lbs. **109.95***

for a Heathkit Christmas



Heath's finest color TV, now available in optional new hide-away wall mount



Here's the inside story:...the Heathkit 25" solid-state color TV with exclusive MTX-5 ultra-rectangular tube to bring you the largest color picture in the industry! The etched, bonded tube face cuts glare, increases contrast for sharper picture, purer colors, more natural flesh tones. But the true story of color TV reliability starts in the solid-state modular circuitry ... 45 transistors, 55 diodes, 2 silicon-controlled rectifiers, 4 ICs containing another 46 transistors, 21 diodes, and just two tubes (picture and high-voltage rectifier). Major circuit functions are contained on individual plug-in glass epoxy boards (see chassis inset above) to simplify assembly, service and adjustment. And, of course, only Heathkit color TV offers you the money-saving advantages of home-serviceability...with the built-in dot generator and tilt-out convergence panel to let you perform the periodic adjustments required of all color receivers.

Other advanced design features include solid-state VHF tuner with MOSFET for greater sensitivity, lower noise and cross modulation; solid-state UHF tuner with hot-carrier diode design for greater sensitivity; 3-stage solid-state IF for higher gain and superior picture quality; Automatic Chroma Control for constant color quality under different signal conditions; adjustable video peaking; adjustable noise limiting and gated AGC; "Instant-On"; VHF power tuning on 13 channels plus one preselected UHF channel; Automatic Fine Tuning; Tone-Control; and an output to your stereo/hi-fi system for the ultimate in sound reproduction.

And to wrap it all up...custom install your Heathkit GR-371MX in the exciting new Heathkit TV Wall Mount. Push the button on the picture frame — or on your optional GRA-70-6 Wireless Remote Control — and the carefully crafted tambour doors silently glide open to reveal your color TV with turned-on picture and sound. Another touch of the button and the doors slide closed, turning off the set. The Custom Wall Enclosure is available in either walnut or unfinished versions. Kit includes trim frame, sliding tambour doors, electric motor assembly — forms completely self-contained enclosure with tilt-out speaker baffle and convergence panel mount, slides easily into prepared opening. Also can be used to conceal wall safe, built-in bar, etc. Cabinet measures $23\frac{5}{16}$" H x $38\frac{11}{16}$" W x $22\frac{3}{8}$" D. Frame measures $26\frac{1}{8}$" H x $39\frac{9}{16}$" W x $1\frac{5}{16}$" D.

Kit GR-371MX, TV only, 125 lbs. **579.95***
Kit GRA-402-25, TV Custom Mount (finished), 50 lbs. . .**114.95***
Kit GRA-407-25, TV Custom Mount (unfinished), 50 lbs. **109.95***

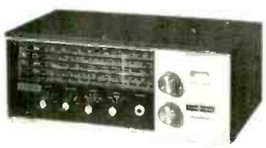
New Heathkit Solid-State Wireless Intercom

29^{95}*

Plug two of them into standard 105-130 VAC outlets for 2-way communications. Three channels let you carry on 3 conversations in a 6-unit system, call one unit without disturbing the others in a 3-unit network. Intercoms have channel selectors, spring loaded "talk" button, slide-action volume control, and "dictate" for extended one-way communication.

Kit GD-113, 5 lbs. ...... **each 29.95***

New Heathkit Solid-State Shortwave Receiver



59^{95}*

Four over-lapping bands provide continuous coverage from 550 kHz to 30 MHz, giving you local AM plus international, amateur, marine & weather and citizens band broadcasts. Features band-spread tuning for close station separation; BFO control for receiving code; signal meter; front-panel headphone jack; noise limiter; built-in AM antenna.

Kit SW-717, 10 lbs. **59.95***

New Heathkit Automatic Battery Charger...

Charges 12-volt batteries automatically. 10 amp max. charge rate. Impossible to hook up wrong. No charge setting to make . . . can be left hooked up indefinitely. Meter monitor charge. **Kit GP-21,** 13 lbs. **29.95***

New Heathkit Automotive Timing Light...

Completely self-contained. Bright flash lets you work in sunshine. Adapter for connecting to distributor. Hi-impact plastic case.

Kit CI-1020, 3 lbs. **19.95***

there's a Heathkit present

229^{95}*

New Heathkit Solid-State Digital Multimeter...

Here's a breakthrough in instrumentation. The new Heathkit IM-102 gives you a true digital multimeter for about half what you'd pay for comparable wired DMM's! And with an accuracy that's better than many wired digital units on the market...decidedly superior to most analog type instruments. This great new meter measures AC and DC voltages and currents, and resistance with no need to change probes or switch for changes in DC polarity. Automatically displays a positive or negative DC voltage and current, indicating the correct amplitude and polarity. Five overlapping ranges measure voltage from 100 uV to 1000 V on DC (either polarity); five ranges cover 100 uV to 500 V on AC; 10 ranges measure 100 nanoamperes to 2 amperes on AC or DC, and six ranges show resistance from .1 ohm to 20 megohms. Input impedance is exceptionally high — approximately 1000 megohms on 2V range (10 megohm on higher ranges), with overload protection built-in on all ranges. Decimal point is automatically placed with range selection and overrange is indicated by a front panel light.

Ends parallax and interpolation errors! There's no mistaking a digital display — everyone reads it the same way. High quality precision components, 3½ digits and ease of calibration contribute to the IM-102's lab-grade accuracy. Analog to digital conversion is accomplished by a patented, dependable Dual Slope Integrator that does not depend on a stable clock frequency for accuracy. A Heath-designed and assembled precision DC calibrator is furnished with each IM-102. An internal circuit and transfer method provides accurate AC voltage calibration. The all solid-state design incorporates cold cathode readout tubes and a "memory" circuit to assure stable, non-blinking operation. Features include detachable 3-wire line cord (no batteries needed), dual primary power transformer, isolated floating ground and completely enclosed, light-weight aluminum cabinet with die-cast zinc front panel and tinted viewing window. Kit includes standard banana jack connectors complete with test leads. Assembles in approximately 10 hours. The new Heathkit IM-102 Digital Multimeter will be the pride of your bench!

Kit IM-102, 9 lbs., mailable **229.95***

New Heathkit Vector Monitor...

49^{95}*

Designed for use with the Heathkit IG-28 Pattern Generator or similar units which display either "rainbow" (offset carrier) or NTSC patterns, the IO-1128 vector display helps you perform fine tuning, static and dynamic convergence, purity, 3.58 oscillator, reactance coil, phase detector transformer, demodulator angle check, and chroma bandpass adjustments. Represents exactly the color signals fed to CRT guns.

Kit IO-1128, 10 lbs. **49.95***

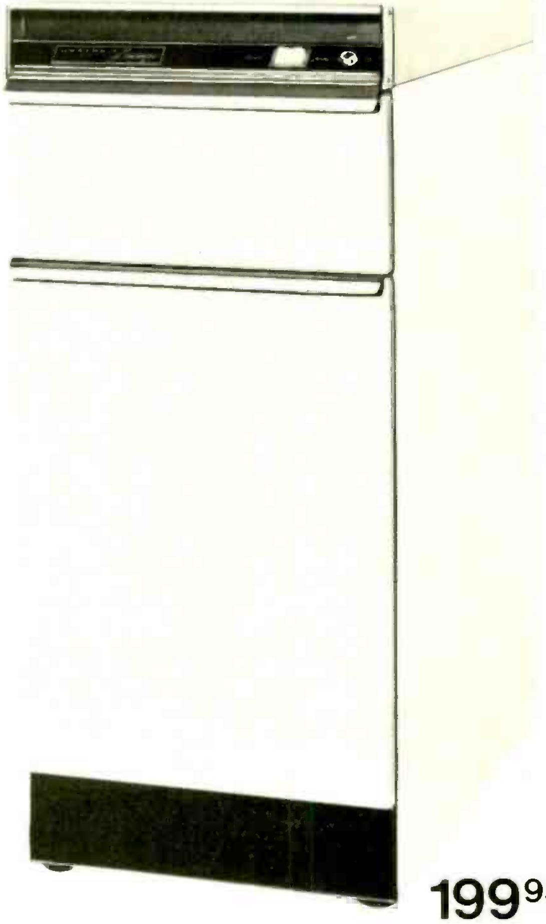
New Heathkit Electronic Switch... 39^{95}*

Provides simultaneous visual display of 2 input signals on a single trace oscilloscope. Has DC coupling and DC-5 MHz ±3 dB frequency response. Conventional binding posts permit fast hook-up. Can be left connected to scope. Ideally suited for digital circuit work; amplifier input and output for gain and distribution checks; simultaneous monitoring of 2 stereo channels.

Kit ID-101, 6 lbs. **39.95***

for every age, every hobby!

New Heathkit "Minimizer" kitchen waste compactor...



Today's most modern refuse handling method in easy-to assemble kit form! Now you can own the most exciting kitchen appliance on the market for less than you'd pay for any other comparable compactor. The Heathkit Minimizer lets Mom throw out the unsightly waste baskets and garbage cans for the latest in clean, convenient, odor-free disposal. The Minimizer handles all normal household trash — food wastes, glass and plastic containers, tin cans, wrappings, boxes, floor sweepings, light bulbs, etc. The packing ram descends with 2,000-lb. force to reduce refuse to almost ¼ of its original size, packaging the material in a strong disposable bag — one bag holds an entire week's trash for a family of four! When the bag's full, Mom simply folds over the top and removes a neat, dry package for normal rubbish pickup. And the Minimizer deodorizes the contents each time the drawer is opened and closed. The sanitation man will love Minimizer, too!

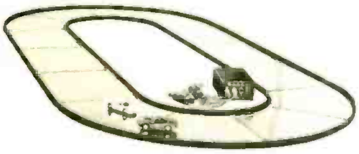
Simple, safe operation! To use, Mom merely inserts a Minimizer plastic-lined bag in the drawer and starts the compacting cycle. In less than a minute the ram forces down the trash, returns to its normal position, and the Minimizer shuts itself off. For maximum safety, the Minimizer uses a key lock switch and an interlock which automatically turns unit off if drawer is not fully closed or is accidentally opened during cycling. Your Heathkit Minimizer can be built-in under the kitchen counter or left free-standing. Its bright white enamel finish with marble-tone vinyl-clad top complements any decor. And you can build it yourself in 6 to 10 hours. Has long-life ⅓ hp motor, plugs into 110-120 VAC conventional household outlet. Kit includes 5 plastic-lined bags, one 9 oz. aerosol can of deodorant. Minimizer measures 34⅜" H x 15" W x 25½" D.

Kit GU-1800, 203 lbs. **199.95***
GUA-1800-1, 15 plastic-lined bags, 5 lbs. **4.99***

199.95*

New Heathkit Slotless 1/32-Scale Raceway

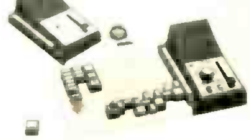
129.95*



You race up to 4 GT cars — each with independent acceleration, deceleration and steering! Make all the maneuvers of real high-speed drivers. You can even turn around completely and backtrack. Kit includes track sections for 8'x4' oval, power transformer, 2 cars and controllers.

Kit GD-79, 13 lbs., mailable **129.95***
Kit GDA-79-1, extra car and controller, 3 lbs., mailable .. **21.95***

New Heathkit Electronic Workshops



Completely self-contained electronics labs teach youngsters the basics of electronics. Each contains basic electronic components in easy-to-work-with module form. Kids simply follow the instructions, arrange the blocks on the board to form actual working circuits for code flashers, timers, alarms, etc.

Kit JK-1033, 36 experiments, 11 lbs. **29.95***
Kit JK-1022, 25 experiments, 8 lbs. **24.95***
Kit JK-1011, 12 experiments, 6 lbs. **19.95***

SEE THESE KITS AT YOUR LOCAL HEATHKIT ELECTRONIC CENTER... or send for FREE catalog!

CALIF.: Anaheim, 330 E. Ball Road; **El Cerrito**, 6000 Potrero Avenue; **La Mesa**, 8363 Center Drive; **Los Angeles**, 2309 S. Flower St.; **Redwood City**, 2001 Middlefield Rd.; **Woodland Hills**, 22504 Ventura Blvd.; **COLO.:** Denver, 5940 W. 38th Ave.; **GA.:** Atlanta, 5285 Roswell Road; **ILL.:** Chicago, 3462-66 W. Devon Ave.; **Downers Grove**, 224 Ogden Ave.; **MD.:** Rockville, 5542 Nicholson Lane; **MASS.:** Wellesley, 165 Worcester St.; **MICH.:** Detroit, 18645 W. Eight Mile Rd.; **MINN.:** Hopkins, 101 Shady Oak Rd.; **MO.:** St. Louis, 9296 Gravois Ave.; **N.J.:** Fair Lawn, 35-07 Broadway (Rte. 4); **N.Y.:** Jericho, L.I.; 15 Jericho Turnpike; **New York**, 35 W. 45th Street; **OHIO:** Cleveland, 5444 Pearl Rd.; **Woodlawn**, 10133 Springfield Pike; **PA.:** Philadelphia, 6318 Roosevelt Blvd.; **Pittsburgh**, 3482 William Penn Hwy.; **TEXAS:** Dallas, 2715 Ross Avenue; **Houston**, 3705 Westheimer; **WASH.:** Seattle, 2221 Third Ave.; **WIS:** Milwaukee, 5215 Fond du Lac.

Retail Heathkit Electronic Center prices slightly higher to cover shipping, local stock, consultation and demonstration facilities. Local service also available whether you purchase locally or by factory mail order.

HEATHKIT
Schlumberger

HEATH COMPANY, Dept. 20-11
Benton Harbor, Michigan 49022

☐ Enclosed is $________, plus shipping.
Please send model (s)________
☐ Please send FREE Heathkit Catalog.
Name________
Address________
City________ State________ Zip________

*Mail order prices; FOB factory.
Prices & specifications subject to change without notice. CL-421

Circle 69 on reader service card

INSTABILITY IN HEATH V-7A VTVM

Over a period of many months this meter gradually became very erratic. It would not stay on zero and the calibration would not stay set. Both drifted up and down quite randomly. I have two of these meters, and one day I just happened to notice that the defective one always deflected the pointer the instant it was turned on, but the good one did not. This was the clue, and a check of the schematic showed only one path for meter current through the 12AU7 bridge tube. Of course this means that the meter should not deflect at the instant it is turned on. Since that part of the circuit has only one chassis connection, I reasoned something must be leaking to chassis. The ZERO ADJUST potentiometer proved to be the culprit so it was replaced. Now I always watch the meter when I turn it on.—*David P. Smith*

FUSE WIRE FOR ADMIRAL HEATER CIRCUITS

In the past, we have not supplied the fuse wire used to protect heater circuits in TV chassis on the supposition that such wire was easily available from local sources. We have found, however, that this wire is not always so "easily" available and that incorrect size wire is sometimes substituted, thus resulting in inadequate protection for the heater circuit.

We are now stocking this wire in 1-foot lengths with instructions regarding proper replacement to provide the original adequate protection.

The following sizes have been used in Admiral chassis and are stocked at 25¢ each.

PART NUMBER	WIRE GAUGE	USED ON
98A136-1	20	B & W TV
98A136-2	22	Color TV
98A136-3	24	B & W TV
98A136-4	26	Color TV
98A136-5	30	B & W TV

Admiral Service News Letter

BELL RP 120

As the 1M3/DM70 level indicators in these preamps get weak, their operation becomes intermittent. The best solution for this is to replace them, but they are usually very hard to get. I have found that it is often possible to get them going again by increasing the

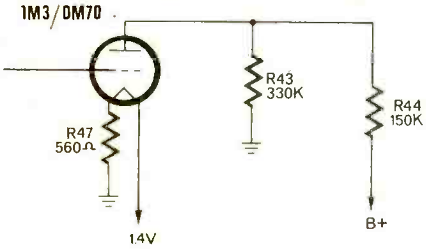


plate voltage. To do this, snip out R43 (82,000 ohms) and replace it with a 330,000-ohm ½-watt unit. In some cases you may not need this resistor at all.—*Gary McClellan*

20G5 & 50A1 STEREO

If you encounter audio distortion or decreasing volume in models STC731, STC741, STC751 & STC761 using the 20G5 and 50A1 chassis, check for a defective or improperly positioned output transistor biasing diode.

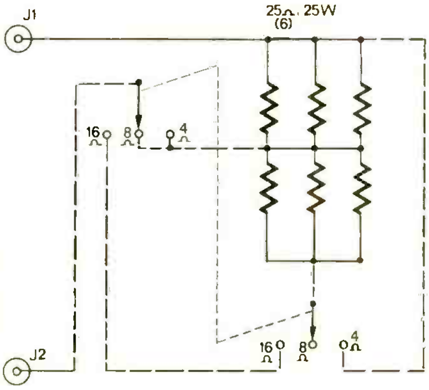
If the condition persists with correctly positioned diode, replace with a 2093A41-57.

On the STC761, we recommend adding diode 93A86-1 across R555 & R556 to further avoid possible overheating of output transistors and power transformer.—*Admiral Service* **R-E**

noteworthy ckts

HIGH-POWER PA LOAD

In the March 1966 issue, Mr. William Kernin described a high-power dummy load for PA systems. He used six 25-ohm, 25-watt resistors and a spdt switch and offered a choice of 8 ohms at 75 watts and 16 ohms at 150 watts *OR* 8 ohms at 75 watts and 4 ohms at 150 watts. He suggested that you take your choice or build two units to cover the three load values.



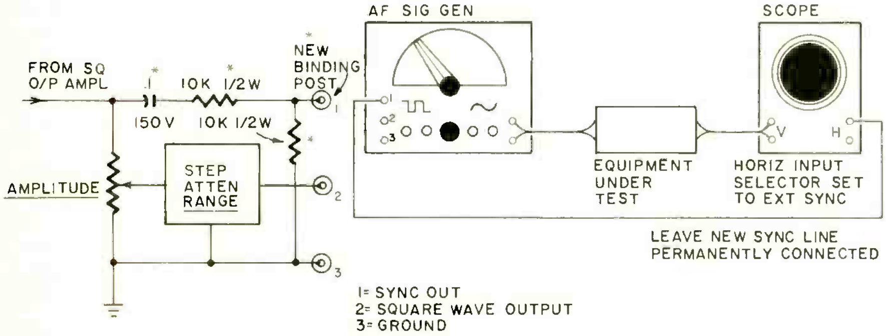
The diagram shows how, by substituting a 3-position double-pole switch, you can have a single 3-in-1 load for 4, 8 and 16 ohms, instead of two separate units. The solid lines show the original wiring, the dashed lines indicate wiring changes. Power ratings are unchanged.—*Edward Naylor.*

SWEEP SYNC FOR EICO 460 SCOPE

One of the things that has always annoyed me while testing various devices on my hobby bench is loss of sync when the scope signal level drops below a certain level. The scope, an Eico 460, is otherwise quite satisfactory, but seemed woefully inadequate after using triggered-sweep HP and Tektronix scopes at work. Since most of my tests used the Heath IG-82 sine-square generator as a signal source, I devised a simple but most effective hookup which other experimenters and technicians may find useful.

The audio signal generator delivers sine and square-wave outputs simultaneously. The addition of three extra components and a binding post to the output of the square-wave circuit provides a constant-level sync signal for the scope. This greatly improves the sync with low-level test signals.

The components added to the generator's square-wave output circuit are marked with astarisks in the partial schematic. The block diagram shows the hookup. No sync ground line is shown; the need for one depends on the conditions surrounding the equipment under test. You may need one on your setup.—*Goeffrey R. J. Sale* **R-E**



Coming Next Month
Build a tic-tac-toe computer that can't be beat. Don Lancaster shows how to it's made with printed circuits and IC's.

Circle 76 on reader service card

Circle 77 on reader service card

EQUIPMENT REPORT

(continued from page 22)

The basic repeater consists of a receiver whose audio output is fed into the modulator of a transmitter on another frequency. When a signal is picked on the input frequency, the receiver's squelch circuit turns on the transmitter and keeps it on until the received carrier drops out.

When AM is the operating mode, several stations may occupy the same or closely adjacent frequencies and yet have a fair chance to get their messages across. Sharp filters along with vernier tuning help separate the stations. Not so with FM. When two stations transmit simultaneously the stronger will "capture" the listeners' receivers and completely eliminate the weaker signal. Only one station can use a channel at a time. Thus, in the interest of gentlemanly operation and consideration for fellow hams, 2-meter transmissions are kept *short*. Hog a channel with long-winded nonsense and you can be sure that there is someone with enough effective radiated power to clobber you.

To discourage long-windedness, some repeaters have built-in timers that cut off the transmitter section if any one transmission runs longer than, say, 1½ to 3 minutes. Most repeaters are set up and controlled by groups or ham clubs. Some, called "open" or "open-access" repeaters, are turned on by the first carrier received on the input frequency. *Limited-access* repeaters are used to restrict operation to a particular club or group; or when several local repeaters have a common input frequency, say 146.76 Mhz.

These repeaters are generally turned on by a tone burst on a precise frequency in the range of 1650 to 2850 Hz. After turn-on, carrier control is used until the repeater has been without carrier input for a short period (usually 15 to 30 seconds).

Now, the nitty-gritty

For the tests, I selected a Hy-Gain MMG150 ⅝-wavelength whip with magnetic base (order No. 710) for simple no-holes mounting on the car top, deck or trunk lid. A Mosley DI-2 ⅝-wavelength ground plane antenna was selected for mounting on a 34-foot tower for tests at the home station.

The Simpson Model A is a neat little package that can be fitted neatly under the dashboard of almost any car (I sure wish that I'd measured it before some thief stole the car). The mounting bracket is designed so the rig can be adjusted to a convenient operating angle or slipped in or out as desired by loosening two thumbnuts. I stuck a cigar-

(continued on page 96)

your color will come back. The actual problem here is that the tube is so badly "out of purity" that none of the colors will register!

SCOPE PROBLEMS

In the horizontal sweep output amplifiers on my scope, one of the plate load resistors gets very warm, and the other doesn't. Tube OK. Dc voltages on the plates don't balance and they should. Trace looks funny too. Sometimes it goes completely out, then won't focus, then brightens up. Which part is causing this?—M.C., Baton Rouge, La.

Would you make that "parts"? You have "double trouble!". The overheating plate resistor in that push-pull horizontal output stage is probably caused by a leaky coupling capacitor to the grid of that stage. Check the dc grid voltage with a vtvm. Too much positive bias will make that half of the tube draw too much plate current and overheat the load resistor.

Second trouble is very apt to be a drifting resistor in the network of resistors from the HV supply to ground. Since these supply all of the voltages to the tube cathode, grid, focus electrode, etc., any change of resistance will upset the grid-cathode voltage and the brightness, or the focus, or all of them at once.

Hint from a confirmed "old-scope rebuilder": always check for leaky coupling capacitors and resistors that have changed value. These cause practically all of the trouble. Fix them and your scope will be as good as new.

NOT ENOUGH HEIGHT, ZENITH COLOR

This one sounds easy, but somewhere along the line I'm missing something! This Zenith 20Y1C48 came in with no vertical sweep. The 6HE5 vertical output tube was cracked, a 470-ohm resistor was burnt, and the 100-µF electrolytic in the cathode circuit had blown up.

I replaced all these parts, and got a good picture, color and all, but now I don't have enough height; all I can get is about ⅔ of a normal raster. What did I overlook?—H.E., Penn.

Same thing I overlook, at too-regular intervals! The rest of that vertical-output cathode circuit. In a color set, this has "more to it than meets the eye!" Beside the regular bias resistor and bypass capacitor, the cathode circuit goes sneaking off over to the convergence board, and goes to ground there through several low-resistance controls, etc.! So, your cathode circuit is actually a complex series-parallel network!

If you'll check the cathode *voltage* on the 6HE5, I expect you will find it high. Excess voltage at this point indicates *too much resistance*—in other words, something is open, over on the convergence board!

new books

PRACTICAL WAYS TO PREVENT BURGLARY AND ILLEGAL ENTRY, by Val Moolman. Cornerstone Library Publications, distributed by Simon & Schuster, 630 Fifth Ave., New York, N.Y. 10020. 192 pages, 5¼ x 8⅛ in. Softcover, $1.45.

An easy-to-read and highly engrossing book on the ways to prevent burglars from entering your home or business. Includes preliminary sections giving details on the crime rates in our country, the types of criminals who "go in" for burglary, their methods of operation. Then the book examines the primary defense moves a citizen may take, when to use what kinds of locks, alarms, barriers, auto-protection devices. It closes with a section on basic theft-preventive measures for when you are away from home.—*MCL*

FIRE & THEFT SECURITY SYSTEMS, by Byron Wels. Tab Books, Blue Ridge Summit, Pa. 17214. 176 pages, 5½ x 8½ in. Hardcover, $7.95, softcover, $4.95.

Guidebook for selecting, installing and generally maintaining home and business security systems. All available systems, from simple door and window switches to ultra-sensitive microwave sensing systems, are described. Complete with photos and diagrams, the guide also discusses fire, water and intrusion detectors, and all commercial security equipment now on the market. Special section on selling and installing the devices for the service technician who wants to branch out to this field.

SILENT SENTINELS, by Robert Kraske. Doubleday & Company, Inc., Garden City, N.Y. 127 pages, 6⅛ x 9⅝ in. Hardcover, $4.50.

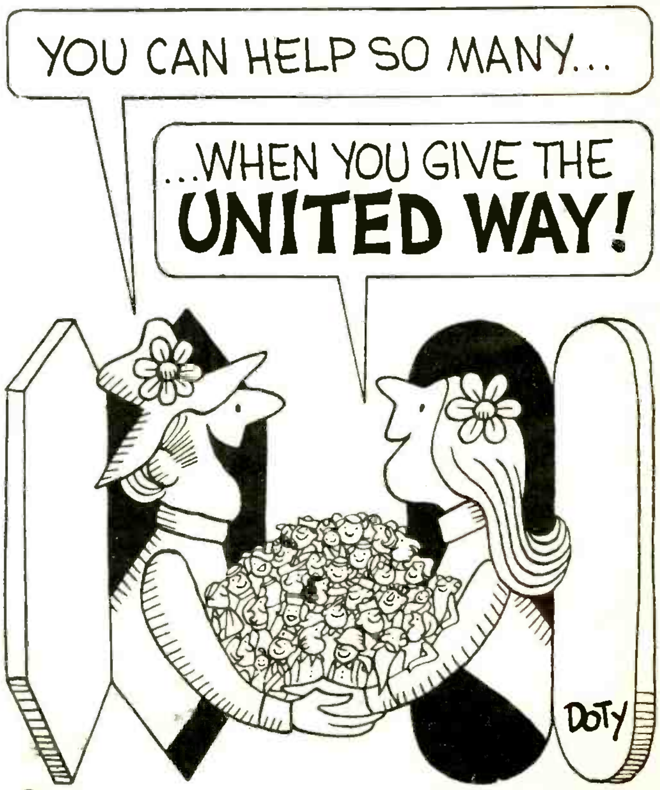
This is a history of the development of locking devices from simple key locks to combination safes to burglar alarms and new electronic devices which see, feel, and hear an intruder even in total darkness. The book is illustrated with photos and diagrams, and deals with the many unusual ways man has tried to guard his property, from ancient curses and booby traps to the pyramids, and the modern "thief proof" locks, safes and vaults, banks and burglar alarms.—*MCL*

DESIGN FOR SECURITY, by Richard J. Healy. John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. 309 pages, 6 x 9 in. Hardcover, $12.50.

Many photographs and schematic drawings bring to life this text on the protection or security of assets of the industrial organization against non-business losses. The book defines the hazards each business must face and describes in detail how defenses can be planned, showing how designing physical facilities to raise the level of security can in many cases also reduce the costs of protection.

INTRODUCTION TO PROGRAMMING AND COMPUTER SCIENCE, by Anthony Ralston. McGraw-Hill Book Co., 330 W. 42nd St., New York, N.Y. 10036. 6¼ x 9 5/16 in., 513 pp. Hardcover, $9.95.

Four languages—Fortran, Algol, PL/1, and Cobol—are discussed with the corresponding features of each compared, in line with the main concern of this book, using procedure-oriented languages on digital computers. Other topics explored include numbers and number systems; Polish notation and the compilation of arithmetic expressions; recursion; Boolean algebra and logical design; hardware characteristics of input, output, and auxiliary memory devices.—*MCL* **R-E**



coming next

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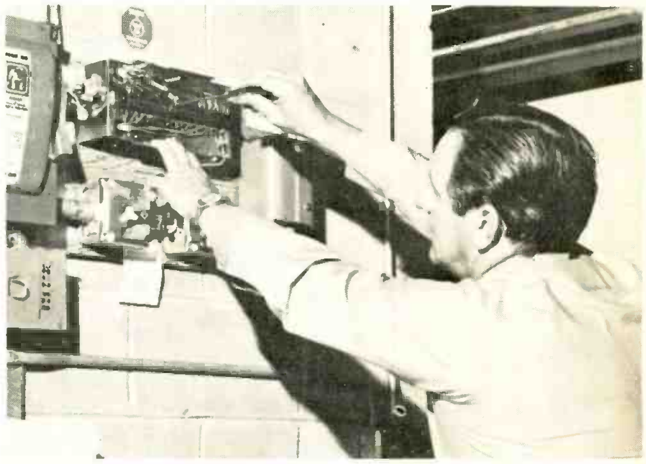
Reed Switch Logic In Action
Jack Darr's Service Clinic
Stereo Amplifier Design

ALARM SYSTEM SELECTION

(continued from page 27)

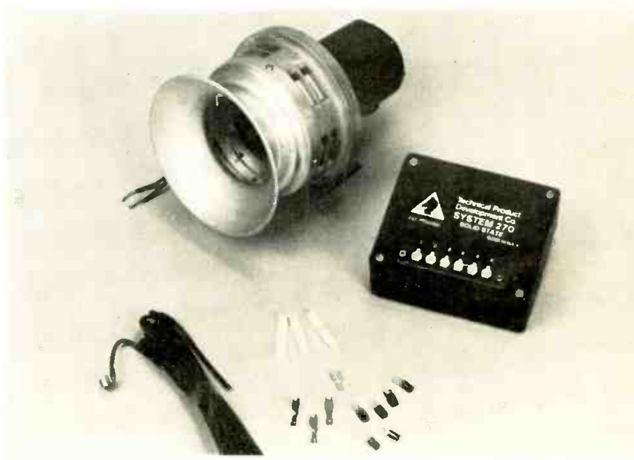
removed. Also available are such special security devices as hold-up foot rails, a hold-up foot switch and hand switch, and even a money clip that closes a switch if paper money is removed from tellers windows, cash registers or cash boxes when the system is activated. A streamlined vibration contact unit can be mounted on walls so forced entry would set off intrusion detection networks.

The complete supervisory system includes provisions for



MULTISTATION ALARM INSTALLATION may call for a central control box. A Westinghouse system is being installed here.

standby batteries to maintain security functions in the event of power failure and until main power is restored. Automatic alarm and alarm reset are time-shared so that one alarm does not inactivate the rest of the system. The system provides facilities for notifying preassigned personnel or security officers and finally evaluates sensor information as to the type of emergency existing and notifies the proper authorities. In addition, the supervisory system recognizes an order of importance of the emergencies, assuming more than one comes up at one time and automatically notifies authorities in the preprogrammed order of their urgency. All circuits are of course fully supervised and tamper-proof, provide both local and remote monitoring of the supervisory system, and are relatively free of electronic jamming such as is possible with units using rf transmission (either AM or FM) as the communication link between sensors and central control unit. Video systems fea-



AUTOMOTIVE ALARM SYSTEM USES A SIREN to warn of tampering. The system shown is made by Technical Product Development Company.

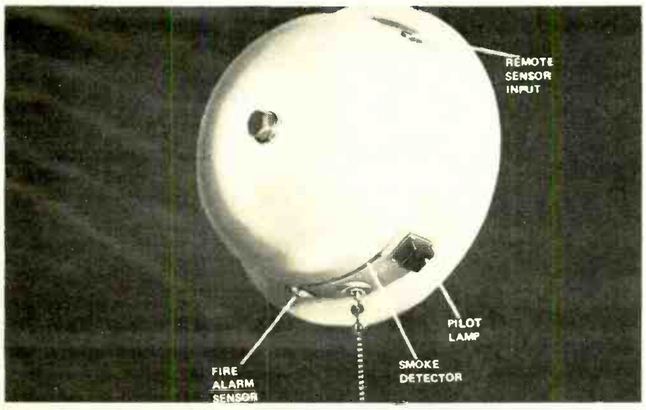
turing various closed-circuit television arrangements are frequently demonstrating their value in burglar identification and subsequent prosecution.

Telephone lines, because they already form an intricate communication network, are the natural choice for notifying a central security office. Direct dialing equipment wired to a leased line or lines transmits a prerecorded message, the nature of which depends on the type of emergency. Special coding is used to indicate the complete nature of the alarm.

The security systems discussed here deal mainly with burglary from outside the plant. An efficiently designed and installed system is of small use if little or no emphasis is placed on *internal* security. It starts with an evaluation of just exactly what must be protected and where the company can be hurt by thievery from within.

PUSHBUTTON SWITCH INSTALLED inside a door jam will detect anyone opening the door. This switch is part of a Westinghouse system.

HEAT AND SMOKE DETECTOR added to Westinghouse system protects against fire in addition to basic intruder protection.



MULTIPURPOSE ALARM made by James Electronics checks for smoke and fire. It also contains a panic alarm.

Training programs and security drills will help families and employees become security minded and go a long way toward assuring you that you are getting the most for your security dollar. **R-E**

Circle 89 on reader service card

Circle 90 on reader service card

Circle 91 on reader service card

EQUIPMENT REPORT

(continued from page 88)

lighter plug on the power cords to avoid making connections under the dash.

On the go, the Model A and the Hy-Gain whip make a powerful team. The 3-dB antenna gain brings the 6-watt transmitter output up to a respectable 12-watt (effective) level. Incidentally, Hy-Gain says that the antenna will withstand speeds up to 90 mph. I'll drink to that!

On trips into upper New York state and then down into the Carolinas, I found 2-meter FM spotty. I could drive for hours without having a signal open the squelch on either 146.94 or 146.76 MHz (channel frequencies are spoken of as simply "nine-four", "seven-six" etc.). At other times, I'd run into lots of activity. I was able to check in with most stations that I heard, either simplex on 94 or duplex (through repeaters) on 34. FM is lots of fun and just the thing to prevent "turnpike hypnosis" on long drives. On the next trip—if I recover my car and the 2-meter gear—I'll take along a small clipboard and cassette recorder to help with the log-keeping.

At the base station, we hung the Model A across a 12-volt storage battery (Oops, I forgot to measure the current drain when transmitting—Simpson says it is 250 mA on standby and 450 mA unsquelched) and tied on the Mosely ground-plane. When conditions were right, we talked to stations in Connecticut, Massachusetts, New Jersey and Delaware; through repeaters or direct. I could get to like the 2-meter FM game as much as I do DX'ing on 20- and 15-meter SSB.

The Model A is built like a battleship with two G-10 glass-epoxy plug-in boards, one for the transmitter and the other for the receiver circuits. It features diode crystal switching and IC's in its solid-state design. All metering and test points and tuning adjustments can be reached by removing the top and bottom cover plates

The receiver is a double-conversion superhet (10.7-MHz and 455-kHz i.f.'s). Sensitivity is 0.6 V for 20 dB quieting. A 455-kHz ceramic filter provides selectivity of 13 kHz at 6 dB down and 36 kHz at 60 dB down. Squelch sensitivity is 0.25 μV or less.

The transmitter uses mode 16F3 (phase) modulation for ±5 kHz deviation for 100% modulation at 1 kHz. The modulation circuitry consists of a basic 6-MHz crystal oscillator phase-modulated by a variable-capacitance diode. The oscillator is followed by a doubler, tripler and two more doublers to multiply the crystal frequency by 24. The speech amplifier (audio) circuits include a clipper/limiter followed by a low-pass filter providing a sharp roll-off above 3 kHz. The clipper/limiter is adjusted so no limiting occurs at normal voice levels but sharp voice peaks are limited so deviation does not exceed ±5 KHz. The final amplifier—two cascaded rf power amplifiers—delivers 6 watts to the antenna. A low-pass filter and pi network match a 50-ohm antenna while eliminating harmonics.

The Hy-Gain whip with its magnetic mount provided a swr of around 1.2:1 on 94 without pruning. However, they should add about 4 more feet to the coax lead-in so it will reach from the dash to rear deck on Fury's and Impala's.

I hope that I've given you guys with "California Kilowatts" some idea as to what 2-meter FM is all about, and if you are planning a long motor trip, you'll consider taking along a rig such as the Simpson Model A. It's just the thing for getting in touch with hams in each town as you approach it—something you may not always be able to do on the lower amateur bands.

As soon as the insurance company replaces the car and hands me $249.00 to replace the Model A, $26.00 for the Hy-Gain whip and $11.75 for the ground-plane, you'll find me monitoring '94 evenings on Long Island. On most National holidays, I spend around 26 hours on I-95 between New York and Darlington, S. C. I monitor 94/76 and hope to say Hello to some of you as I pass within range. Till then, 73's. **R-E**

Technicians Meet

Here is the rundown on the key resolutions passed by the National Electronic Association membership at its annual meeting in Portland, Oregon.

The NEA recommends the installation of interference rejection circuits in all TV receivers to reduce the problem of FM interference in TV reception.

They ask the Federal Trade Commission to adopt the California law regarding the grading of picture tubes as a national regulation as part of their current rules regarding the disclosure of what is new or what is used in the manufacture of picture tubes.

They recommend to all State affiliates of NEA, and all other service organizations to consider and endorse the new RCA solid state training concept of joint service association/distributor/manufacturer technician upgrading training seminars.

The NEA commends Mr. M. L. Finneburgh, Sr., EHF, and Mr. Donald J. Martin for their efforts on behalf of the service industry in directing the activities of the S.I.S. program, 1970-71. **R-E**

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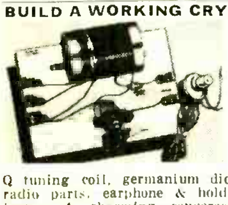

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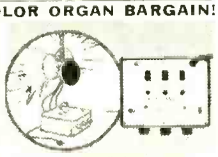

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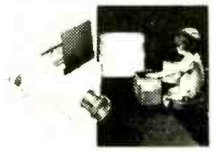

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Bargain kit ideal for economical experimenting with amazing L.E.D.s. the tiny solid state monochromatic lamps that use low voltage DC, last up to 1MM hrs. Used in card-tape readers, character recognition, hi-speed detectors, all kinds of electro-optical applications. Kit incls 3 L.E.D.s: gallium arsenide (MLED 600, MV 50, MLED 930); 2 visible red emitting (6600 A°); 1 infra-red emitting (9000 A°); 6 resistors; 1" 20mm plastic fibre optic light pipe; instrs.
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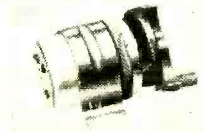

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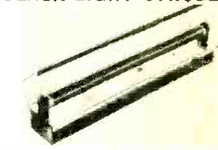

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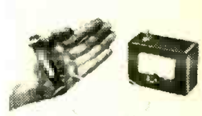

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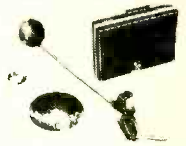

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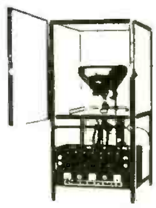

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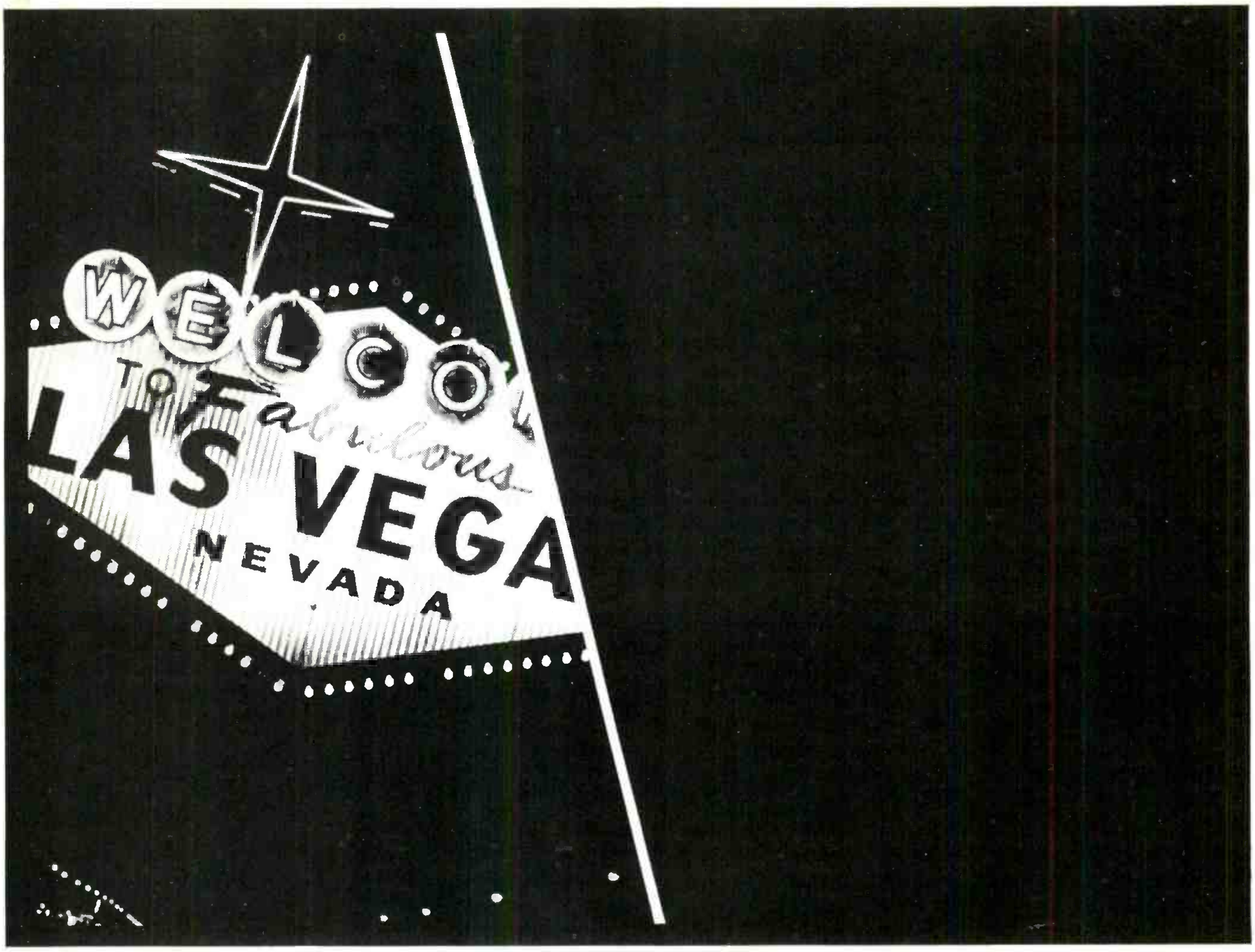

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