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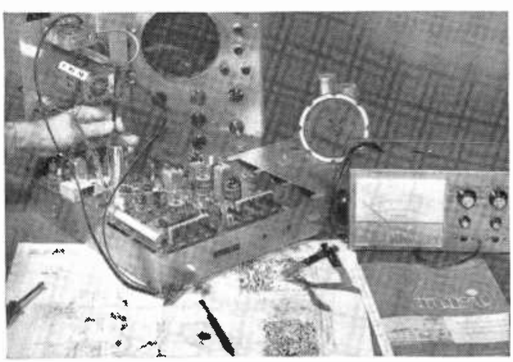

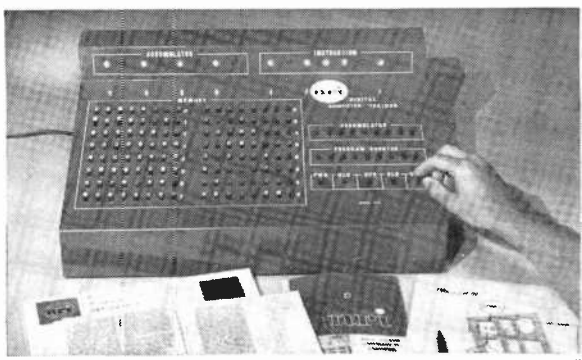

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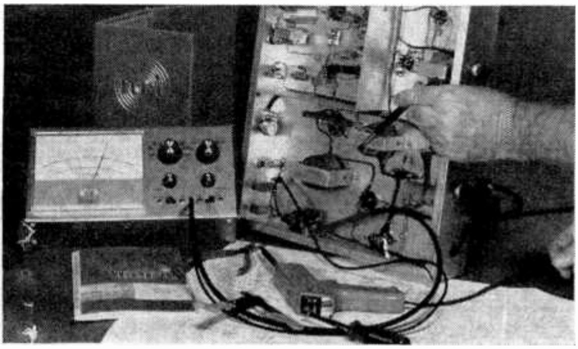

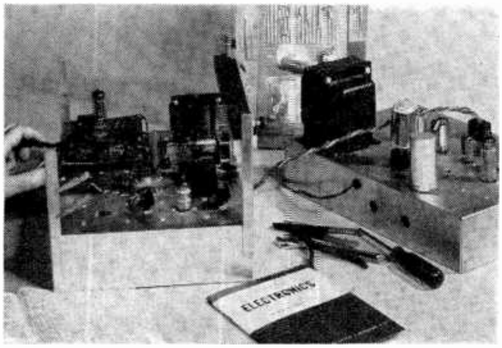

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VOLUME I NUMBER 2 **FEBRUARY 1972**

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Editorial

By Milton S. Snitzer, Editor

NEW DEVELOPMENTS IN AUDIO

When we visited the Audio Engineering Society Show not long ago, we found lots of interest in things old and new. For example, one of the technical sessions featured a paper on a "Modulated Air Flow Direct Radiator Loudspeaker" by Dr. Harry Olson of RCA Laboratories. The low-frequency speaker uses a high-velocity fan to force air through a rectangular opening whose size is varied. The air-flow woofer, strictly a laboratory development, occupies only one-eighth cubic foot.

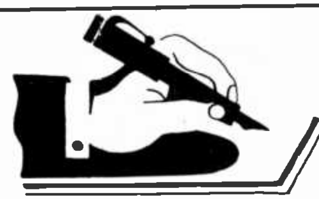
Other papers in the same session were analyses of bass-reflex speaker enclosures. Although this type of enclosure has been with us for many years, its operation is still not fully understood. And just now its characteristics are being studied through the use of computer design techniques.

Most of the excitement at the show for audio professionals was in the area of 4-channel or quadraphonic sound. There were professional encoders which take four separate channels from a master tape, encode it by several different matrixing and signal-handling techniques, and produce a 2-channel output containing a mixture of the four channels. The two channels can then be cut onto a disc, a 2-track tape, or transmitted over the air by FM broadcast.

We saw and heard equipment from CBS Labs, Sansui, and Electro-Voice. All of this equipment produced some pretty effective demonstrations of quadraphonic sound. Unfortunately, however, each system uses different matrixing arrangements, gain-riding circuits, and phase shifters to produce what each company considers to be the best results.

All systems claim good compatibility—that is, the encoded signals can be played back on regular 2-channel or even monophonic equipment with little or no loss of information. All systems also claim good separation and no degradation of sound quality. What's more, a number of commercial records or demonstration discs have already been pressed using the various encoders, and four-channel broadcasts using both Electro-Voice and Sansui encoders are being made. While all systems claim stereo and mono compatibility (though CBS Records is making separate discs for 2- and 4-channel use), they are not compatible with each other. That is, a disc encoded with one of these systems will work using a decoder designed for another system, but the results will not be optimum. A step forward in this direction is a recent announcement by Electro-Voice that they have developed a circuit which is fully compatible with the CBS system.

It seems everyone is rushing to be there first—which is a little hard on the consumer, who would best be served by one standardized, agreed-upon system that everyone could use. But in the meantime, if you want quadraphonic sound now, there are plenty of equipment and records around to make it worth your while.



Letters

PATENT ATTORNEY GIVES FREE ADVICE

I am constantly reading non-professional advice about inventions and patents. Reading greatly over-simplified material, the inventor can be lulled into the complacent belief that the whole matter is really quite simple; but patents are extremely complex matters. Mr. A. S. Dubar, in an Interface letter [July 1971] mentions the Patent Office "Disclosures Document Program" and writes: "The inventor can then describe his invention to possible manufacturers without fear of loss of his patent office disclosure." Nothing could be further from the truth.

If an inventor does nothing more than disclose his invention, he is extremely vulnerable to complete loss of his invention and any patent rights he might seek. If he goes no further than writing his disclosure, no matter how well it can be proved, another person, by reducing the invention to practice or by filing a patent application, can take over the entire invention both properly and legally.

An inventive concept is not a completed invention. In order for the original inventor to protect his rights, he must diligently perfect his invention or file a patent or file a patent application. Even then he has no assurance that a patent will be granted.

My advice is: Beware of over-simplifications!

ALFRED W. BARBER
Registered Patent Attorney
Flushing, N.Y.

Very true! In fact, in November's "Opportunity Awareness", Dave Heiserman gave quite a bit of helpful information on how to obtain a patent—his most important point being that the very first step is to consult a registered patent attorney.

NO CHANGES NEEDED

I built "The Drummer Boy" (July 1971) from a kit which I purchased from PAIA Electronics, Inc. I am happy to report that it worked perfectly the first time I turned it on and adjusted it. I connected the Drummer Boy to my wife's Thomas organ, and she is very pleased with the way it works.

In the October 1971 issue, some corrections to the Drummer Boy were given (Out Of Tune). I can see no reason for making any changes since it works just fine.

F. RIESE SWEARINGEN
Miami Springs, Fla.

Reader Swearingen has put his finger on one of the most important benefits that can be derived from purchasing a kit of parts from the sources listed in POPULAR ELECTRONICS *construction articles. This is that any errors which inadvertently creep into the article or any changes that will make the project less costly or operate better will become part of the kit. Hence, even though a few errors might have been in the published article, the kit and instructions that accompanied it took into account those errors.*

MAIL-ORDER PARTS

It sometimes happens that electronics hobbyists who buy parts via mail experience slow delivery. The result is often a flow of nasty letters to the supplier, the magazine involved, the Better Business Bureau, etc., if the parts do not arrive within a reasonable time.

Being a parts supplier (we furnished the kit for the "Underwater Fish Detector," August 1971), I am painfully aware of this situation. On one hand, I feel personally responsible to the people who have sent in their hard-earned money for the kit; but on the other hand, I wonder how my suppliers, distributors, and original equipment manufacturers feel about the spot they have put me in by failing to ship to me for some reason or another.

One company has been promising for months to ship me 250 potentiometers. Although we have finally received 150 pots, we are again hearing a story about future delivery delays. Consequently, we have been forced to ship out about 70 kits without the pot and to ship, at our own expense, the pots when we receive them.

I would like to thank our many customers for their patience and to assure them that they have not been forgotten.

W.L. GREEN
President
Alpha Research Corp.

U-CHANNEL SUPPLIERS

Where can I buy the ⅝" x ¼" aluminum U-channel specified for the booms in the "Mini-Pyramidal UHF TV Antenna" article (December 1971)? No one in my area handles this item.

PAUL BOGDANOFF
Philadelphia, Pa.

Try your local hobby shop or curtain rod supplier.

By J. Gordon Holt

Basic Hi-Fi Trouble-Shooting

ONE of the most attractive features of solid-state circuitry is supposed to be its dependability. Tubes were nice in many respects (and indeed, some tube-type equipment *sounds* as good, if not better, than some of the top solid-state components), but it must be admitted that tube-type components often contained the seeds of their own destruction—what insurance policies call "inherent vice." They generated large amounts of heat, and heat shortens the lives of resistors and capacitors. In addition, tube-type components required rather high operating voltages.

Transistors were supposed to do away with these problems, which in fact they have, almost. Resistor and capacitor breakdowns are relatively rare in solid-state equipment; but, while transistors don't usually go gradually downhill with age as do tubes, they have not thus far proven all that much more dependable. So solid-state components sometimes need servicing, too. And, when problems arise, the first question the audiophile must answer is "Which component is defective?"

Almost a third of all home audio system "malfunctions" are not even the result of component failure. They are the result of ridiculously simple things like corroded plugs, broken wires, and—occasionally—things we do not even care to admit to our best friends (like leaving the tape switch in the monitor position while trying to listen to FM).

Let's consider first the condition of both channels being dead. If this is the case, on one program source only, obviously that is the source of the trouble; and about all you can do is check to make sure it is getting ac (showing signs of life like a lit pilot light or a wisp of smoke) and that it is connected to the amplifier. If all inputs are dead, though, the trouble is at or around the amplifier.

Most important: if your system is dead or operating at lower-than-normal volume, do not try to "clear the tracks" by cranking up the volume control. The trouble may be between the amplifier outputs and the loudspeakers, and the result could be damage to or destruction of the power amplifier. Alternately, you just might manage to break through the "obstruction" in the system, if it happens to have a barely intermittent condition, and then you could blow your loudspeakers.

If the amplifier's pilot light is lit, you can assume it is getting ac power. If not, make sure it is plugged into and making contact with a properly energized wall outlet, and that its ac switch is on. Sometimes fuses blow without showing any visible evidence. Try another one, and then plug something like a table lamp into a switched ac outlet to make sure the amplifier's power switch is working.

You've Got Power. Now, let's say the pilot light goes on, but all input sources are still dead. (If you only have one input source, switch the selector to another position and insert a small nail about a quarter of an inch into either of those input sockets. If there's no hum, all inputs are dead.) First check to make sure

UNANIMOUS ACCLAIM!

First test reports on the Zero 100 by the industry's leading reviewers

Brief excerpts reprinted below. Let us send you the full reports.

HIGH FIDELITY *Sept. 1971*

Altogether, this new arm strikes us as an excellent piece of engineering; it probably is the best arm yet offered as an integral part of an automatic player. ☐ Operation is simple, quiet, and reliable. ☐ All told, we feel that Garrard has come up with a real winner in the Zero 100. Even without the tangent-tracking feature of the arm, this would be an excellent machine at a competitive price. With the novel (and effective) arm, the Zero 100 becomes a very desirable "superchanger" with, of course, manual options.

AUDIO *July, 1971*

The Zero-100 performed just about as we expected after reading the specifications. Wow measured .08 per cent—that is in the band from 0.5 to 6 Hz. Flutter, in the band from 6 to 250 Hz, measured .03 per cent, both of which are excellent. ☐ Thus, the Garrard Zero 100 is certainly the finest in a long line of automatic turntables which have been around for over 50 years. ☐ We think you will like it.

Stereo Review *July, 1971*

Indeed, everything worked smoothly, quietly, and just as it was meant to. If there were any "bugs" in the Zero 100, we didn't find them. ☐ Garrard's Zero 100, in basic performance, easily ranks with the finest automatic turntables on the market. Its novel arm—which really works as claimed—and its other unique design features suggest that a great deal of development time, plus sheer imagination, went into its creation. In our view, the results were well worth the effort.

The GRAMOPHONE *August, 1971*

Reproduction quality was excellent with no detectable wow, flutter or rumble under stringent listening conditions. End of side distortion, which is always a possibility with pivoted arms, was virtually absent, due no doubt to the tangential tracking arm.

Popular Electronics *August, 1971*

Our lab measurements essentially confirmed the claims made by Garrard for the Zero 100. We used a special protractor with an angular resolution of about 0.5°, and the observed tracking error was always less than this detectable amount. The tracking force calibration was accurate, within 0.1 gram over its full range. ☐ The Garrard Zero 100 operated smoothly and without any mechanical "bugs."

Rolling Stone *Sept. 16, 1971*

This unit has every imaginable gadget and gewgaw one might possibly desire, and *it works*. And considering how much it does, and how well it does it, at 190 bucks it doesn't even seem expensive. The changer has so much in it that an analysis of its innards is almost a case study in record player design.

HI-FI STEREO GUIDE *Fall, 1971*

One could go on cataloguing the virtues of the Zero 100 indefinitely.

For 8-page test reports booklet and a 12-page brochure on the Zero 100 and the entire Garrard series mail to British Industries Company, Dept. B232, Westbury, N.Y. 11590.

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the loudspeakers are connected (or headphones plugged in) and that every tape monitor switch in the system is set where it belongs. Many add-on devices like equalizers have their own monitor switches, duplicating the function of the one on the amplifier, and it is easy to remember one and forget the other.

If everything is still dead, start dismantling. Remove all plugs from the amplifier's tape-out and tape-in receptacles, set its monitor switch to source or input, plug a high-level source (which could be your recorder's preamp outputs) into the tuner or aux inputs, and set the source selector appropriately. If you get sound now, you may have had the tape recorder connections reversed, or you may have a condition whereby the tape output connections are shorting the signals to ground. (Some tape recorders, for example, ground their input connection when they are set for playback.)

If there is still no sound with this basic system hookup, look for a burned-out tube (if you have any in the system) or resign yourself to the possibility of a power supply repair.

If your preamp and power amplifier are separately powered, a further check will show which of these is the offender. Unplug one cable from its preamp output receptacle and touch its bared tip with your finger. If you get hum, the power amplifier is OK and the preamp is at fault. No hum, and the power amplifier is the troublemaker.

One Channel Dead. This is the most common malfunction in systems that "used to work fine," and one that can tax the patience and ingenuity of any audiophile, particularly when the system happens to be a fairly complex one with all sorts of hang-on accessories and a hopeless tangle of identical-looking interconnecting cables. You can generalize about such a condition, though, with the thought that, if you routinely (or even occasionally) change connections, the trouble is probably a wiring error. Otherwise it is probably a malfunctioning component. In either event, a simple process of elimination will pinpoint the source of the problem.

Wiring errors generally stem from lack of identification of interconnecting cables. Unless they are color coded or tagged at both ends, it is easy to pick up one end

of a cable and trace it back to the wrong socket. So the recorder's input cable may go to the preamp's tape-out receptacle or the preamp's FM input gets the other end of the cable that goes to its auxiliary input. The long-range answer to this problem is to mark your cables properly at both ends—either with identically colored splotches of paint (sold in little bottles in hobby shops) or with tape or paper labels. With the latter, you can use a ballpoint pen to write such things as "preamp tape out left" and "recorder in left" at opposite ends of the cable. You can also use a more flexible system composed simply of numbers with one cable having 3L at both ends and its mate having 3R at both ends. Then no matter how tangled your cables get, you can always make sure that what comes out of one component goes into the proper receptacle on another component. On the other hand, if you have one dead channel in your system now, you may not be immediately concerned with long-range solutions.

To locate the trouble, then, first establish whether or not the dead channel is out on one input source only or on all inputs. To do this, simply interchange the input connections from the affected source and note if the malfunction is on one side or the other or if it stays put. If it reverses, the trouble affects that source only and is located either in that component or in its interconnections to the preamp. Check to make sure that both interconnecting cables are properly inserted and that the wires coming from that component actually go to their appropriate preamp inputs.

Suppose you do have a tangled mess of cables behind your preamp? How do you know which end of which cable goes where? Set the selector to the desired source, unplug each cable (at the source), and touch the bared tip with your finger. If one doesn't cause a hum, either the cable is open or it is shorted internally; or you're not touching the end of the cable you think goes to that preamp input. To find out which one you are touching, switch inputs until one responds to your touch with the requisite hum. If you're still no further ahead of the game, tag that cable at the loose end and take the time to unravel it from the tangle. It may not be connected to anything. If the interconnections are all OK, then the defect

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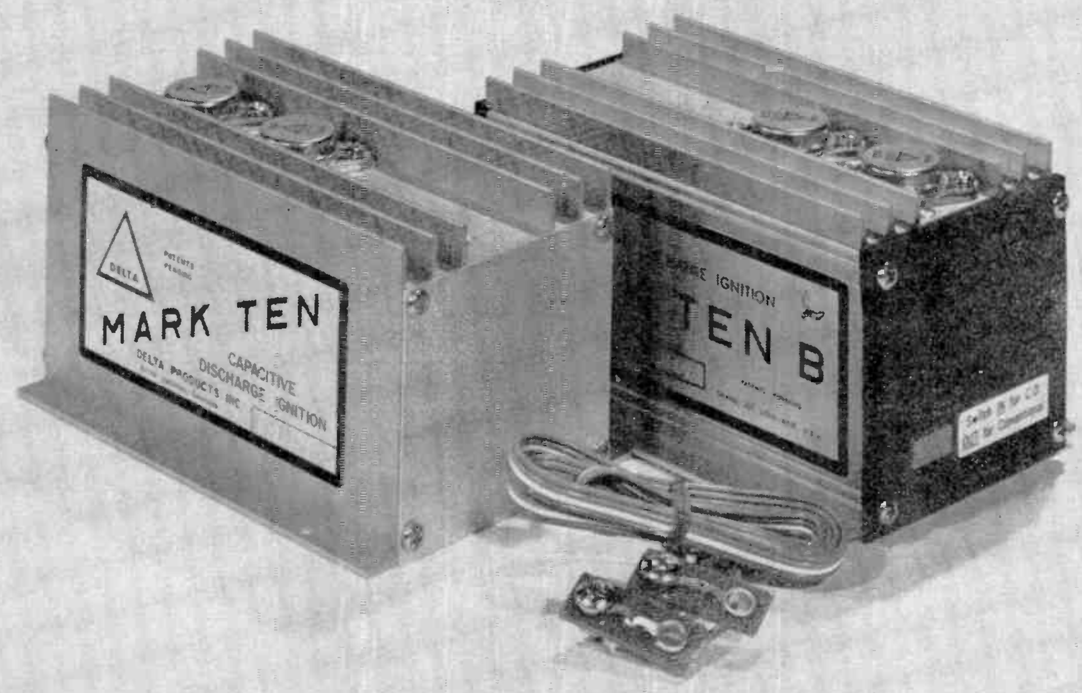
must be in the pickup or tuner or whatever else is involved.

Go to the Other End. Now, assuming that switching inputs did not reverse the affected channel, then there is trouble in the preamp or later in the system. At this point, it is generally best to start at the end of the system and work forward. First, check the most obvious things—unplugged plugs and strands of speaker cable shorting across their terminals. Then interchange the loudspeaker connections at the amplifier, swapping them right for left. If the malfunction then reverses channels, the speakers and their wires are OK and should be restored to their original connections. (Make sure that the ground and zero terminals of each speaker are connected to the corresponding amplifier connections, to maintain correct phasing.) If the same speaker remains dead when the leads are switched, make the same connection reversal at the speakers. If this causes the dead channel to switch sides, that speaker cable has a break in it and should be replaced. If the same channel is still dead, scratch one loudspeaker. Open circuits in speaker cables and entire speaker systems are rare, but they do happen. (Most lose just woofer or tweeter.)

If you've exonerated the speakers and their connections, interchange the channels at the next accessible spot ahead of the power amplifier. With a separate amplifier and preamp, do this between them at the power amplifier, switching left for right. (Make this switch with the system turned off.) If the dead channel changes sides, the power amplifier is OK and the trouble is ahead of it—either in the preamp or in one of the interconnecting cables. To check for the latter possibility, try another cable in the dead channel.

If the trouble appears to be ahead of this point in the system, it is in the preamp. (You've already checked out the input sources.) A common cause of one-channel loss here is an intermittent tape monitor switch, so check this by gently rocking it back and forth to see if it lets the missing signal through in any position. If it does, a squirt of contact cleaner may give it a new lease on life. If not, or if the monitor switch is evidently not the culprit, then the preamp or the whole amplifier will need the ministrations of a competent service technician. ◈



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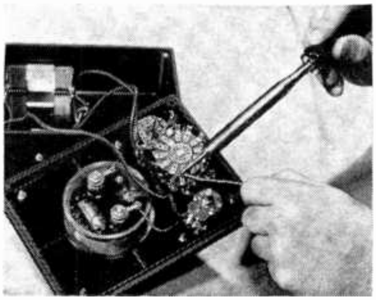
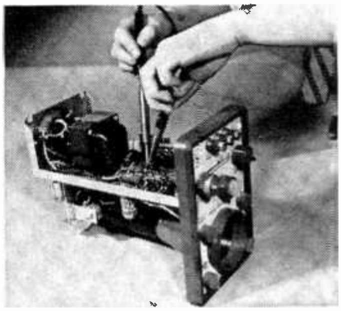
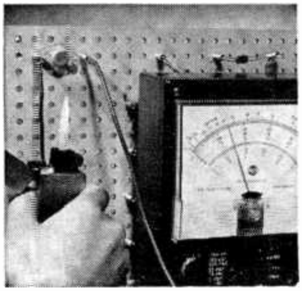
Construction of Multimeter.





Construction of Oscilloscope.

Temperature experiment with transistors.



News Highlights

RCA Records Comes Out for Discrete 4-Channel Disc

At a recent press conference, RCA Records came out strongly for the discrete 4-channel disc pioneered by the Victor Company of Japan (JVC) rather than for any of the matrix methods that have been proposed. They described the matrix method as offering "the compromise of electronically processed sound which only simulates a 4-channel effect." RCA gave a progress report in which they reported that the disc could become a marketable reality in the not-distant future, after the mechanical compatibility problems have been completely solved. Because of the very high frequencies on the disc (up to about 50,000 Hz), record wear and cartridge design have been problems but these are both headed for solution, according to RCA. The idea is to produce a single record for each release that would be playable on discrete 4-channel or stereo equipment so that the record dealer will have but a single inventory. Playback equipment from JVC and Panasonic were also demonstrated. This equipment is expected to be available in a matter of months when the 4-channel records hit the market.

Broadcasters and CATV Operators Agree on Rules

A compromise agreement between TV broadcasters and CATV operators should pave the way for future growth of cable TV. Cable companies will be allowed to offer two out-of-town broadcasts to big-city viewers in addition to all the local channels and the operator's own programs. In the 50 largest-market cities, copyright restrictions will limit imported programs to those for which local broadcasters have not already bought exclusive rights. Also, some form of compensation to film copyright owners will have to be negotiated by the CATV operators. The FCC is expected to issue new rules shortly based on the compromise agreement which has been worked out.

Sony Plans Color-TV Plant in U.S.

Sony Corporation announced recently that it is planning to construct a facility in suburban San Diego, Calif. to assemble color television sets. Operations are scheduled to begin in May of this year. Although the initial production target of the new plant will be 5000 Trinitron color television sets per month, it will have a potential capacity of assembling up to 20,000 sets per month. The plant will be about 140,000 square feet in area and will be constructed in a manner to allow for future expansion. It will be owned and operated by Sony's wholly owned subsidiary, Sony Corporation of America.

Laser Recorder for Business Machines

What is claimed to be the first practical laser recorder for use with business machines has been developed by Datalight, Inc. of Bloomfield, Conn. The system, named "Datawrite," uses a low-power laser to write directly on dry process recording media, and therefore produces instantaneous copy. High-speed performance is made possible by the use of acousto-optic laser deflection and modulation. This technique uses the interaction of high-frequency acoustic waves with the laser beam in a solid medium to control laser brightness and direction. The system writes alphanumerics, graphics or digital words from computer data at speeds consistent with the fastest digital equipment. Applications include phototypesetters, non-impact printers, digital storage systems and displays.

Holography Inventor Awarded Nobel Prize

Dr. Dennis Gabor, staff scientist for CBS Laboratories, has been awarded the 1971 Nobel Prize for Physics for his invention of holography. Dr. Gabor invented the lensless photographic technique of producing three-dimensional images by light-wave interference patterns some 23 years ago. But it was not until the laser emerged much later that practical holographical techniques became possible. Holography has since become a tool for use in industry, science and government, and has found practical applications in such areas as color television and medicine. Dr. Gabor worked out the mathematical basis for holography when he discovered how to reconstruct images of objects from the light-wave interference patterns. He used this interference principle to construct the first hologram in 1948, which he named after the Greek word "holos" meaning whole.

Teleprompter Guilty of Bribery

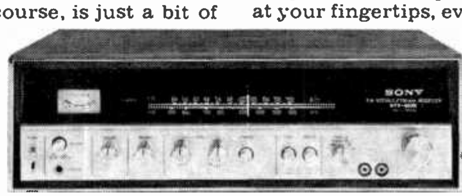
The Teleprompter Corporation and its board chairman, Irving B. Kahn, were found guilty in New York Federal Court of bribing city officials to obtain a CATV franchise in Johnstown, Pa. Two of the officials involved, the former mayor and city councilman, pleaded guilty to a conspiracy charge at the start of the trial and testified for the prosecution. Lawyers for the Teleprompter Corp. stated that the corporation and its board chairman were victims of economic extortion by the officials in return for an exclusive cable television franchise.

Thermal Duplication of Video Tape

DuPont Co. has been granted a U.S. patent on its thermal method for duplication of chromium dioxide magnetic tape. The process, known as thermoremanent duplication, is based on the particular magnetic properties of chromium dioxide, used in the company's Crolyn magnetic tape. The process can duplicate video tape at least 10 to 15 times faster than present electronic methods without loss of quality. Application of the technology should play an important role in the growth of the large consumer market predicted for pre-recorded video cassettes. Sony, Philips, Memorex, Ampex and BASF are companies which hold licenses from DuPont to make, use and sell chromium-dioxide-based magnetic tape products. In addition, the company itself supplies video and audio wide tape stock or finished tape.

Superscope Acquires Japanese Stock

In what is said to be the first time in the history of Japan, the Japanese government has permitted a foreign corporation to obtain 50 percent of a publicly listed Japanese company. The foreign corporation in this case is Superscope, Inc. and the Japanese company is Standard Radio Corp. Under the terms of the agreement, Superscope has acquired 5,600,000 shares of Standard's capital stock for an undisclosed sum. Standard Radio has been associated with Superscope as supplier of moderate priced Marantz products, manufactured by Standard to Marantz engineering specifications. Marantz is a subsidiary of Superscope, Inc.


SONY

MOST people relaxed and quit worrying about fallout and the "bomb" nearly a decade ago. The Limited Test Ban Treaty (June 1963) ended atmospheric testing of nuclear weapons. Only Red China and France have exploded bombs since then with predictable radio-active clouds wafting across continent and ocean.

In spite of the "now" issues, the spectre of harm from nuclear radiation is still with us. Tests of nuclear explosives continue, although most are performed underground. Nuclear power plants dot the nation. The result is that *chances* of radiation pollution keep mounting.

Some scientific authorities say that we relaxed under false assurances. The Atomic Energy Commission keeps telling us that none of today's uses of nuclear energy present any significant danger. Yet, the evidence keeps piling up that potential radiation danger lurks in peaceful uses of nuclear power.

We have accumulated more knowledge of the Hiroshima/Nagasaki survivors and their descendants. Some genetic consequences were already acknowledged. We know now that even the grandchildren of the survivors are affected. Abnormalities include birth defects, stillbirths, and heredity-related diseases. Lately, cancers began appearing in the bomb victims themselves, and at a rate greater than the national average for all of Japan. And the incidence of the disease is roughly proportional to the amount of radiation the survivors received during the five-year period following the bombings. Accelerated aging is noticeable in some victims who were exposed to fallout when they were very young.

Consequences like these, turning up so long after exposure, require that we re-evaluate our thinking. What illnesses will workers near radioactivity contract? What effects will they have on their offspring in the future.

Electronics helps monitor and control contamination you can't see, hear, taste, smell, or feel

BY FOREST H. BELT

Editor's Note: There are many benefits to be derived from the peaceful use of nuclear energy, especially in the fields of power generation and medicine. Although this article points out the dangers involved, we can take advantage of the benefits and minimize the hazards by enlisting the aid of electronics and other safeguards in control and monitoring. Those involved with the applications of nuclear energy are well aware of the problems in working with such a potent force. Hence, safe operating practices are observed to keep all hazards to an absolute minimum.

Proponents of more nuclear power put forth a *threshold* theory which assumes that there is some small radiation dosage below which effects are zero. This concept is based mainly on the lack of any immediate symptoms when the radiation dose is very low. But evidence gathers for the *linear* theory; that radiation-related diseases and genetic aberrations increase in proportion to the radiation one accumulates, even to the most minute dosage. This means that radiation might have a cumulative effect. It is possible then that future generations well may carry the burden of any radiation carelessnesses now.

Radioactive Materials. If neutrons forced out of atoms as a result of nuclear reaction reach the air, they can mix with nitrogen atoms and form carbon-14. This radioactive nuclide has an extremely long life and can be very dangerous to man. Obviously, then, in employing nuclear reactors for peacetime applications, neutron escapes must be prevented.

The decay of uranium-235 also forms variants called isotopes. If the isotopes get out of a reactor, they can carry radiation to us in various ways, mainly by concentrating in our food and water.

Strontium-90, for example, settles to earth where grass absorbs and concentrates it in its blades. Cows grazing on the contaminated grass increase the concentration in their milk. Anyone who drinks the milk gets a hefty dose of the beta rays given off by the isotope. Other nuclides collect in other foods, animals and fish. Many of these nuclides, in addition to giving off beta rays, are contaminated with alpha or gamma radiation.

Beta radiation is not strong. Skin, muscle, and other tissue help to block it when the body is externally exposed. Taken internally, however, strontium-90 settles in bone and muscle where beta rays freely emanate for more than 25 years. This is an open invitation to leukemia and cancer.

The isotope cesium-137 also goes to muscles and bones. Beta and gamma rays from it endure beyond the nuclide's 33-year halflife. (NOTE: Radionuclides are considered to be ineffective after half their atoms have decayed, although some of their rays remain potent for a longer time.) Gamma rays are intensely more penetrating than are beta rays. They can destroy body cells from relatively great distances.

Iodine-131 gathers in thyroid and salivary glands. This isotope has a half-life of only eight days, but gamma and beta rays from it are energetic. They damage sensitive throat cells and trigger thyroid cancer.

Plutonium-239 is the most hazardous by-product of uranium-235 fission. Its halflife is 24,100 years. It is a deadly source of alpha and gamma rays that are so powerful that they still produce lung cancers when the isotope has aged 200,000 years! Exposure to fresh plutonium-239, even briefly, multiplies cancer susceptibility a thousand-fold.

Ionizing radiation produced by atomic decay attacks body cells. Radioactive par-

NUCLEAR RADIATION ...INSIDIOUS POLLUTER

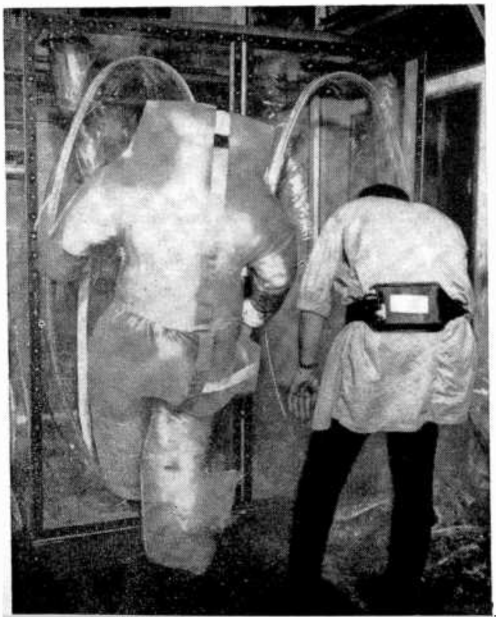
ticles rip electrons out of atoms in cells. Sometimes the shock kills the cell, sometimes it merely fouls up operation. Damaging a body cell sets the stage for cancer and other diseases. Chromosome damage in the reproductive cells leaves consequences that may linger for generations.

Some cell damage self heals. Some damage is irreparable. The body often replaces dead cells, which leads some experts to contend that there is a threshold level below which radiation will do no somatic or genetic damage. True, below certain levels no *immediate* clinical symptoms appear, but radiation doses accumulate and eventually produce effects that *are* noticeable.

Typical Radiation Doses. We cannot see, hear, taste, or feel radiation, but it is always around us. We get yearly background dosages of about 125 millirads—more if we live at high altitudes. (A rad is a measure of radiation standing for Radiation Absorbed Dose and is roughly equal to a Roentgen, or rem, which is a technical unit of radiation. The rad is abbreviated as the letter "r.")

An average of 50 mr of annual background dosage is due to cosmic radiation from high-energy protons originating in outer space. Another 50 mr or so comes from potassium-40, thorium, and uranium in the air, soil, and buildings. And about 25 mr comes from inside our bodies. We ingest through breathing, eating, and drinking traces of thorium, potassium-40, carbon-14, and tritium; and there is no way to avoid them.

Two-layer plastic radiation suits reduce exposure danger for workers entering contaminated area. Umbilical tube carries fresh air and communication wiring. On leaving area, worker simply shucks the outer suit. (Photo: US Atomic Energy Comm. Richland Operation)



Whenever we have an X-ray picture taken, we get a dose of radiation. The younger we are, the more damage X-radiation is likely to cause. A study by Dr. Alice Stewart of Great Britain—confirmed by Dr. Brian MacMahon of Harvard—relates X-rays during pregnancy to a rise of cancer and leukemia in children age 10 years and younger.

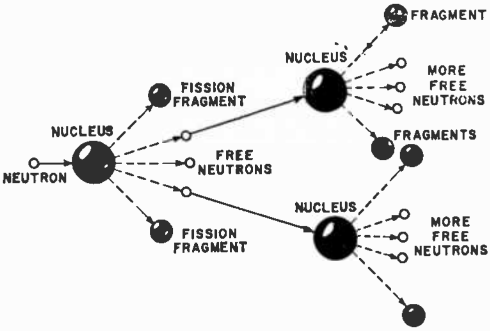
X-rays are, nevertheless, beneficial diagnostic tools in medicine. The American College of Radiology, however, advocates reduction of per-photo dosage; this will help. X-rays, cobalt-60, and other radioactive isotopes also have high therapeutic value. But in spite of their obvious beneficial qualities, they remain sources of hazardous radiation.

Safety guidelines have been set up by the Atomic Energy Commission, with aid provided by the Federal Radiation Council, the National Committee on Radiation Protection and Measurement, and the International Commission on Radiological Protection. The guideline doses are represented as "safe" exposures. But in light of recent data and experience, some scientists in the nuclear and health fields dispute their safety.

The guidelines suggest that the average dosage for the population at large be less than 170 mr/yr, not counting natural background radiation. Any one person should receive no more than 500 mr/yr, say the guidelines. Individuals in radiation-associated jobs are permitted an "acceptable" dosage of 5000 mr/yr—40 times the background level.

Medical Physicists John W. Gofman and Arthur R. Tamplin of the Lawrence Radiation Laboratory in California make a strong case that even 170 mr/yr can induce an extra 32,000 cancer (plus leukemia) cases annually, representing a 10 percent rise over the usual average. Also, genetic effects might add 150,000 deaths and even more deformities and diseases.

Naturally, nuclear industries take elaborate precautions to maintain exposure below the AEC maximum. Shielding and special suits are used to block nuclear rays. Remote control handling keeps operators away from critical materials. Instruments monitor radiation levels where contamination might exist or develop. Some cities, like New York, monitor nuclear radiation level constantly. Film badges check the daily and weekly rad dosages of workers who risk exposure. But for the ordinary citizen, the only real safety lies in prevention.



Nuclear fission occurs when a high-speed neutron splits nucleus of uranium or plutonium. Tremendous energy is released and other neutrons are knocked loose. If released energy is sufficient, chain reaction can occur.

Fission vs Fusion Power. There is currently a big controversy raging with reference to nuclear-electric power plants. The plants may look clean and harmless, but their reactors are sources of radioactive discharges into the surrounding environment. There is also the possibility that accidents caused by man or nature (freak tornadoes, floods, earthquakes, etc.) could spread radiation for miles.

Hauling and storing nuclear leftovers also present pollution hazards. This particular problem worries Kansans around the Lyons salt mines where nuclear waste is being dumped. And there are dangers near plants where reactor fuels are processed.

Many worried citizens want no more nuclear power plants built unless they release no contaminants at all. California, Oregon, Minnesota, and New York City have even legislated moratoriums that are still in the courts.

Meanwhile, power companies state that we must convert to nuclear power because we have enough fossil fuel to carry us through only 200 more years. This is a poor argument considering that we have only 75 years' worth of uranium at our present rate of consumption.

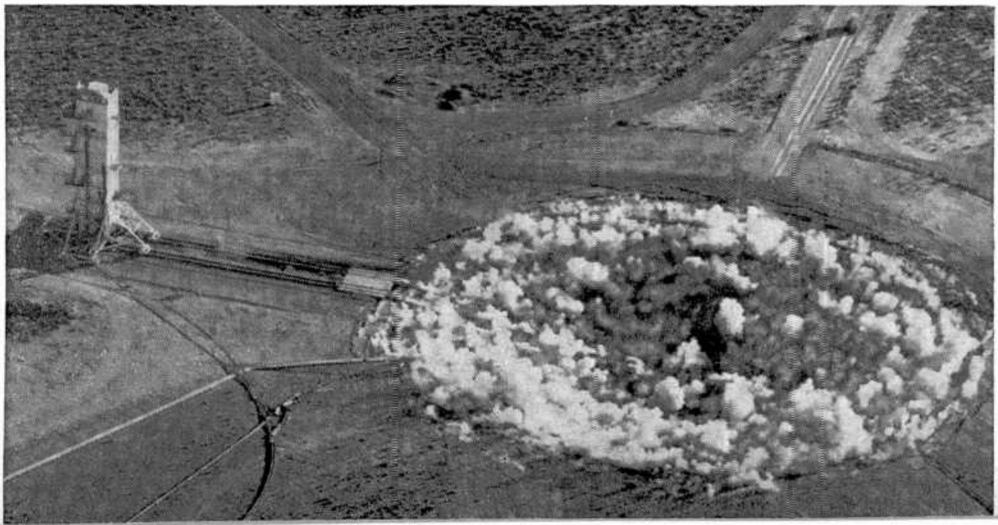
Fast-breeder reactors can develop large quantities of a plutonium-239 byproduct that can be fissioned into other reactors. But plutonium is formidable to store and transport.

Fusion, the thermonuclear reaction used in the hydrogen bomb, offers an alternative. Its deuterium fuel, a heavy isotope of hydrogen, is abundant and relatively inexpensive. A little generates a lot of power, and known accessible reserves could last us 50,000 years. But most promising, for equivalent energy released, a fusion reaction produces about a million times less radioactivity than does a fission reaction.

The problem is that fusion reaction is not easy to produce or control. We have machines that can take care of both jobs on a limited basis, but none is ready for commercial exploitation, nor are they likely to be for a decade or more.

The chief radiation danger from fusion is high-energy neutrons. As already stated,

Nuclear test blast in Nevada near Los Alamos lab had nearby tower that held electronic instruments to measure seismic shock, radiation, etc. (Photo Los Alamos Scientific Lab)



neutrons form carbon-14 in air. Also, neutrons wear out the protective vanadium alloys used in reactors.

Tritium, produced within the reactor, has a halflife of 12.5 years and emits strong beta rays. So, it must be kept from contaminating air or water.

A deuterium-helium thermonuclear reaction can make electricity directly. The method is being worked out at the Lawrence Radiation Laboratory. A plasma is confined in a straight tube called a "magnetic mirror machine." The reaction spews electrons out of the tube into an expansion chamber. Collector electrodes gather positive charges and a charge separator picks up the electrons. Output terminals feed the direct current to whatever load is provided.

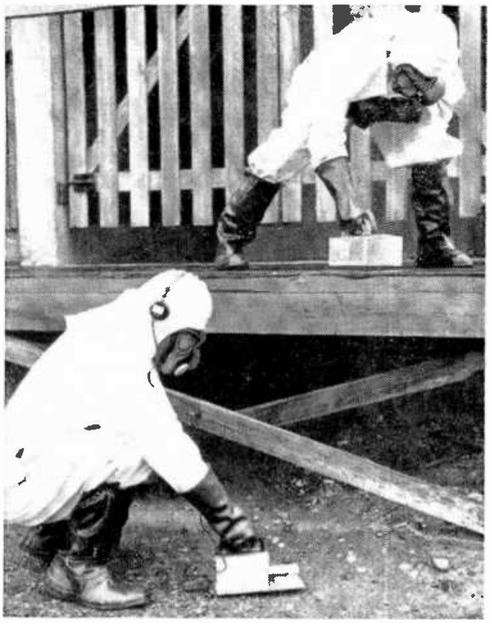
Fusion reaction is a relatively "clean" method of generating power, but mechanical problems in employing it on a universal scale are still far from resolved. Consequently, we are stuck with fission reactors to produce energy; so, we are also stuck with the dangers they present—unless legislation eliminates the use of nuclear power plants altogether.

A Growing Tide. We still test nuclear weapons in spite of the April 1970 Treaty on Nonproliferation of Nuclear Weapons and our present Strategic Arms Limitation Talks. Controversial underground tests continue in Colorado and Nevada. And, in early November, a giant 5-megaton thermonuclear device for our anti-ballistic missiles was tested a mile beneath the ground on Amchitka Island. Neither earthquakes nor tidal waves were triggered and the AEC states that no radiation escaped into the atmosphere.

Missile submarines such as the *USS George Washington* and ships like the carrier *USS Enterprise* carry fusion reactors for propulsion. No reactor is entirely "clean": so, only "safe" doses of radiation reach the men who run our nuclear fleet.

The National Aeronautics and Space Administration has a nuclear-powered rocket called NERVA (Nuclear Engine for Rocket Vehicle Application). Nuclear propulsion could considerably shorten trip time between earth and moon. Astronauts already get nearly 1000 mr of radiation exposure on an Apollo trip, mostly from traversing the

Articulated mechanical arms and hands let chemist work with radiopharmaceuticals in safety behind concrete wall and sheets of heavily leaded glass. (Photo: USAEC)



Emergency radiation team members at AEC's Hanford Works show how Geiger and scintillation counters are used to measure radioactive contamination should it get out of control of users of radioactive isotopes. (Photo: Hanford Oregon, Atomic Products Operation)

Van Allen radiation belts. A quicker trip through the belts may balance out the effects of radiation from the engine.

A new nuclear-electric rocket develops only a few pounds of thrust. However, it operates continuously over a long period of time; so, deep-space vehicles could build up extreme velocities over the long haul. Systems for Nuclear Auxiliary Power, or SNAP, thermoelectric generators already make electricity for scientific experiments on the moon. Larger versions might serve earth needs. Our SNAP-27 uses plutonium-239, but scientists are working on safer versions.

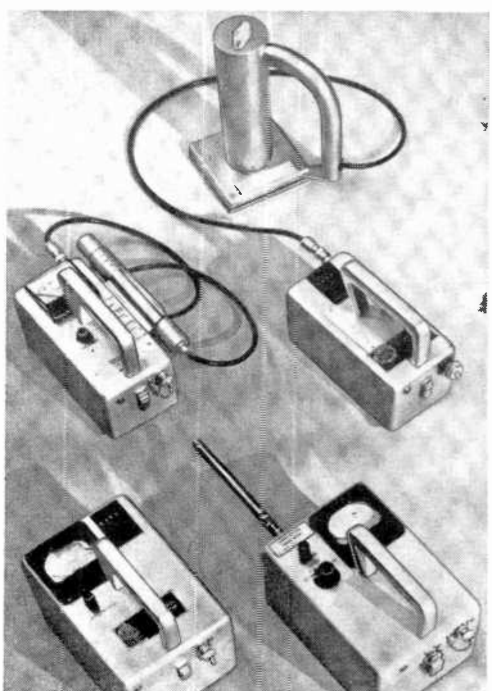
The Big Ditch. Massive nuclear explosives offer engineering promise. But radiation problems hamper the use of such power. A detonation in 1967, called "Gasbuggy," attempted to boost gas output of a well in New Mexico. Rulison, a similar project in Colorado, took place in 1969. Unfortunately, the gas released is dangerous; no matter whether fission or fusion explosives were used, tritium or krypton-85 in the gas exposes customers to radiation. Decontamination is too costly or impossible. Tests in oil fields also flopped; the blasts left too much tritium in the oil output.

The most exciting excavation proposal to date is the large sea-level canal to be cut across Central America to replace the soon-outmoded Panama Canal. Thermonuclear blasts appear to be the only economical means for such difficult digging chores—but not without problems.

Nuclear tests have been detonated aboveground very little since 1963. Engineers are not sure how to deploy the explosives to achieve the desired results. Seismic shock could tear up nearby towns, and the acoustic shock wave has its own dangers. But worse still is the fact that scientists simply cannot produce a radiation-free nuclear explosion. The cleanest fusion explosives still dump neutrons and tritium into the atmosphere.

The new canal is therefore stymied. So are other excavation projects. Truly safe peacetime nuclear technology awaits fission or fusion that does not cause radiation pollution. ◈

Portable radiological survey instruments built by private industry for Oak Ridge National Laboratory. Individual meters are for neutrons, beta and gamma rays, and alpha particles. (Photo: Oak Ridge National Laboratory)



PRECISION LAB POWER SUPPLY

BUILD THIS REGULATED SUPPLY
WHICH DELIVERS UP TO 30V AND 1.2A

BY C. R. BALL, JR.

EVERY electronics hobbyist and service technician needs a bench power supply. To obtain best results, the supply should be completely variable from zero to the maximum voltage used in semiconductor circuits (usually 30 volts), and be capable of delivering enough current to carry normal loads (at least 1 ampere). In addition, the supply should have excellent regulation (both with power-line variations and load changes), minimum ripple and noise, automatic current limiting, and provisions for avoiding damage in case of inadvertant shorts.

The power supply described here meets these requirements. Its output is 0-30 volts with a line or load regulation of 0.02% or 1 mV; 0-1.2. A with line or load regulation of 0.2% or 1 mA. Transient recovery time is less than 25 microseconds, and ripple and noise are less than 0.25 millivolts rms. Cost is less than $80.

Theory of Operation. The complete schematic of the power supply is shown in Fig. 1. However, its operation can be better understood by referring to the block

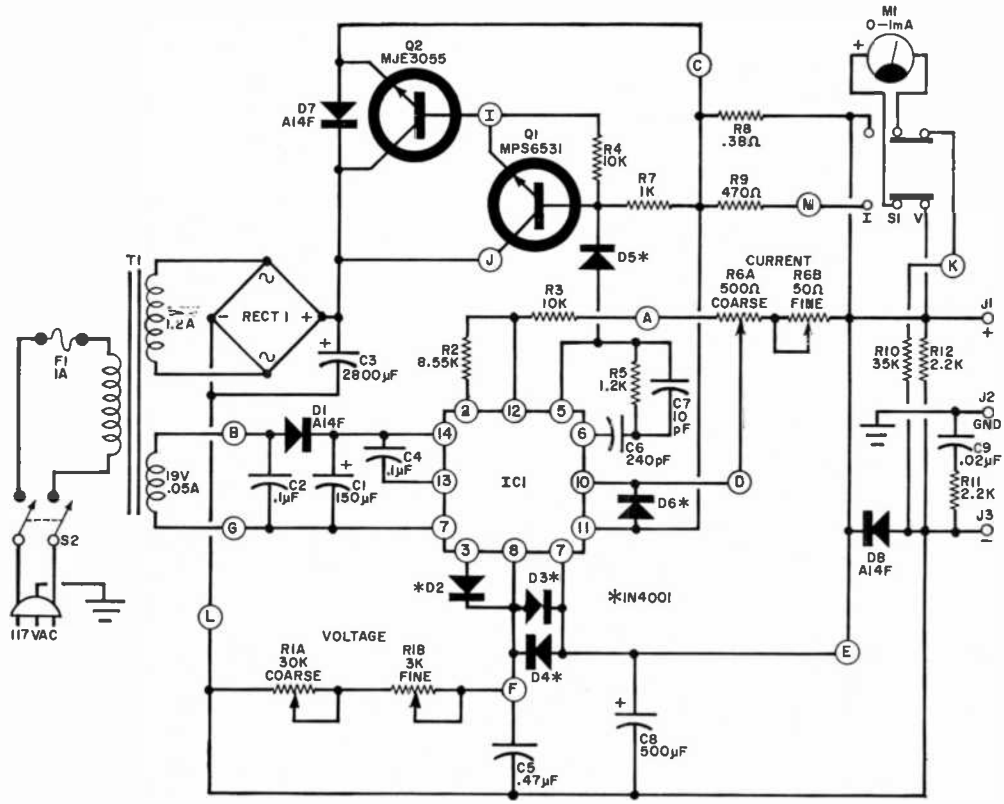


Fig. 1. The use of a recently developed integrated circuit gives the supply its excellent electrical characteristics. The circled letters indicate the connections to the board if you decide to duplicate prototype.

PARTS LIST

C1—150-µF, 50-volt electrolytic capacitor
C2, C4—0.1-µF, 50-volt disc capacitor
C3—2800-µF, 50-volt electrolytic capacitor
D5—0.47-µF, 50-volt Mylar capacitor
C6—240-pF, 500-volt polystyrene capacitor
C7—10-pF, 500-volt, polystyrene capacitor
C8—500-µF, 50-volt electrolytic capacitor
C9—0.02-µF, 600-volt disc capacitor
D1, D7, D8—A14F silicon rectifier diode (GE)
D2-D6—1N4001 diode
F1—1A slow-blow fuse and holder
IC1—Integrated circuit (Beco 670-003)
J1-J3—Five-watt binding post
M1—0-1-mA meter (requires scale modification)
Q1—Transistor (Motorola MPS6531 or HEP736)
Q2—Transistor (Motorola MJE3055 or HEPS5001)
R1—Dual concentric control, 30,000-3000 ohms
R2—8550-ohm, ½-watt 1% metal film resistor
R3, R4—10,000-ohm, ½-watt 5% resistor
R5—1200-ohm, ½-watt 10% resistor
R6—Dual concentric control, 500-50 ohms
R7—1000-ohm, ½-watt 10% resistor
R8—0.38-ohm, 10-watt 5% resistor
R9—470-ohm, ½-watt 1% resistor
R10—35,000-ohm, ½-watt 1% resistor
R11, R12—2200-ohm, ½-watt 10% resistor
RECT1—Bridge rectifier (Varo VS248)
S1, S2—Dpdt switch
T1—Power transformer; secondaries: 32V at 1.2A and 19V at 0.05A
Misc.—Suitable chassis, heat sink (Delco 7281353), power transistor mounting hardware and insulator, silicone grease, capacitor mounting bracket, edge connector (Amphenol 143-010-03), three-wire line cord, wire, solder, etc.
Note—The following are available from Beco Solid State Systems, P.O. Box 686, Salem, VA 24153: two PC boards (PS30A) at $4.95; IC1 (670-003) at $11.50; meter with special scale (650-004) at $8.50; transformer (101-050) at $9.70; complete kit of parts including all hardware, nameplates, wire harness, etc. (PS30K) at $78.40.

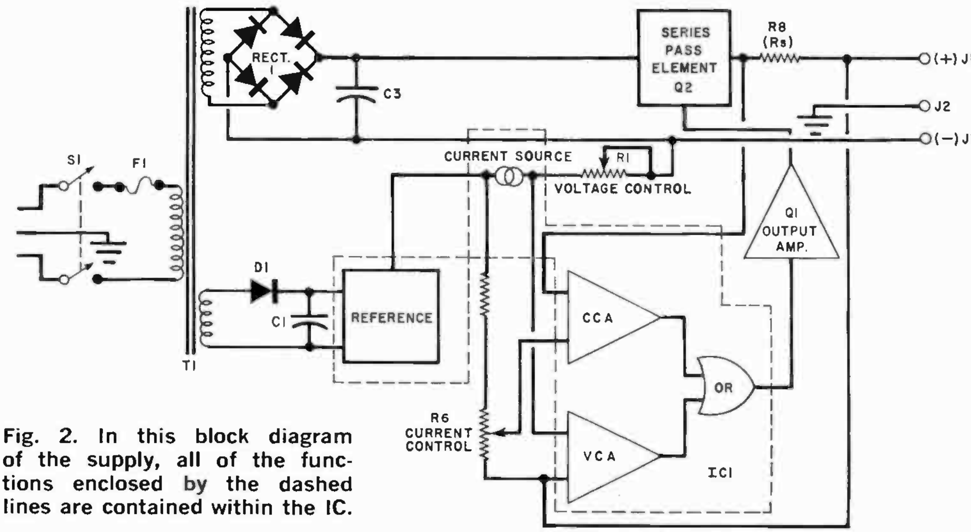


Fig. 2. In this block diagram of the supply, all of the functions enclosed by the dashed lines are contained within the IC.

diagram in Fig. 2. The ac power is applied to transformer *T1*, one of whose secondaries supplies bridge rectifier *RECT1* and filter *C3* to provide unregulated dc for the overall regulator. The other secondary supplies rectifier *D1* and filter *C1* to create the dc power required by the reference voltage regulator in *IC1*.

There are five functional circuits in *IC1*. In addition to the reference voltage regulator, they are a constant-current source, a voltage-controlled amplifier (VCA), a current-controlled amplifier (CCA), and an OR gate. Transistor *Q1* is an amplifier driven

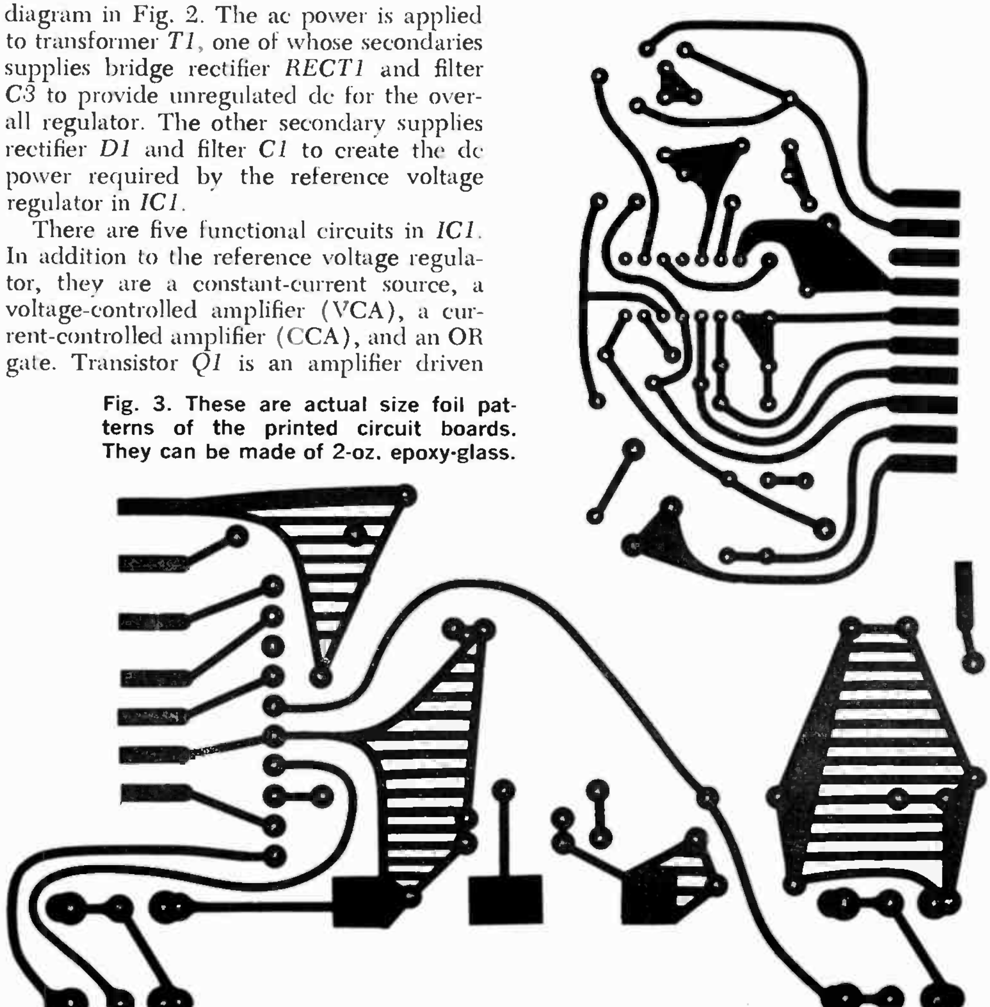


Fig. 3. These are actual size foil patterns of the printed circuit boards. They can be made of 2-oz. epoxy-glass.

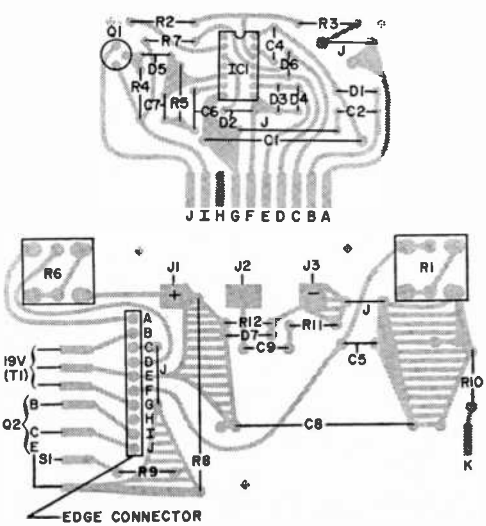
by the output of the OR gate; and $Q2$ is the main series-pass regulator.

The reference voltage regulator provides a stable reference voltage for the constant-current portion, against which variations in other parameters are compared. The VCA functions as a voltage-error sensing amplifier. One input to this differential amplifier is connected to the positive output of the supply, which is compared to a reference voltage derived from a known current passing through a variable resistance (the voltage-control potentiometer). The preset resistance of the potentiometer multiplied by the known current flowing through it determines the reference voltage. Since the VCA tries to maintain the voltage between its two inputs at zero, any difference between them produces a change in the VCA output, thus causing either an increase or a decrease in the drive to $Q2$.

The CCA operates in a similar fashion, except that its inputs are derived from either side of a current-sensing resistor (R_s). Therefore, any difference between the voltage set by the current-control potentiometer and the voltage across R_s causes a change in the output of the CCA to increase or decrease the drive to $Q2$.

The *OR* gate determines whether the voltage or current control sets the output of the power supply. If either the VCA or CCA calls for a change in drive to Q2, then that amplifier is in control. Output amplifier $Q1$ provides the necessary gain to drive $Q2$.

Fig. 4. This shows how components are mounted on the boards. The small one plugs into edge connector on big one.



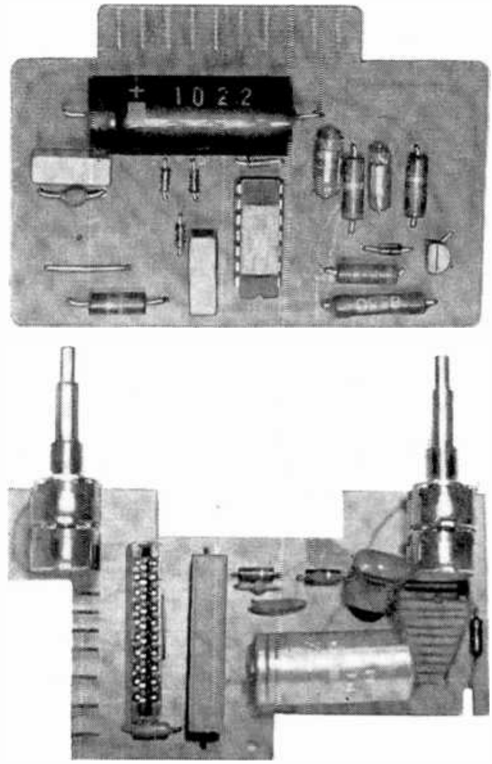


Fig. 5. Completed boards should look like these. The two dual potentiometers mount big board to chassis front.

Construction. The power supply can be assembled in almost any manner, but the "mother-daughter" PC board approach used in the prototype represents an easy assembly procedure and also allows for variations in the circuit, if desired. Foil patterns for the two boards are shown in Fig. 3. They should be fabricated on 2-oz epoxy-glass board and joined by a 10-pin edge connector.

The components are installed on the boards as shown in Fig. 4. The layout of the large board is such that several points are provided for the same connection of some components to allow for variations in size among manufacturers. Observe the polarities of polarized capacitors and semiconductors. Dual potentiometers $R1$ and $R6$ should be mounted close to the board before soldering since they provide support for the front end of the large board. Clip off the excess potentiometer terminal lengths after soldering. The completed boards are shown in Fig. 5.

The boards and other components are mounted in a suitable chassis as shown in the photograph. The heat sink for Q2 is mounted on the rear apron using thermal insulation (cork, rubber, etc.) between heat sink and metal chassis. When mounting Q2, use generous amounts of silicone grease and the insulator washers provided with the transistor.

The photographs show how the various controls, the meter, and output jacks are mounted on the front panel. Remember that the two power controls also support the mother board (with spacers and mounting hardware). The line cord is brought out through a grommeted hole in the back of the chassis. The large filter capacitor (C3) is secured in a clamp mounted on the chassis, while the power transformer is mounted along the back of the chassis.

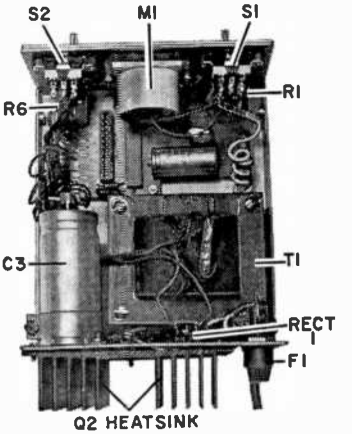
The scale of the meter must be modified to indicate from zero to 35 volts with each 5-volt step identified. On the current scale, each 0.2-ampere step should be marked from zero to 1.5 amperes.

Checkout and Use. Before putting the supply in operation, recheck all wiring and interconnections. Be especially careful with Q2, making sure that it is insulated from the heat sink and chassis and that it is properly connected.

Turn on the power and set *S1* to the VOLT position. Set the concentric current controls (*R6*) to about midrange; and rotate the concentric voltage controls (*R1*), noting that the meter indicates between zero and approximately 30 volts. Place *S1* in the AMP position, short the output terminals (*J1* and *J3*) and rotate the current controls. The output current should vary between zero and 1.2 amperes.

Set the current control about midrange. remove the short between *J1* and *J3* and connect a 15-ohm, 30-watt resistor across the output terminals. Place *S1* in the VOLT position and slowly turn up the voltage control until the meter comes to a stop. Note both the voltage and current at this point. This is called the voltage-current transition point. Now, increase the voltage and note that the current does not change. (The system is now in current-regulation mode.) Rotate the voltage control back to the point where the voltage just starts to decrease. Then rotate the current control toward maximum and note that the voltage does not change. (The system is now in voltage-regulation mode.) If all these checks work properly, the supply is ready for use.

If you want to limit the current flow in an external circuit, short *J1* and *J3* and set the current control to the desired level. Remove the short and connect the supply to the circuit. No matter what happens in the circuit, the maximum current flow will be limited. As the voltage is brought up to the required value, the circuit current can be read off the meter. The supply can also be used for constant current by presetting the current and varying the voltage. ◈



This shows the completed supply except that the small board is not plugged into the edge connector so that it doesn't hide other parts.

PROJECT EVALUATION
HIRSCH-HOUCK LABORATORIES

The ripple was well within specs, typically from 135 to 250 microvolts depending on load and output voltage. The line regulation was excellent, with no perceptible change in output from 105 to 125 volts input. (We could detect as little as 1 millivolt if it had existed, since we used a stable reference voltage to buck out the supply voltage and a Triplett VOM on its 0.3-volt scale as a null meter.)

Load regulation was not as good as claimed. At 5 volts output, the 0.02% regulation would have corresponded to 1 millivolt, a barely detectable level. We measured a change of 18 millivolts from no load to 1.2 amperes, indicating a source resistance of 0.015 ohm. Good, but not as rated.

No measurements were made in the constant-current mode, but the constant-voltage to constant-current transition seemed to occur smoothly and as intended.

CLASS "E" CB OF THE FUTURE?

OVERCROWDING ON CB CHANNELS MAY BE A THING OF THE PAST IF THE CLASS "E" CITIZENS RADIO SERVICE IS ESTABLISHED

BACK in 1958, the Federal Communications Commission recognized the need and the right of individual citizens to have the safety and convenience of personal two-way radio. And so, it established our current class D Citizens Radio Service at 27 MHz. In past years, citizens radio has grown beyond the wildest dreams of those who created the service. Somewhere around 1,800,000 licenses have been issued with about 900,000 currently active.

As the number of CB users continues to grow, it becomes increasingly clear that more channels—beyond the original 23—are required. It is this very real need that had led many individuals and groups to present countless proposals to the FCC for its consideration.

Last year (see "Communications," POPULAR ELECTRONICS, September 1971), the Citizens Radio Section of the Electronic Industries Association recommended the establishment of the class E Citizens Radio Service at 220 to 222 MHz. It should be stressed here that the new proposed class E service would be in addition to the present class D service. Briefly summarizing the EIA proposal, the new service would utilize a relatively unused portion of the amateur 220-225-MHz band, and would provide 80 new channels. Industry sources indicate that 80 channels would provide uncrowded operation for a minimum of 2.5 million licensees.

Power output to the antenna would be limited to 25W, with special public safety agencies permitted to license a base station at 100 W output to the antenna when using this band to assist in public convenience or necessity for safety. Antenna height would be limited to 20 ft above the nearest man-made structure or natural object within 500 yards; or 60 ft above the existing terrain (whichever is higher).

The proposal suggests guidelines for the specific use of channels for various applications, such as highway communications assistance, home-to-vehicle, car-to-car, etc. The basic reason for such recommendations is to guide the service in an ordered growth, foreseeing potential requirements.

What would it be like to operate on class E CB? First of all, a class E CB system is intended to be—and definitely is—a short-range system. Range would be 10 to 20 miles mobile-to-base depending upon antenna height, location, etc. At 220 MHz communications range is essentially limited to line of sight. Skip communications and skip interference would be non-existent in the class E service. Communications quality and range would be very consistent since atmospheric conditions have little effect on 220-MHz propagation. Also almost non-existent on class E would be man-made interference (often found on class D) caused by such things as ignition noise, diathermy, and other industrial radiations. To summarize, if you've ever heard a very good police communications radio system, class E CB would be very similar in performance.

Is class E right around the corner and what will equipment cost? No one can really answer that question. Too many factors are involved and too many details still require further analysis and discussions by the FCC. Best industry estimates put the proposed service at least a year away even if immediate rule making were to take place. It takes a while to put the machinery together for such a significant step in personal communications.

If you're currently considering getting into CB, take a close look at the present class D service which will admirably serve the CB'ers needs for years to come. Equipment in the $100 class is quite common in Class D. It is estimated that class E equipment will be in the $250-$300 range when it is introduced. Manufacturers anticipate that it will take two or three years after the establishment of class E before unit volume will enable cost of radios to drop to $100 or $150. You may find that class D is the low-cost way you'll want to go or perhaps you'll choose to wait for class E. There's also much talk on the air by people who want both! ◈

U.S.ARMY

ELECTRONIC ENGINEERING EXPERTISE AND ARTISTIC TALENT TEAM UP TO GIVE MUSIC AN EXCITING NEW DIMENSION

MOST people associate the word "synthetic" with "fake" and conjure up ideas of inferior versions of the genuine article. Perhaps it is only natural, then, that many people do not consider music synthesizers and their electronically produced sounds a legitimate part of real music. Electronic music has, admittedly, undergone rather gimmicky stages of development, but that is all over now. Today's sophisticated music synthesizers leave their gimmicky predecessors behind and take an important place in the evolution of legitimate music.

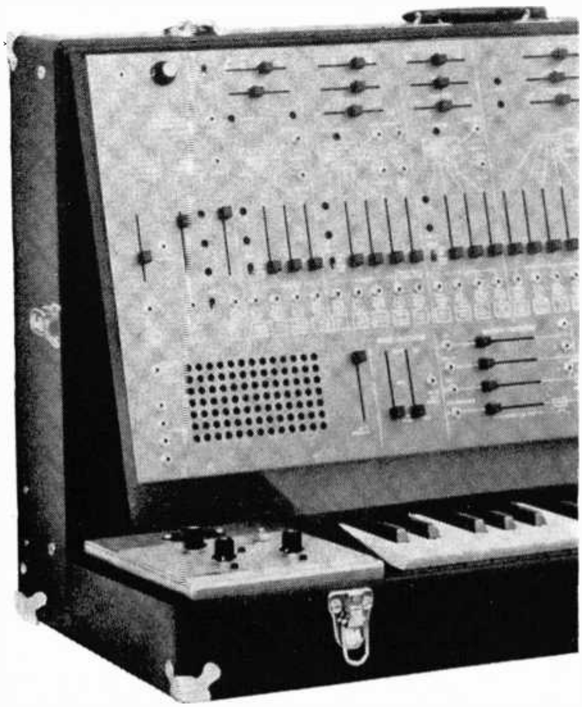
Music synthesizers are especially noted for the variety of sounds they can assemble or synthesize. A skilled performer can mix together a handful of basic tones to make the instrument mimic familiar sounds, including those of other musical instruments. Some of the sounds may not be very musical in the usual sense. But just how "unmusical" they sound depends upon the performer's artistic talent and the listener's personal tastes.

A good performer can make a synthesizer sound like a cathedral organ one moment; and then by changing some plugs and dials, he can make it sound like someone walking across a gymnasium floor in wet sneakers. Then, of course, there are the unlimited number of unfamiliar sounds—too strange to describe—that are possible with the music synthesizer.

An Awesome Experience. The neophyte who sits down at a synthesizer console for the first time, is in for an awesome experience. Seeing all those dials, switches, wires, and plugs can make him feel inadequate. The tendency when approaching a synthesizer is to equate it with familiar musical instruments. And it is this attitude that can defeat a beginner at the outset.

With a piano, the musician has a choice of one out of 88 notes to play. He can start anywhere and, with one finger, fumble out a tune. But it is different when he is sitting at a music synthesizer console where the choices of things to do first are virtually infinite in number. What is more, while the piano is ready to play immediately, the synthesizer must first be prepared to play. The proper combination of switches must be thrown, dials have to be turned, and patch cords have to be plugged in. Only then will the synthesizer condescend to utter a peep.

Playing a music synthesizer probably will not always be as difficult as it is now. This



new art/technology wedding is still new. Hence, it is constantly being improved. But even if the mechanical and electrical bugs are ironed out tomorrow, there will remain a major obstacle: How does one write a musical score for an instrument that does not fit the mold of traditional musical instruments? The little black notes that have served musicians fairly well for centuries cannot begin to manage the task of com-

THE ART AND TECHNOLOGY

BY DAVID L. HEISERMAN

municating an electronic sound no one has ever heard before.

From a performer's viewpoint, present-day music synthesizers have two technical drawbacks. First, most can produce only one particular note at a time. And, second, they can produce only one particular tonal quality at a time. Unlike a piano player who can play up to ten notes simultaneously, and run through an entire composition without

Portable synthesizer made by ARP Instruments (Div. of Tonus Inc.)

stopping, a synthetic music performer can generally play only "one-finger" music and, whenever he wants to change the tonal quality of the notes, he must stop the music and reprogram the instrument.

Because of this stopping and starting, a tape recorder is a vital part of the synthetic music studio. The performer records a segment of his composition, stops the recorder, patches a new sound into the synthesizer, then records the next segment. After completing the recording session, playing the tape straight through gives the impression that the sequences of sounds flow smoothly from one to the next. At this point, though, the music still sounds like a shallow one-finger melody.

Just as the tape recorder can take care of pauses for reprogramming the sound, so, too, can it make one synthesizer sound like four instruments. By using a four-channel tape recorder, the performer records his basic one-finger melody on the first track. After that, he fills in the other three tracks, one at a time, with the desired background, harmony, and rhythm. It is the same old trick that can make one singer sound like a quartet.

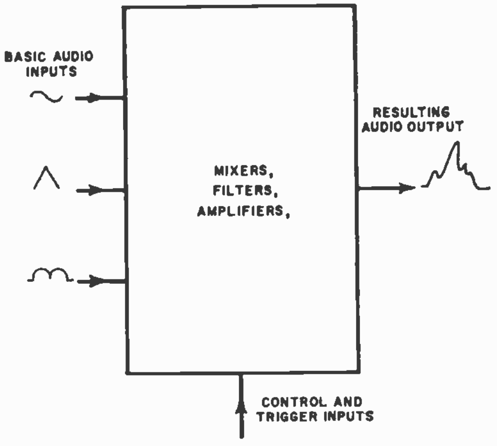
So, the serious composer and solo performer finds that a four-channel tape recorder is just as important as the synthesizer itself. Several groups of accomplished performers, however, have been touring the country with live synthesizer concerts. By using three or four performers and synthesizers on stage, one or two of them can be playing while the others reprogram and tune their synthesizers to pick up the music when the others come to the end of a certain sound segment.

From an economic point of view, music synthesizers are very expensive. Professional instruments bear price tags starting at about $2000. By adding desirable extras and a good tape recorder, the cost of setting up a decent studio quickly runs over the $8000 mark. This, combined with the fact that few people have the expertise to handle the synthesizer properly, keeps the systems out of the hands of the general public.

In spite of the drawbacks inherent in present-day synthesizers, they are exerting a powerful influence on the evolution of modern music. As the art and technology of synthetic music progresses, music synthesizers promise to become as popular as the piano.

How Synthesizers Work. It is the har-

OF ELECTRONIC MUSIC



Basic synthesizer scheme shows audio inputs combined into complex output. Performer controls the final outcome.

monic structure of the sound from a violin that makes it distinctively recognizable from the sound of a clarinet. In the music synthesizer, all sounds that emerge begin from a number of basic tones. By running these tones through electronic mixers, filters, and amplifiers, a performer can juggle the harmonic structure of an electrical waveform to make it produce just about any kind of sound he chooses.

Music synthesizers generate three different kinds of electrical signals: audio signals, control signals, and trigger signals. The audio signals eventually emerge from the system as sounds. Control signals vary the audio signals to make them change loudness, pitch or quality. The performer can do these things manually, but it is easier and more convenient to let control voltages do the job. The trigger signals begin and end control sequences according to a preset program. Again, the performer could perform the trigger operations manually, but an electronic trigger circuit does the job better.

Most synthesizers get their basic audio tones from a set of tone oscillators and a noise generator. Each of the tone oscillators produces one note at a time, while the noise generator produces a wide range of frequencies at once, the result sounds like pure static.

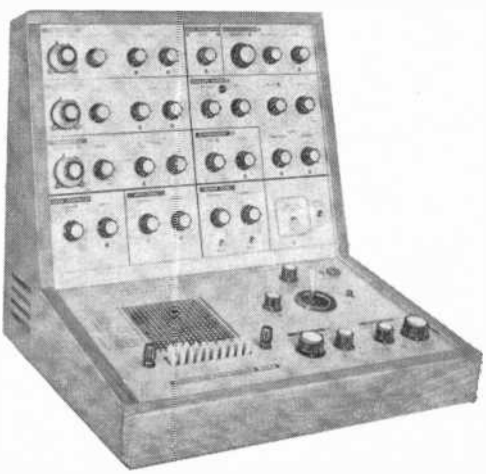
Larger music synthesizers have four or more identical tone oscillator modules in them. Each oscillator has a manual control that can be used to adjust the output frequency. These oscillators also have voltage control inputs to accommodate output frequency control by means of a voltage from some external source. Typical frequency ranges for the audio tone oscillators run between 2 and 30,000 Hz.

These oscillators have separate output jacks or selector switches for sinusoidal, rectangular, sawtooth, and triangular waveforms. The different outputs give the operator a choice of four basic tonal qualities from each oscillator. The sinusoidal waveform produces a pure sound much like that from a tuning fork. Rectangular waveforms produce one basic tone, too; but it sounds rather raspy because the sharp rising and falling edges contain a large number of high frequency harmonics. The sawtooth waveforms have a lot of raspy-sounding harmonics only on one edge. Finally, the triangular waveform produces basic notes that have a quality somewhere between that of a sine wave and a rectangular pulse.

A performer can change frequency from an audio tone oscillator without stopping the flow of music. Whenever a change is desired in the basic waveform, however, the operation must be stopped long enough to patch in a different waveform or to turn a selector switch.

The noise generator produces mixed-up frequencies that cover the entire audio spectrum. This "white noise" has a hissing quality. By means of filter circuits, all but one narrow section of the spectrum can be wiped out, producing a "pink noise." Pink noise sounds like static, too; but it has a dominant frequency that slices through. It sounds something like wind whistling through tree branches. The operator has complete control

Ionic Industries' "Putney" model has a joy stick to let the performer control two different kinds of functions at once. Keyboard is also available.



The Model IIIc synthesizer, made by R. A. Moog, is perhaps the most versatile, sophisticated, and well-known system that is on the markey today.

over the loudness and dominant frequency of the pink noise.

While it is possible to vary the frequency and output level of the audio tone signal sources manually, it is far more convenient to let control signals do most of the work. The various kinds of control signal sources produce voltages that can change the operating frequencies of a tone oscillator. And, by feeding the control voltages to special voltage-controlled amplifiers, it is also possible to vary the loudness of the audio signals.

Devices that generate the control signals include a 4-octave keyboard, ribbon controller, envelope generator circuit, foot pedal, and joy stick. Most synthesizers come equipped with at least one built-in envelope generator module, and performers generally use at least one keyboard and a ribbon controller.

The musical keyboard of a synthesizer looks like a short piano keyboard. But the similarity stops at looks. Each key operates a switch connected to a long resistive voltage divider network. Operating one of the keys picks off a voltage from the divider and sends it to a keyboard output jack. The keyboard can be set up so that playing up the scale makes the keyboard generate stepwise increases in output voltage.

This keyboard output voltage can be patched into any of the voltage-controlled circuits in the system. After plugging the output into one of the V-C audio tone oscillators, for example, playing up the scale on the keyboard makes the synthesizer produce scale-like tones. Depressing the middle-C key on the keyboard, however, does not necessarily make the synthesizer produce a familiar middle-C note.

By adjusting a manual control on the oscillator module, any key on the keyboard can be made to produce just about any note desired. If desired, the performer can even patch the system so that playing up the scale on the keyboard makes the synthesizer produce a downward-going scale.

What is more, the frequency difference between two adjacent white keys need not be the familiar one-note difference. A control on the keyboard lets the performer adjust the frequency differences between keys.

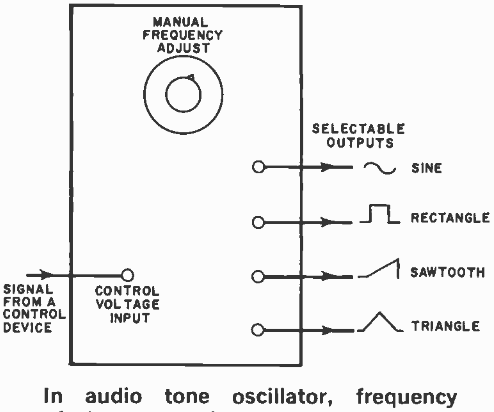
The output of the keyboard can be connected to circuits other than the audio tone oscillators. By patching the keyboard to a mixer or filter module, it is possible to use the keyboard to change the harmonic structure of waveforms generated by other circuits. Or, the keyboard can be used as a stepwise volume control by patching it to one of the voltage-controlled amplifiers.

Thus, the keyboard for a music synthesizer can perform many different functions. Perhaps it is a case of sentimentalism on the part of musically inclined engineers that a synthesizer's keyboard looks like an ordinary musical keyboard. There is actually no real reason why it should not look like a typewriter keyboard—and, in fact, it might be more useful if it did.

Another common control device, the ribbon controller, does about the same kinds of jobs as a keyboard. Instead of producing stepwise voltage changes, however, it produces continuous changes in output voltage. A ribbon controller works something like a potentiometer, and, by patching its output to a tone oscillator, it can be used to produce sweeping, theremin-like tones.

Optional control devices such as foot pedals and joy sticks work about the same way as a ribbon controller. A joy stick has the added advantage of being a two-dimensional controller. Moving the handle in one direction can vary the output frequency of a tone oscillator, while moving it in the other direction changes overall tonal quality. Moving it obliquely, it can produce degrees of both changes simultaneously.

Most of the control devices also generate a brief trigger signal whenever changes are made in the control voltage output. Every time a key is depressed, the keyboard circuits generate both a control voltage and a brief trigger voltage.



In audio tone oscillator, frequency of the output is adjusted by control knob or by use of an external signal.

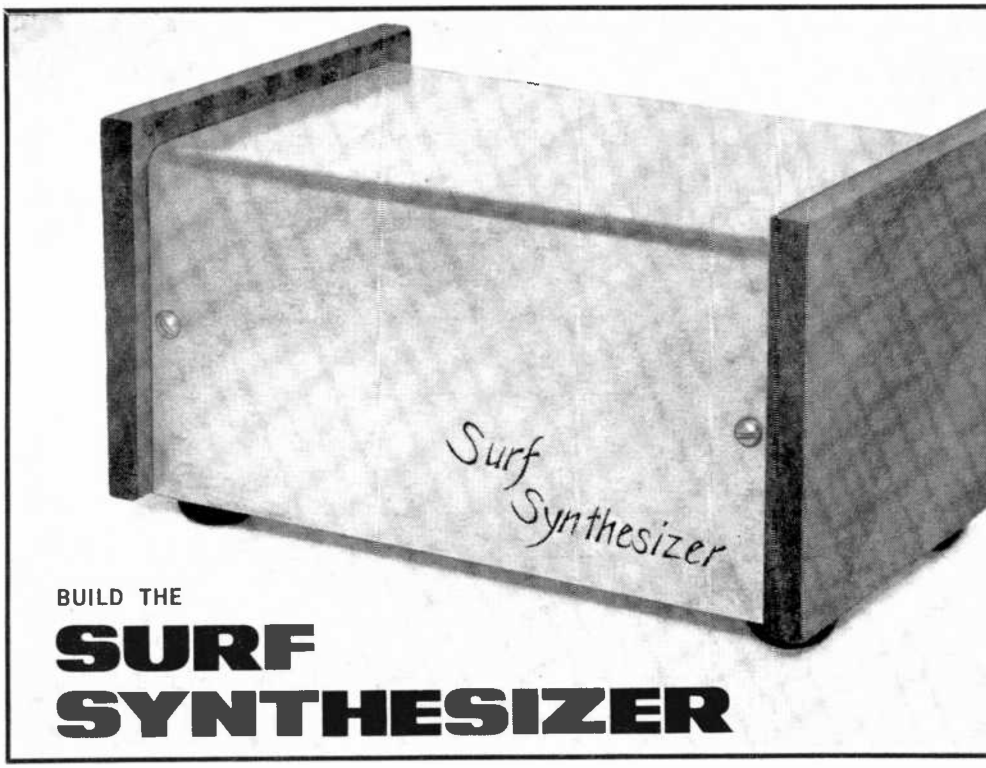
These trigger voltages can initiate other control operations, such as those performed by an envelope generator module. The envelope generator is capable of producing various control waveforms that can be used to adjust the attack, decay, and sustain level of a note. Instead of having every new note come on at full volume, for example, a patch cord, run between the envelop generator and one of the V-C amplifiers, can make the note sweep up in volume. Likewise, a note can be made to decay away slowly instead of decaying rapidly. By adjusting the contour setting on the envelope generator, a note can be made to sustain even after the player takes his hands off the keyboard.

Electronic mixers, audio amplifiers, and high-quality headphones and loudspeakers also play important roles in a music synthesizing system. A performer can make his instrument about as complex as his finances will allow. In general, the more add-ons he buys, the more versatile his instrument becomes. In the long run, though, it is actually the technical and artistic competence of the performer—not the complexity of the system—that determines the versatility of the synthesizer and the quality of the performance.

Synthesizers Vs. Composers. A performer at the console of a professional music synthesizer has complete control over every sound that comes from the system. In principle at least, he "plays" the system much the same way one plays an organ or piano. There is a growing number of electronic music "composers" appearing as construction projects and finished items in a few stores. These devices, costing about $50 for parts and about $300 for the finished item, are close relatives of the synthesizer.

Electronic music composers, however, do not synthesize different harmonic structures. Instead, they assemble different tonal patterns to produce strange sounding and sometimes pleasing melodies. By adjusting dials or switches, they can be made to produce an almost limitless number of different melodies that can run for years without repeating. In a sense, an electronic music composer works something like a player piano. Once the user sets the program, the instrument takes over all the work of producing the melodies.

Composers occupy an important place in modern elementary music classes, and they are fun to build and use. But an electronic music enthusiast should be aware of the fact that the versatility of an electronic music composer cannot even begin to approach that of its big brother, the professional music synthesizer. ◈



BUILD THE

SURF SYNTHESIZER

REPRODUCE THE SOUND OF BREAKERS AGAINST THE SHORE

BY JOHN S. SIMONTON, JR.

ONE of the most relaxing sounds imaginable is the roar of the surf. From Presidents on down, anyone who is close enough, and has the time, heads for the seashore when he wants to unwind. But what is really nice is to have the sound of the surf always available at the flick of a switch—and now you can. With a "Surf Synthesizer," you can turn your home into an apartment at Malibu Beach.

The Surf Synthesizer is actually a special-purpose electronic music synthesis system which operates through your hi-fi amplifier. White noise is generated by an inexpensive silicon transistor and voiced by a voltage-controlled, low-pass filter and attenuator under the control of a random voltage generator.

Design Analysis. A complete schematic of the Surf Synthesizer is shown in Fig. 1, but it is convenient to break the unit down into blocks as shown in Fig. 2. There are a noise source; voltage-controlled, low pass filter (VCF); voltage-controlled attenuator (VCA); and random voltage generator.

The noise source (*Q7*) is built around a reverse biased pn junction operating above its breakdown potential. The shot noise resulting from the avalanche breakdown mechanism is amplified by *Q8*.

Control voltages for the VCF and VCA originate in the random voltage generator which consists of three astable multi-vibrators (*Q1-Q6*) running at different rates and with different duty factors. The three outputs are summed and appear across *R18*. While the voltage across *R18* is to a certain extent random, it is weighted by the different periods and duty factors of the astables and the different values of the summing resistor to approximate the "roll" of the ocean.

If there is a secret to the Surf Synthesizer, it is in the VCF (*D1*). When the VCA is disabled and only the VCF is operating, the sound is close to that of the surf

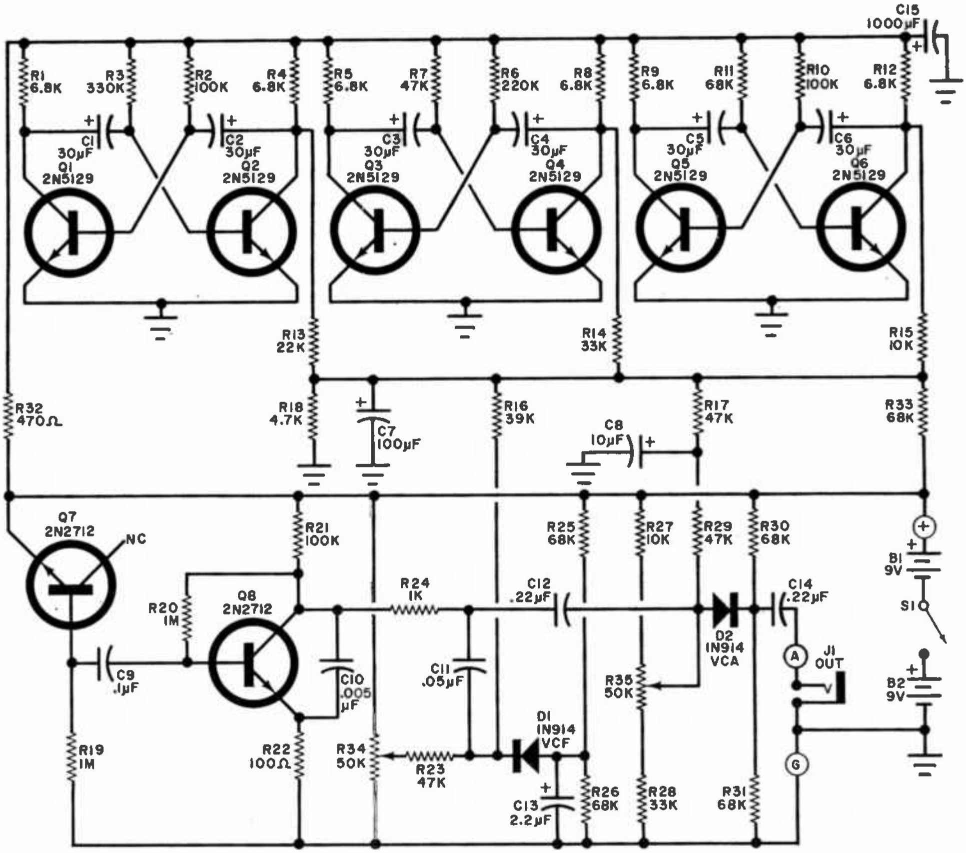


Fig. 1. The three astable multivibrators develop a composite voltage that controls both the voltage-controlled filter (VCF) and the voltage-controlled attenuator (VCA) to form the sound of the surf.

PARTS LIST

B1,B2—9-volt battery
C1-C6—30-μF, 10-volt electrolytic capacitor
C7—100-μF, 16-volt electrolyic capacitor
C8—10-μF, 10-volt electrolytic capacitor
C9—0.1-μF disc capacitor
C10—0.005-μF disc capacitor
C11—0.05-μF disc capacitor
C12,C14—0.22-μF Mylar capacitor
C13—2.2μF, 16-volt electrolytic capacitor
C15—1000-μF, 10-volt electrolytic capacitor
D1,D2—1N94 diode (or similar)
Q1-Q6—2N5129 transistor
Q7,Q8—2N2712 transistor
R1,R4,R5,R8,R9,R12—6800-ohm, ½-watt resistor
R2,R10,R21—100,000-ohm, ½-watt resistor
*R3—330,000-ohm, ½-watt resistor**
R6—220,000-ohm, ½-watt resistor
R7,R17,R23,R29—47,000-ohm, ½-watt resistor
R11,R25,R26,R30,R31,R33—68,000-ohm, ½-watt resistor
R13—22,000-ohm, ½-watt resistor
*R14,R28—33,000-ohm, ½-watt resistor**
*R15,R27—10,000-ohm, ½-watt resistor**
R16—39,000-ohm, ½-watt resistor
R18—4700-ohm, ½-watt resistor
R19,R20—1-megohm, ½-watt resistor
R22—100-ohm, ½-watt resistor
R-24—1000-ohm, ½-watt resistor
R32—470-ohm, ½-watt resistor
R34,R35—50,000-ohm trimmer potentiometer
S1—Spst switch
Misc.—Case, battery connectors, battery clamps, output jack, wire, solder, hardware, etc.
Note—The following are available from PAIA Electronics, P.O. Box 14359, Oklahoma City, OK 73116: etched circuit board #3711pc at $3.00 postpaid; kit of parts with circuit board and selected transistor for Q7, but less batteries and case #3711K at $10.95 plus postage for 1 lb; case #3711C at $2.50 with kit order.

**If the surf sound is not natural enough, try changing R3 to 270,000 ohms, R14 to 22,000 and R15 to 15,000.*

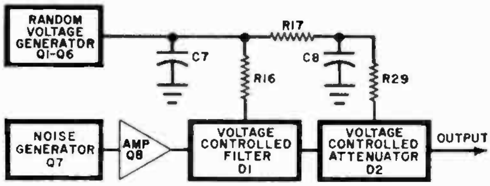


Fig. 2. Block diagram shows how random signal is filtered and level controlled by integrated random voltages from three sets of multivibrators.

even though there is no amplitude change. If, on the other hand, the VCA is working alone, the result only sounds like interstation radio static fading in and out.

The VCF uses the nonlinear V-I characteristic of a conventional silicon diode as a voltage-controlled resistor. By proper adjustment of *R34*, diode *D1* is ordinarily forward biased, resulting in a loss of high frequencies through *C11*, *D1*, and *C13*. As the control voltage of the VCF increases, it reverse biases *D1* and allows less high-frequency loss to ground. The high frequencies not shunted to ground naturally become part of the output signal.

The operation of the VCA is similar to that of the VCF. Diode *D2* is in series with the signal and is slightly reverse biased by *R35*. As the control voltage applied to the anode of *D2* increases, its effective resistance becomes less, allowing more signal to pass. Capacitor *C12* blocks dc from the VCF and does not noticeably contribute to the overall frequency response.

Construction. Since there are no very high frequencies involved and parts placement is not critical, any method of construction may be used. An etched circuit board will make the job easier, however. If you decide to use a board, the foil pattern is given in Fig. 3. Component layout is also shown in Fig. 3. Leave transistors *Q7* and *Q8* till the last; their selection and installation are explained later. Be sure to get polarized components properly installed and use a heat sink on the semiconductor leads when soldering. In fact, it is good practice to save the installation of all semiconductors for last so that the heat from soldering adjacent components does not damage them.

When all of the components except *Q7* and *Q8* have been installed, connect the positive lead of one of the battery connectors to the circuit board point marked "+" and the negative lead of the other to point "G". Solder the remaining lead from each connector to either side of switch *S1*. Also connect the output jack to points "A" and "G" with wires that will be long enough to reach from the location of the jack to the circuit board when it is installed in the case.

To select *Q7* and *Q8*, remember that not every 2N2712 breaks down when its base-emitter junction is reverse biased with 18 volts. However a piece-by-piece survey of over 5000 transistors indicated that approx-

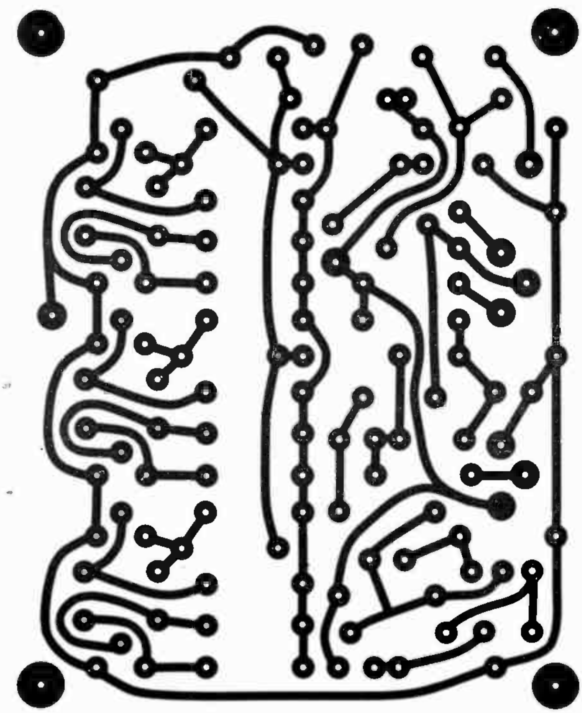
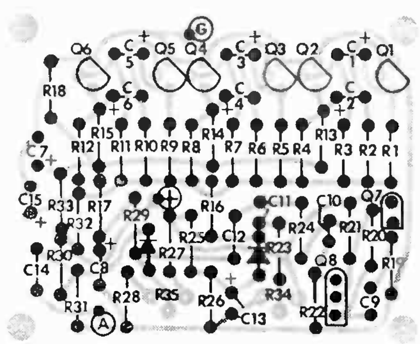
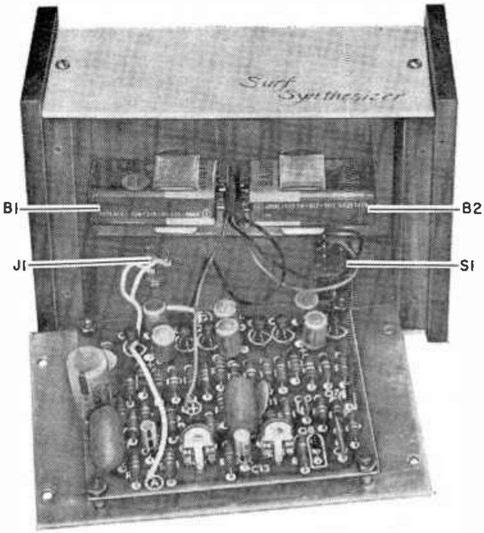


Fig. 3. Actual size foil pattern and component layout. Take care when installing semiconductors, diodes, etc. See text before installing Q7 and Q8.





Interior view of author's prototype shows method of mounting boards and location of both of the batteries.

imately 80% of them were suitable for use as a noise source. Since two of these transistors are used in the synthesizer, there's a good chance that one can be used for *Q7*. Arbitrarily select *Q7* and *Q8* and lightly solder them in place. Note that the collector of *Q7* is not connected to any point in the circuit. Rotate *R34* and *R35* fully clockwise as viewed from the nearest edge of the board. Run a jumper from the output jack to the low-level input of a hi-fi or instrument amplifier and adjust the amplifier's gain about midway. Install two 9-volt batteries in the Synthesizer and turn on *S1*. You should hear a rushing sound from the amplifier. If you don't, unsolder *Q7* and *Q8* (being careful to avoid overheating) and interchange them. When you are sure that *Q7* has been properly selected, solder it and *Q8* permanently in place.

This is a good time to check the voltages at the collectors of *Q2*, *Q4*, and *Q6* to make sure that all three astables are operating. Use any VTVM set to a 20-to-25-volt scale. The voltage on the collector should go from about ½ to 17 volts and have a period of several seconds.

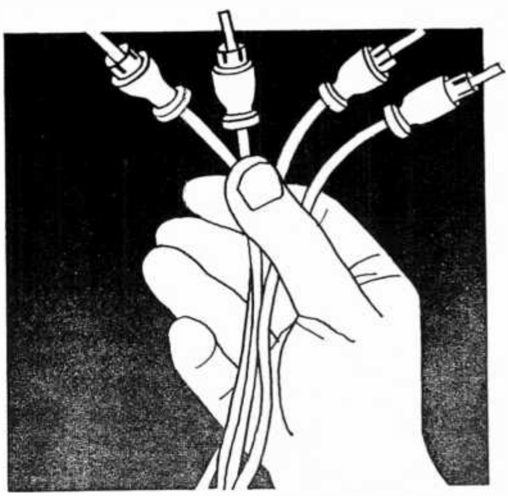
The Surf Synthesizer may be housed in any convenient case. In the prototype, the case was made of sheet aluminum folded into a U measuring about 5″ x 2½″ x 3¼″. The ends of the U were sealed with walnut blocks having a rabbet cut around each edge. The ends are held in place by #4 wood screws through the aluminum. Holes were cut in the back of the case to provide clearance for the output jack and the power switch. The battery clips were glued to the top of the channel.

The circuit board was fastened to the aluminum bottom plate with 4-40 hardware and ¼″ standoffs. The bottom plate was fastened to the wooden ends with #4 screws.

Setup and Operation. The only adjustments to be made on the Surf Synthesizer are the settings of *R34* and *R35*. While these settings are largely a matter of personal preference, a couple of tips will get you started.

Connect the Synthesizer to an amplifier and turn both on. With *R35* set fully clockwise, adjust *R34* for the widest and most natural sounding tone changes. When you are satisfied with the adjustment of the tone control, you can set *R35* for volume changes. You will probably find that the most natural sound results when the Synthesizer is completely muted for short periods of time. There is little electrical interaction between *R35* and *R34*, but it will probably take some twiddling before you are completely satisfied with their adjustments.

Bear in mind that the quality of the amplifier used with the Synthesizer will greatly affect the final sound. Use an amplifier with the best bass response available so that the "roar" of the surf can be heard as well as the crescendo-like crash as the waves break. It will probably be necessary to advance the bass boost of the amplifier to achieve a really natural sound. ◈



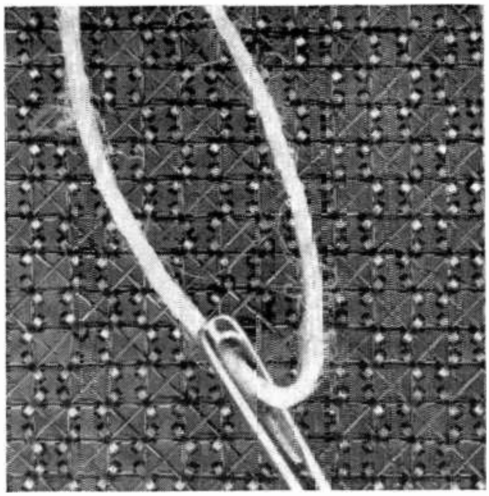
Computer Core Memories Still Handmade

IT IS an ironic fact that one of the most critical and costly parts of modern computers is produced by handwork more exacting than the finest embroidery. This is the core memory, the portion of the computer that stores information for high-speed electronic calculation—and transfers it at speeds measured in billionths of seconds. The performance of this central memory, more than any other part, determines how efficiently a computer can do its job. In fact, a core memory may account for more than half the cost of a large high-speed computer.

The cores are tiny rings of an iron oxide material, some less than a fiftieth of an inch in diameter. Each core may be magnetized in a clockwise or counterclockwise direction to store a unit (bit or binary digit) of computer information.

Women's deft hands string these tiny beads together with hair-like wires. Up to three wires may be run through the almost invisible center of the core. The wires carry electric current that reads, writes, or erases the information in each individual core. As many as ten million cores may be contained in a single memory. For years, computer designers have sought ways to automate the production of high-speed memories and eliminate this handwork. Various methods have been tried at great expense, but none has yet emerged that can equal the combination of speed, economy and reliability that hand-wired cores achieve.

Semiconductor memories with higher operating speeds are beginning to be used in some of the newer computers. Such memories have shown up to three times the speed of core memories, though they have yet to equal their economy. But the core will continue its vital role for many years to come. Further increases in core speed, economy and compactness are certain. Besides there are more than 50,000 computers in use in the world today that rely on core memories. Since these computers have been designed with cores, it would require radical and expensive changes in the computer itself to replace existing core memories with semiconductors. ◈



Common #7 needle and 00 thread dwarf cores and wires in typical section of Ampex computer memory. Each core stores unit of computer data. Three wires go through center of each core.

Aided by powerful microscopes, skilled women weave hair-like wires and tiny ferrite cores into a computer memory.

NEW IC'S AND CIRCUITS FOR COLOR TV

MANY NEW AND NOVEL CIRCUITS WILL SOON BE FOUND IN COLOR-TV RECEIVERS

WHAT STARTED OUT only a short time ago as a sort of token acknowledgement of integrated circuits in color TV receivers is now blossoming into full-scale usage; and they are being accompanied by other solid-state devices such as plug-in modules, Varactor tuners, and high-voltage doublers and triplers. Add to this, new developments in CRT's and yokes, and it looks as if color TV reception is about to take some giant strides. Most TV manufacturers have associated themselves with IC producers (either separate companies or branches of their own organization) in order to make maximum use of semiconductor technology in consumer applications.

RCA is now using five IC's in their current line, and Motorola will soon equal this—in addition to using a new horizontal line frequency switched power supply. Zenith is also introducing plug-in transistors and IC's, while General Electric has started its first solid-state monochrome production line with some interesting circuit innovations. GE is also looking into the possibility of an advanced color receiver for next fall.

Not all the changes are in semiconductor circuits. For example, Sickles (G.I.), a TV component manufacturer, is using a special alloy in its deflection yoke cores to change permeability with temperature and oppose convergence drift due to heating. The drift is reduced from about 9% to close to 1%, resulting in a more color-stable picture during long hours of use.

As for the color tube itself, the 110° tube presently in wide use suffers from one big problem: lack of industry standardization. Some are made with small diameter necks, which can possibly mean more internal arcing; while others have large necks, which means greater deflection power is needed. Although the Americans are indecisive, the Europeans will probably select the thin-neck version using a dual toroidal yoke for both vertical and horizontal deflection.

Here is what three typical manufacturers have in store for us.

Motorola. Semiconductor research, development, and manufacture for Motorola is carried out at Phoenix, Arizona, while the receiver plant is at Franklin Park, Illinois. Ideas advanced by the R&D engineers at Phoenix are not always immediately evident in the sets from Franklin Park.

For instance, the 10-IC color-TV receiver whose block diagram is shown in Fig. 1 may well represent the solid-state future (but not the present) for Motorola. Except for the unshaded blocks, representing the uhf and vhf tuners, horizontal driver and output amplifier-damper, the low-level video amplifier, and the chroma outputs, every other circuit is an IC, currently in the works. There appears to be no logical reason why the unshaded blocks could not be IC's shortly. Motorola certainly makes some excellent high-frequency transistors and Varactor diodes, so the front end is a real possibility. More than likely, the other blocks are also being designed.

But making an integrated circuit out of a discrete-component circuit is not all that easy. A lot of sophisticated thinking went into the video detector portion of the IC that is the i-f amplifier detector shown in Fig. 2. Conventional video detectors use a semiconductor diode, which, being nonlinear, often produces "birdies" (undesirable sum and difference signals) that disturb the picture. The partial circuit shown in Fig. 2 is a double-balanced, full-wave, synchronous circuit with linear detection and frequency response to 6 MHz. Transistor *Q7* is a constant current source, *Q1* and *Q2* form a differential amplifier, and *Q3* through *Q6* are carrier operated switches. The three inputs are derived from the video i-f amplifier portion of the same IC.

When positive half cycles of the amplitude-modulated carrier appear at the base of *Q1*, the transistor conducts. The in-phase clipped carrier that simultaneously appears

Above are RCA hybrid networks built on ceramic substrates for color TV.

at the base of *Q3*, will cause that transistor to conduct and allow more current to flow through *R1*. No current flows through *Q4* since it is switched off by the out-of-phase clipped carrier. When the negative half cycles of the modulated carrier appear at the base of *Q1*, it turns off, but *Q2* conducts through the differential action. The reverse-phase carrier pulse turns *Q4* on causing the current through *R1* to increase. No current flows through *Q3* since the in-phase carrier pulse is negative at this time. The current flow through *R1* increases for either positive or negative half cycles of the carrier, thus causing a voltage change at the collector terminals of switched transistors *Q3* and *Q4*.

The reverse action takes place in *R2* due to *Q5* and *Q6*. Curve (A) in Fig. 2 shows an amplitude modulated carrier as it would appear at the base of *Q1*, while *Q2* would see the same signal inverted. The two clipped carrier pulses are shown in curves (B) and (C).

The overall detector is switched at twice the carrier frequency (with *Q3* conducting on the positive half cycles and *Q4* on the negative half cycles), producing waveform (D) in Fig. 2. This is the waveform across *R1*. Note that the original carrier no longer exists and the detected modulation is constructed of pulses of double the original carrier frequency. The stages that follow the basic detector have a limited frequency response and amplify only the lower-frequency components (modulation), thus making the detector self-filtering for any high-frequency products. So the detector need not be shielded to prevent spurious radiations of the i-f and harmonics of the i-f from getting into other circuits and causing various types of unwanted moire patterns.

Fairchild-Warwick. IC manufacturer Fairchild Semiconductor and receiver maker Warwick Electronics have combined their skills to demonstrate a complete monolithic color processor on a 20-pin package. If the idea of a 20-pin IC frightens you, consider the fact that this single package requires only 42 external components as opposed to the 62 to 77 required by the active 2- and 3-package systems presently under consideration.

This new chroma subsystem (Fairchild μA782) includes a 3.58-MHz oscillator/amplifier, an oscillator phase control, an automatic phase control detector, and automatic color control circuit, i-f gain control, chroma i-f amplifier, chroma demodulator, and color killer. The other necessary elements are a 3.58-MHz crystal, chroma bandpass transformer, oscillator RLC phase-reference tuned circuit, phase and color level potentiometers, and assorted resistors and capacitors.

General Electric. The General Electric engineers at Portsmouth, Virginia, are proud of their new U-1, a 21-transistor, 16-diode, 1-IC monochrome receiver for 1972. Two discrete-component circuits are especially interesting.

The three-stage video i-f strip shown in Fig. 3 uses only one transformer *(T101)* coupling the i-f to the detector. This circuit is the result of 2 years of work on RC coupling techniques, providing a minimum of tuned circuits to process the relatively low-level video information.

The band shaping is performed by series inductor *L104* and the detector transformer,

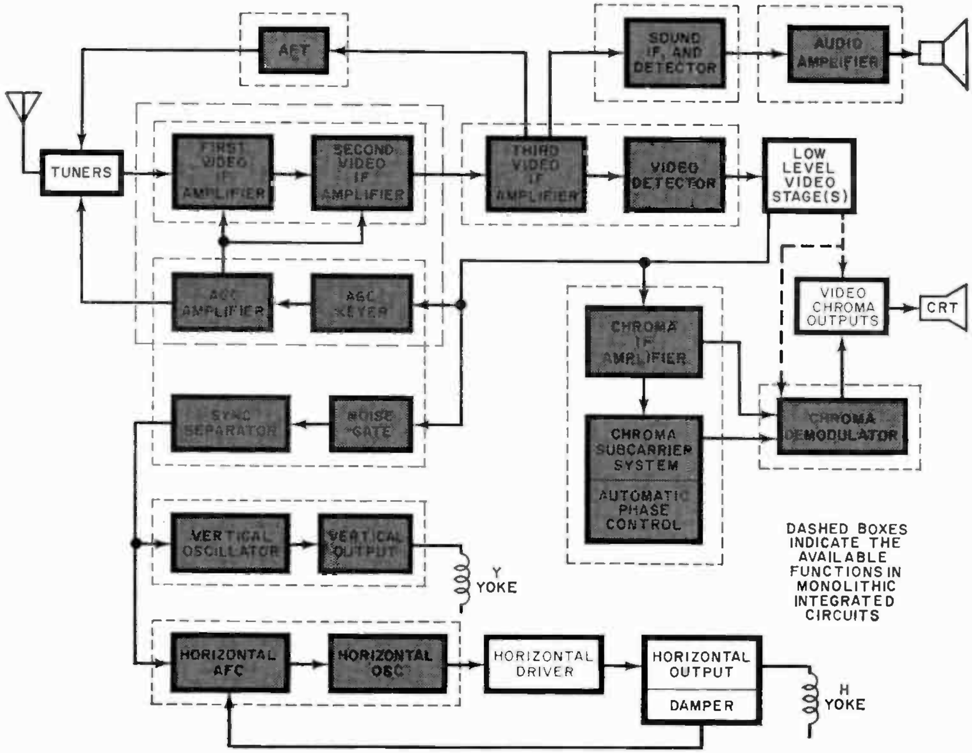


Fig. 1. Shaded blocks in this diagram of Motorola's experimental color TV receiver are available now as integrated circuits. When design of the remaining circuits is complete in integrated form, the set will be all-IC.

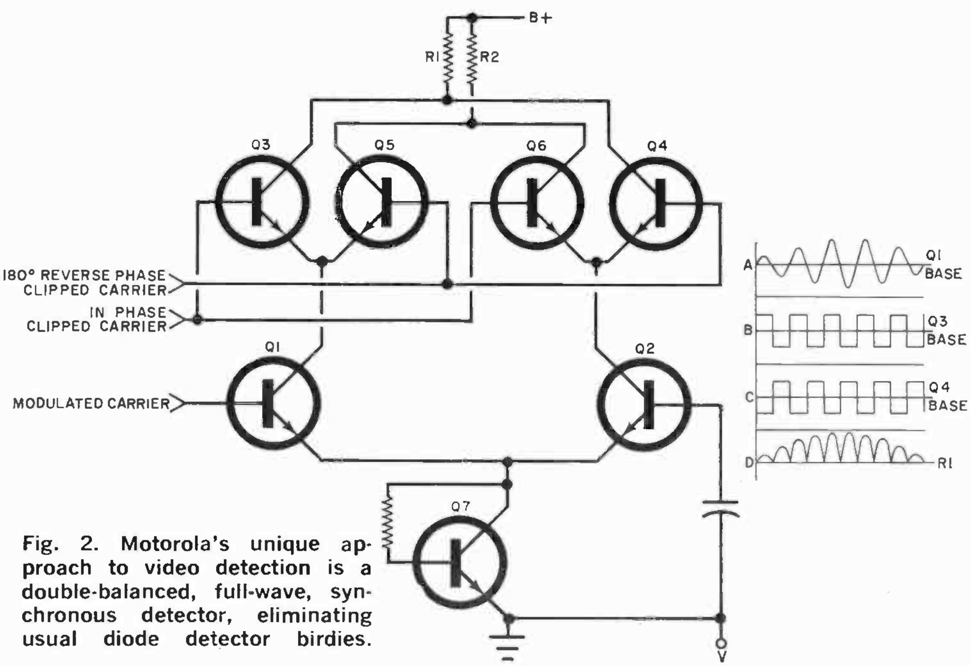


Fig. 2. Motorola's unique approach to video detection is a double-balanced, full-wave, synchronous detector, eliminating usual diode detector birdies.

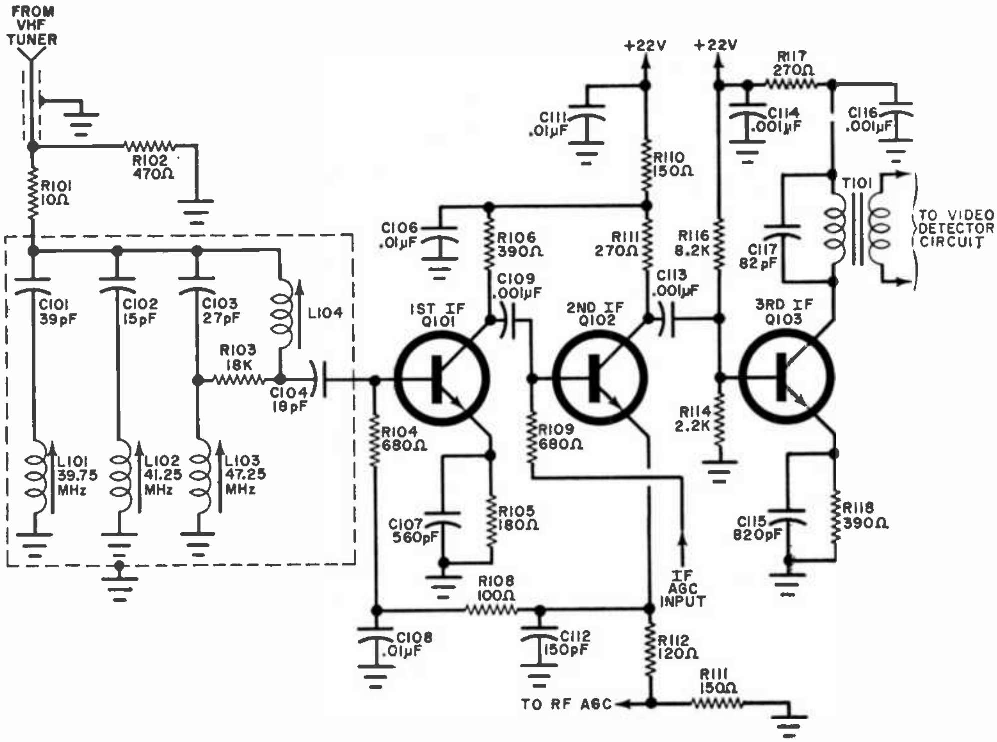


Fig. 3. This three-stage video i-f strip by General Electric uses resistor/capacitor coupling and special emitter bypassing to eliminate more standard i-f transformers. Technique provides a minimum of tuned circuits for low-level video information. It will be in GE's U-1 monochrome units.

with the emitter bypass capacitors selected for maximum gain within the bandpass. Using a 45-MHz i-f center frequency, this circuit places the 45.75-MHz video carrier at the 50% point on the response curve, and the 42.17-MHz chroma carrier at the correct 50% point on the other side of the skirt.

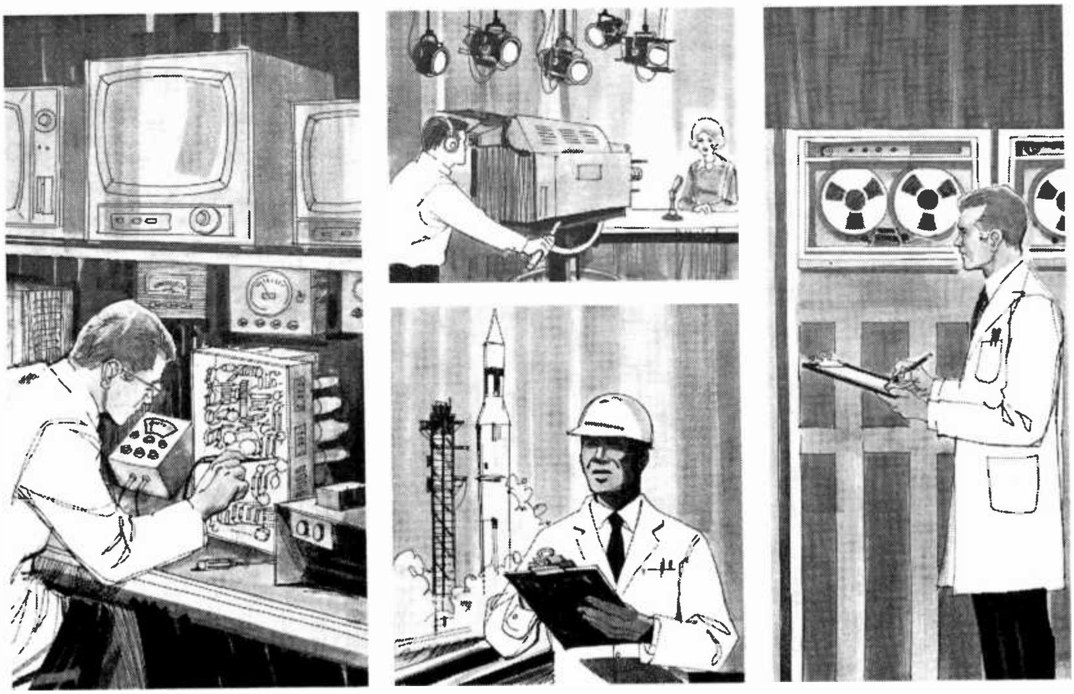
The i-f agc is fed (via *R109*) to the base of the second i-f amplifier *Q102*, with positive forward feed agc for the r-f stage generated at its emitter. This approach was used to prevent excessive current drain on the agc keyer stage. The overall circuit develops maximum gain from three i-f stages and permits 275 lines of horizontal resolution and full 3.5-MHz bandpass, which is substantial enough for color and excellent for monochrome reproduction.

The other GE circuit is a four-transistor vertical oscillator and output system. In this circuit, the so-called oscillator stage and the output stage are cross-coupled to create the overall vertical sweep system through use of positive feedback. A single transistor is used as the buffer between the "oscillator" and output stage, while the other transistor acts as a variable-gain feedback amplifier. The circuit arrangement is such that the active portion (4 transistor, 2 diodes, resistors, etc.) lends itself readily to an IC format.

Other Things in View. Obviously, these three companies are not alone in their TV advances. Other semiconductor and receiver manufacturers are working to develope new IC's and fascinating circuits so that they can get their share of the multi-million dollar color-TV market.

Keep your eye also on what is going on abroad. With the beginnings of an IC industry in Japan, and with their usual excellent approach to miniaturization, it is possible to expect some really marvelous things from there in the next year or two. One of their major contributions, the Trinitron color tube by Sony (with a non-shadow mask and simple convergence adjustments) is probably just a preview of things to come. ◈

Great careers



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Fundamentals of Solid-State Receivers

RECEIVERS, like almost every other kind of electronic equipment, have grown increasingly complex—primarily because people expect so much more of them in terms of performance and versatility. Almost all of the bands, commercial and amateur, are getting so congested that selectivity poses a real problem in the design of a good high-frequency receiver. Single sideband, with all of its advantages, has brought with it the need for stability far greater than that required for conventional AM. And, to top it all off, everyone wants receivers that are smaller and more compact.

The appearance of the transistor provided the answers to some of these problems. Space and weight could be trimmed significantly, while heat, long one of the big enemies of electronic equipment, could be almost eliminated. However, transistors had problems of their own—leaving a lot to be desired as far as stability, overload, and circuit design were concerned.

Then along came integrated circuits and field effect transistors. The IC brought more space reduction and, in some cases, simplification of circuits. The FET has solved many of the overload problems connected with bipolar transistors. The FET high input impedance has almost eliminated loading of tuned circuits, resulting in higher Q's and improved selectivity; and the low noise of FET's has improved sensitivity. So it is now possible to design and build a solid-state receiver that is equal to, or even better than, its vacuum tube counterpart.

Most electronic experimenters choose to buy factory built receivers because they feel the task of constructing one is beyond their capabilities. This is not necessarily the case. They build many other electronics projects that are just as complicated. Perhaps a better understanding of just how a solid-state receiver is designed and how it works would cause many to try constructing one for themselves.

The Basic Superheterodyne. A block diagram of the basic superhet system is shown in Fig. 1—applicable to simple BCB units, FM receivers, CB rigs, radio control, etc.

Assume that the input circuit of the mixer is tuned to 5.000 MHz. A local oscillator built into the receiver is tuned to 5.455 MHz and is coupled to the mixer. When a nonlinear device has two such signals fed into it, there are four signals at the output: 5.000, 5.455, 10.455 and 0.455 MHz. By following the mixer with a selective tuned circuit and amplification (the i-f amplifier) at the difference frequency (455 kHz) considerable improvement in selectivity can be achieved as opposed to the mere amplification of the 5.000-MHz signal alone. Why? Because the higher the frequency of a tuned circuit, the less selective it becomes. For this same reason, the sum frequency (10.455 MHz) was passed over.

Double Conversion. In considering the layout in Fig. 1, a logical question arises: Why not move the local oscillator frequency nearer to that of the received signal? This would lower the frequency of the i-f amplifier and provide even more improvement in selectivity. This is true; but, as the i-f frequency is lowered, problems of another nature arise.

The mixer is not selective enough to attenuate all signals other than 5.000 MHz—especially those close to 5.000 MHz. If, for example, a strong signal at 5.910 MHz appears at the input, it too will mix with the local oscillator frequency and will also produce a difference frequency of 455 kHz. This will be amplified in the i-f amplifier, producing what is called an image of the other 455 kHz. Images can appear anywhere in the tuning range of the receiver.

Thus, it can be seen that moving the local oscillator frequency closer to the received signal brings the images closer and makes it more difficult for the tuned circuits to attenuate them. Adding more tuned circuits between the antenna and the input to the mixer will help, and this is one reason for adding an r-f amplifier. However, as receivers are called upon to get signals of higher and higher frequencies, the number of tuned circuits needed to solve the image problem becomes prohibitive.

One solution is to use double conversion as shown in Fig. 2. Now, with the same 5.000-MHz input, the first local oscillator is tuned to 11.000 MHz; and the output of the first mixer is 6.000 MHz, the difference frequency. The image frequency is now 17.000 MHz, which is far enough away from 5.000 MHz to be attenuated.

To get a lower i-f frequency for better selectivity, the second mixer is fed by a local oscillator at 6.100 MHz, and the difference frequency of 100 kHz is amplified and detected.

In addition to solving the image problem, double conversion can be a real asset in improving stability. An oscillator is always a source of frequency drift in a receiver, and the higher the frequency, the greater the problem. In some double conversion receivers, the first local oscillator is crystal-controlled for stability, and the second, working at a much lower frequency, takes care of the tuning. Overall stability is thus considerably improved.

New semiconductors, new IC's, and new circuits make much better receivers possible

BY JIM WHITE, W5LET

However, double conversion receivers are not without their drawbacks. Every time an oscillator is added, chances of spurious responses increase considerably, so quite a few single conversion receivers are still to be found. But, instead of a low i-f frequency, they use a frequency as high as 9.000 MHz to reduce the image problem. The development of excellent crystal filters for this frequency range has helped to solve the problem of selectivity for these single conversion units.

R-F Amplifier. An r-f amplifier is included in high-frequency receivers for two main reasons: to increase the level of the antenna signal to a point where it will override the noise generated in the mixer, and to offer discrimination to spurious signals. Too much amplification can create problems with cross-modulation and blocking, which can occur when one stage of the receiver (the r-f or mixer) is overloaded.

The circuit of an r-f amplifier using a dual-gate FET is shown in Fig. 3. The FET works well as an r-f amplifier because of its excellent "square-law" behaviour, which means that a frequency applied to its input appears at the output along with the frequency's second harmonic—and no other harmonic. If the circuit is tuned (as in an r-f amplifier), the second harmonic is of no importance since it will be eliminated. The square-law behaviour of a FET is much better than that of a bipolar because the latter has characteristics similar to a diode, resulting in more harmonics.

In the circuit shown in Fig. 3, the signal is applied to one gate of the dual-gate MOSFET, while automatic gain control is applied to gate 2. This use of feedback to control the gain on the second gate is one of the big advantages of the dual-gate FET. As mentioned previously, the FET also has a high input impedance so that it does not load the tuned circuit and it makes possible a very high Q to prevent spurious signals.

Mixer. As its name implies, the mixer stage takes two signals, mixes them, and provides outputs which are the sum and difference of the two. By selecting the proper output, a high frequency can be converted to a much lower one.

Any nonlinear device can be used as

a mixer: diodes, bipolar transistors, or FET's. Usually the diode is not used at lower frequencies because there is a signal loss in conversion, and the characteristics of a bipolar limit its usefulness when handling strong signals.

Here again, the dual-gate MOSFET is preferred—even over the junction FET or single insulated gate FET. The second gate is used for the local oscillator input (see Fig. 4). With the r-f input on gate 1, the signal and the oscillator are well isolated. This eliminates a problem called "pulling," which means that the tuning of the mixer causes a shift in the frequency of the oscillator.

A mixer using a junction type FET is shown in Fig. 5. Like the circuit in Fig. 4 it provides signal gain while converting the input to the i-f frequency (conversion gain), but the isolation of the oscillator frequency is not as good as provided by the circuit in Fig. 4.

Local Oscillator. In the simple superheterodyne, the tuning range of the local oscillator must maintain the difference between its own frequency and that of the input so that the i-f frequency is always the prescribed amount—in the case of the example used here, either 455 kHz above or below the signal. This frequency difference must be maintained throughout the frequency range of the receiver if the i-f amplifier is to pass and amplify (called "tracking") the mixer output.

Many modern double conversion receivers use a crystal-controlled first local oscillator to improve stability at high frequencies. The second local oscillator, operating at a much lower frequency is tunable. In addition to providing stability, this method assures the same tuning range on all bands and makes calibration easier because the oscillator's tuning range is the same on all bands. Several types of communications receivers used by amateurs utilize this principle, and often as many as a dozen crystals are used in the first local oscillator.

If more expanded coverage is desired, the designer must include more crystals and a more complex switching arrangement. Some of the more expensive and complicated receivers, designed to receive signals between 500 kHz and 30 MHz, have a first oscillator whose frequency can be shifted, either by conventional tuning, or by bandswitching inductance and capacitance. Such an oscillator normally would be too unstable, but in this case it is phase-locked to harmonics of a very stable crystal oscillator. Though somewhat more complex, this arrangement offers excellent stability, a reduction in the number of crystals needed (usually only one or two), a much wider range of frequencies, and simplified switching.

A block diagram of a phase-locked oscillator is shown in Fig. 6. A precision 500-kHz crystal oscillator drives a harmonic generator, which provides good, strong harmonics to frequencies well above 30 MHz. These harmonics, appearing at every 500 kHz, are fed to a phase detector which also receives the output of the tunable oscillator. As long as the tunable oscillator is at an exact multiple of 500 kHz, the output of the phase detector is zero. However, if the oscillator drifts, the output voltage of the detector, which is coupled to a variable capacitance diode connected across the oscillator tuning coil, brings the oscillator frequency back to the correct value. With proper design, a phase-locked oscillator has extremely good stability—even better than some crystal oscillators operating at higher frequencies.

For those interested in a simpler approach, Fig. 7 is a crystal-controlled oscillator using a junction FET. The circuit in the drain is tuned to the crystal frequency. For multi-band operation it is necessary to switch crystals and tuned circuits.

As mentioned previously, many receivers have a tunable second local oscillator that determines the frequency stability of the receiver. In the circuit shown in Fig. 8, a buffer stage is included to provide more isolation and minimize "pulling" of the oscillator. The oscillator uses a single-gate MOSFET, while the buffer is a conventional bipolar transistor.

I-F Amplifier. No mention has been made so far about the use of integrated circuits. Why? Simply because there does not seem to be any IC that equals the performance (in the circuits discussed so far) of the devices suggested. With the i-f amplifier however, it's a different story. There are several IC's available

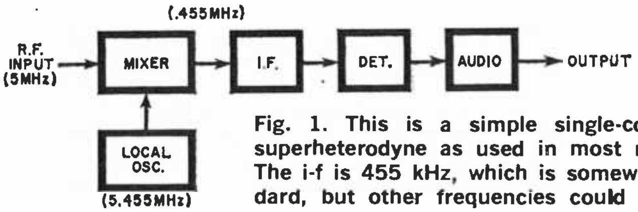


Fig. 1. This is a simple single-conversion superheterodyne as used in most receivers. The i-f is 455 kHz, which is somewhat standard, but other frequencies could be used.

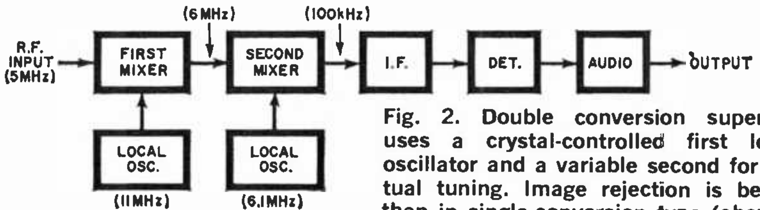


Fig. 2. Double conversion superhet uses a crystal-controlled first local oscillator and a variable second for actual tuning. Image rejection is better than in single-conversion type (above).

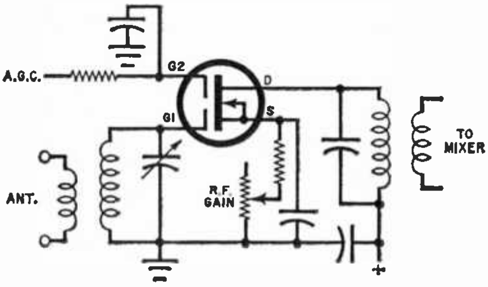


Fig. 3. Here, the dual-gate MOSFET r-f stage has its gain controlled by a negative voltage which shown is applied to gate 2.

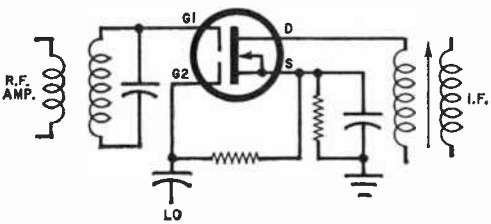


Fig. 4. This mixer also uses a dual-gate MOSFET, with the local oscillator signal applied to gate 2 of the transistor; r-f on gate 1.

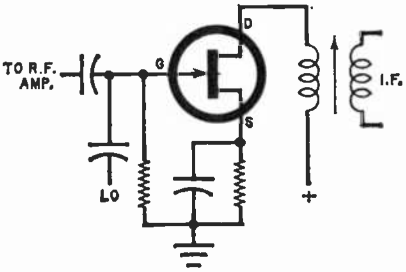


Fig. 5. This circuit shows how a junction FET can be used as mixer. There is less isolation than when the dual-gate MOSFET is employed.

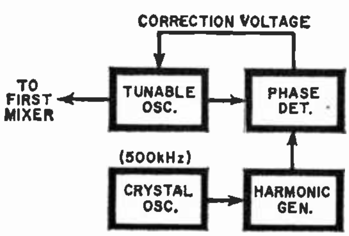


Fig. 6. This tunable oscillator is locked to harmonic of crystal frequency and kept on frequency by the action of the phase-locked loop.

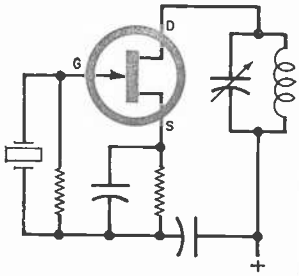


Fig. 7. Typical crystal-controlled oscillator using a junction FET. The tuned circuit in the drain is set to the crystal frequency. For a different frequency, both crystal and the tuned circuit components must be changed.

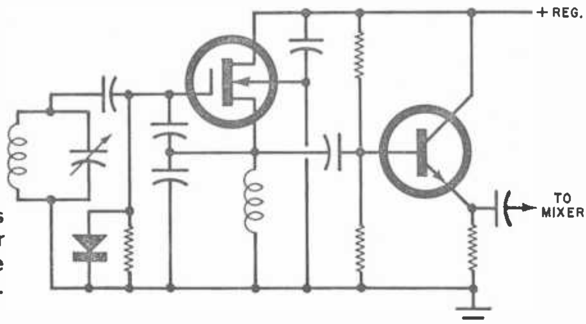


Fig. 8. This tunable circuit is used as second local oscillator with a buffer stage to provide isolation from the mixer circuit.

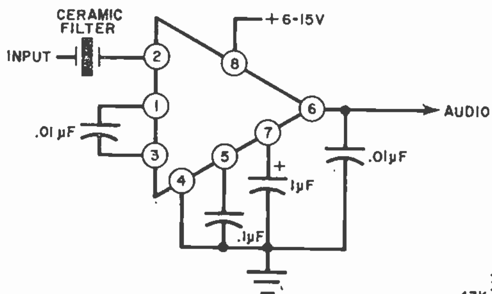


Fig. 9. This IC i-f stage provides 0.8 volt output from an input as low as 50 microvolts. The circuit also has agc range of 60 decibels.

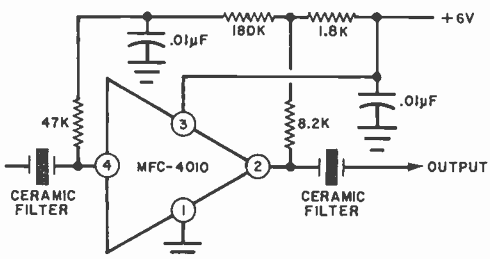


Fig. 10. The integrated circuit used in this i-f strip costs only $1.50 and provides 70 dB gain at 455 kHz.

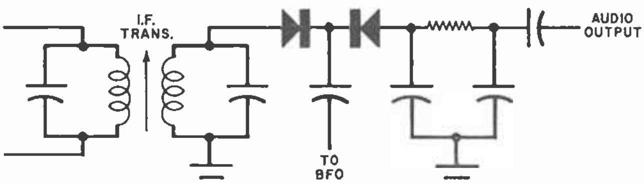


Fig. 11. This simple product detector for CW and SSB applications uses a back-to-back dual diode arrangement.

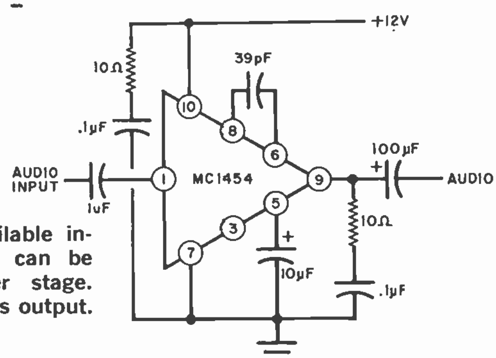


Fig. 12. There are many available integrated circuit devices that can be used in the audio amplifier stage. Some will provide up to 5 watts output.

that certainly do an excellent job here.

What do we expect the i-f amplifier to do? Amplify, of course; but it is here that we seek to achieve much of the receiver's selectivity. It is possible to provide amplification very simply with an IC; but selectivity must be added, usually in the form of a crystal or mechanical filter. Recently, also, ceramic filters have been used and they offer some advantages, especially in size and cost. A ceramic filter approximately ¼" square and ¾" long can be bought for less than $15 and it can be combined with an IC to make a very good i-f stage.

Generally speaking, most crystal filters used today are of the higher frequency types (up to about 9 MHz) and the mechanical filters are for lower frequencies (to about 500 kHz).

Space does not permit a description of all of the IC's that are available for an i-f amplifier. One typical example, however, is shown schematically in Fig. 9. Designed for AM use only, it provides 0.8 volts, peak-to-peak with inputs as low as 50 microvolts at pin 2. It has an extremely good agc network as well as an AM detector. The agc range (referred to pin 2) from 50 microvolts to 50 millivolts is 60 dB. The IC is in a TO-5, 8-pin case and with four capacitors and some means of achieving selectivity, it makes a good AM i-f strip. The IC is an LM-372.

A schematic of an i-f strip built around a new, low-cost IC recently announced by Motorola is shown in Fig. 10. It is extremely small, but provides a gain of up to 70 dB at 455 kHz. The IC is about $1.50.

Product Detector and BFO. Most modern receivers use one form or another of a product detector for SSB and CW reception. To understand why a product detector is desirable, we must review some basic facts about these two modes of transmission. First, with both SSB and CW, something must be added at the receiving end to produce audible signals. With CW we have a carrier, but no audio modulation. So an oscillator is built into the receiver with a frequency very near the i-f. When the two are mixed (beating against each other) a signal in the audio range is produced. It is the same principle as in the mixer stage except that the output is an audio beat. Usually the beat oscillator is variable in frequency so that the pitch can be varied to suit the operator.

In receiving SSB signals, we must remember that the carrier was suppressed at the transmitter so that the receiver must supply the carrier. This is done by the beat oscillator operating with the sideband to produce audio. Just as with CW, the beat oscillator must be positioned properly as far as frequency is concerned for best results.

Why a product detector? Because the regular diode detector most often used with AM will introduce severe distortion unless a proper balance is maintained between the signal and the beat oscillator. This is difficult to do. In most receivers lacking a product detector, it is necessary to reduce the signal input with the r-f gain control. With a product detector, which is really a mixer-type demodulator, the requirements as to the ratio between the received signal and the beat oscillator is much less critical so the audio is much "cleaner."

One very simple product detector circuit, with back-to-back diodes, is shown in Fig. 11. The beat oscillator must be stable and also must have sufficient output. Because of the need for exceptionally good stability in the BFO, many manufacturers use crystal-controlled oscillators. Usually two crystals are provided so that the frequency will be correct for either upper or lower sideband when receiving SSB.

Audio Amplifier. The use of an IC in the audio portion of a solid-state receiver is the only logical approach. There are many available to do the job. One possibility is the circuit shown in Fig. 12. It uses a minimum of parts and operates with a 12-volt input. An RCA unit uses a maximum of 9 volts. The General Electric PA-234 provides 1 watt; the PA-237, 2 watts.

Other Considerations. There are many other factors involved in the design and construction of a solid-state receiver. Not all of them can be covered here, but most of them have to do with mechanical details. For instance, it is almost imperative to use printed circuit techniques, and the construction should be good and solid. The power supply must be of the well-regulated, solid-state type. ◈

Communications Scene

By Richard Humphrey

The Case for a National CB Organization

THE Citizens Band—and unless mention is to the contrary, we mean the 27-MHz class D band—has gone through its adolescence and should now be ready to undertake the responsibilities of communications adulthood.

This demands the creation of a national organization to put together and propose rule changes to the Federal Communications Commission, to promote the interchange of news and information of interest to the CB community, and to figure out some form of self-policing, possibly like that used by the amateurs.

Whether or not such a group should be patterned after the amateur's American Radio Relay League is hard to say. At first glance, you'd say that the basic job of such an organization should be the same as the ARRL's: to represent its members in all the necessary ways. This makes sense. But then the similarity ends. It's just a different scene, that's all. It can be argued that more "communicating" is done on 27 MHz than on all the ham bands combined.

Yes, a national CB organization *should* represent its members. But for *their* reasons and not what somebody else thinks is good for them.

Who Speaks for the CB'er? Some of the efforts to weld Citizens Band licensees into a national group have been mildly successful, others have had a brief moment of glory then died, some just never seemed to get off the ground. This is not to underrate their efforts—or the work of groups like REACT, which, after all, is primarily interested in help in emergencies and doesn't enter into the discussion; or the publications devoted either entirely or in part to CB activities; or even industry-oriented groups with obvious aims.

The point is, no one speaks for the Citizens Band population as a whole. And such a speaker is needed.

For instance, magazines devoted to amateur radio and many groups with the same interests make valuable contributions; but when the chips are down, it's the ARRL that's snapping at the FCC's kneecaps for rule changes—or defending some ham wrongly accused of TVI.

The need for a national organization to carry the CB torch was pointed up by the application last year by the Electronic Industries Association to the FCC to establish 80 CB channels in the

220-222-MHz band. If the idea is approved by the FCC, the Electronic Industries Association possibly will have rendered the CB'ers a valuable service.

But shouldn't this petition for rule changes have been submitted by a *Citizens Band* association rather than an association representing the manufacturers of CB equipment? And there's no reason why the EIA could not have done most of the leg work for a CB organization in such a circumstance. It's perfectly ethical and is common practice in many communications areas.

To carry the argument a bit further: the Electronic Industries Association petition sparked a vigorous protest in the September (1971) issue of *QST*. (The ARRL got into the battle to protect the 220-225-MHz amateur band!). The editorial raised some old questions and asked some new ones.

"Would this simply be another instance," said *QST*, "where manufacturer advertising would pervert the Commission's objectives, as industry advertising and promotion did to the present 27-MHz segment?"

Anything the EIA says in answer to the question is going to be suspect. An answer from a Citizens Band organization wouldn't be so shaky. Even if it had received massive help in the preparation of such an application from the EIA.

The *QST* editorial went on to mention the many violations on the 27-MHz band ("skip" talking, illegal antenna height, illegal power) and also cast a clammy eye on the EIA's suggestion for "instant" licensing—having the applicant "issue" his own call by using the initials of his state plus the last six numbers of his Social Security number.

"Skip" talking (QSO's in excess of 150 miles) will always remain a problem. (Though it should be less of a problem in the next few years due to reduced sunspot activity.) It was a mistake—whose fault it was is immaterial now—to think that limiting power would make the ionized layers above the earth's surface stop working and, thereby, eliminate "skip". Putting the entire CB operation on 220-222 MHz would, of course, be a solution. But it hasn't yet been decided whether it would be a good one.

Antenna Height Regulations. According to Prose Walker, the Chief of the Amateur and Citizens Division of the FCC, the far-from-satisfactory antenna-height regulations are in for revision. Presently, class-A Citizens Band requirements call for a "ground slope" limitation for base-station antennas near airports with one-foot-above-ground for every 100′, 50′ or 25′ the antenna is from the nearest runway depending on the size of the airport. In no case can the antenna be higher than 200′. This can all be changed if the antenna is shielded by natural terrain or existing structures. Class D—along with classes B and C—has the familiar "20 feet above natural formation or manmade structure" limitation.

"We can equalize this situation," Mr. Walker said "by giving them something higher than they've got at the present time but," he emphasized, "it would have to be a certain height above ground or a certain height above the building."

In other words, all CB classes would have the same antenna regulations with the height limitation higher than the present class D (and B and C) requirements. If there were a national group representing the CB'er, some significant suggestions might be forthcoming.

Serious CB'ers—those who abide by the rules and use the service sensibly and not as a form of electronic exhibitionism—have long griped about the many violations of their less-serious brothers and didn't have to be reminded by any editorials that the situation is miserable from time to time.

"You can't let things like this go on," says the FCC's Prose Walker, "because if you do, the transgressions will eventually find their way into other services. If you're going to have rules, make rules you can enforce; then enforce them. If you're not going to do this," he says, "then you'd better not have rules."

All of which means that the FCC is aware of the problem and, what's more, it intends to do something about it.

"We've asked the Office of Management and Budget to give us some more dollars," says Walker, "so we can get some more teams out into the field and clean this mess up."

And what a help it would be to have a national CB association putting the pressure on members of Congress. Comments from local and regional Citizens Band clubs and organizations certainly would help. But the impact of a national CB group representing 878,000 licensees would be, I submit, certainly much more powerful.

Other Changes in the Works. Of even greater interest to CB'ers—and yet another reason for a common front—are the FCC plans for a change in the way you go about getting your license.

"One of the ideas we're kicking around," a Commission representative told us, "would require an examination on the rules rather than the simple statement in form 505 that they have read and understand the necessary sections of Part 95. We'd let them use a book—anything they want but they'd have to get 100%."

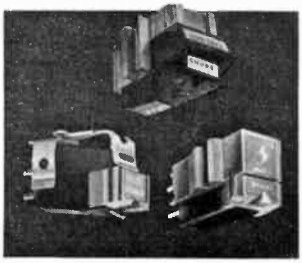
Another of the Commission's ideas involves some highly sophisticated thinking and, possibly, the necessity of getting your license *before you are permitted to buy your CB rig*! Mr. Walker refused to reveal just exactly what is involved but he assured us that "it will create a sensation."

If there weren't any other reason for a national CB organization to coordinate the aims of the many independent groups, it would seem that the FCC plans for CB licensing would be a focal point. Obviously, things are moving on the CB front. As far as that goes, the entire communications scene has been undergoing—and will continue to undergo—major changes for the first time in over 50 years. An association to present a common CB front to the FCC, to critics, and to the communications industry has become a virtual necessity.

Putting it bluntly, there's got to be someone to do the hard never-ending work of seeing to it that there will continue to be frequencies for CB'ers to use. It should be an organization to question and, if necessary, challenge FCC rule making procedure when it's felt that the best interests of the Citizens Band community are threatened and an association to defend, represent and counsel what is probably the largest group of communications licensees in the entire world.

It's nice to have help and it's nice to have friends. But with its enormous potential, do you really think the CB'er has to be helped across the street like a little old lady? ◈

To each his own.



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CIRCLE NO. 38 ON READER SERVICE CARD

Tuner for the Neglected Band

BUILD THIS COMPANION TUNER FOR THE LICENSE-FREE TRANSMITTER DESCRIBED LAST MONTH

BY JIM WHITE/W5LET

LAST MONTH, we described a one-watt transmitter for the 160-190-kHz band. This month, as promised, we will discuss a companion long-wave tuner.

The circuit, shown in Fig. 1, uses four conventional vacuum tubes and requires only an audio amplifier and antenna to make it a top-notch receiver. Headphones can be connected directly to the audio output if desired. Both *V1* and *V2* are r-f amplifiers and are adjusted to the same frequency as the transmitter you will be receiving.

The very low power of the transmitter makes it necessary to have a sensitive tuner, so two r-f stages are used. Also, two r-f stages provide a better rejection of strong BCB signals that can creep into a low-frequency converter. The use of two fixed tuned stages also eliminates the problem of tracking, with its increase in cost.

Following the two r-f stages is *V3*, a converter stage, where the input frequency is changed to 455 kHz. This is then amplified by *V4*. Diode *D1* is both the a-m detector and agc device. The power supply is a conventional half-wave type.

The two r-f transformers, *T2* and *T3*, are conventional 262-kHz types with trimmer capacitors to bring their frequency down to the 160-190-kHz range. The antenna coil, *T1*, is a TV horizontal width coil with 30 turns of #28 enameled wire added as the coupling coil.

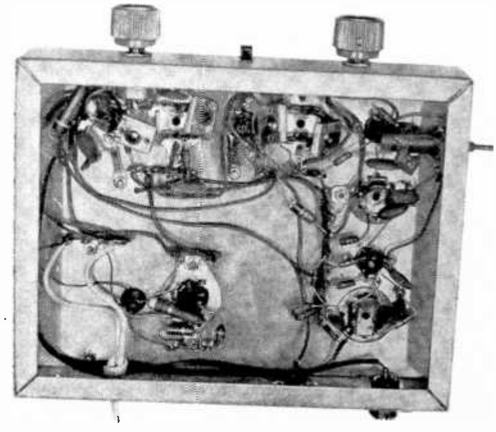
The tuner has three controls: *R15* for audio gain, *R18* for r-f gain, and *S2*, the standby switch. The ac control switch, *S1*, is mounted on *R15*.

Construction. The prototype of the tuner was built on a 7" X 9" X 2" aluminum chassis (the same as the transmitter) and the general layout is shown in Fig. 2. The large holes for tubes, transformers, etc. were made with chassis punches, while all the smaller holes were drilled. Mount the components so that interconnecting leads are as short as possible. A number of terminal strips were used below the chassis to support most of the components. The trimmer capacitors for *T2* and *T3* were soldered directly to the appropriate terminals on the transformers.

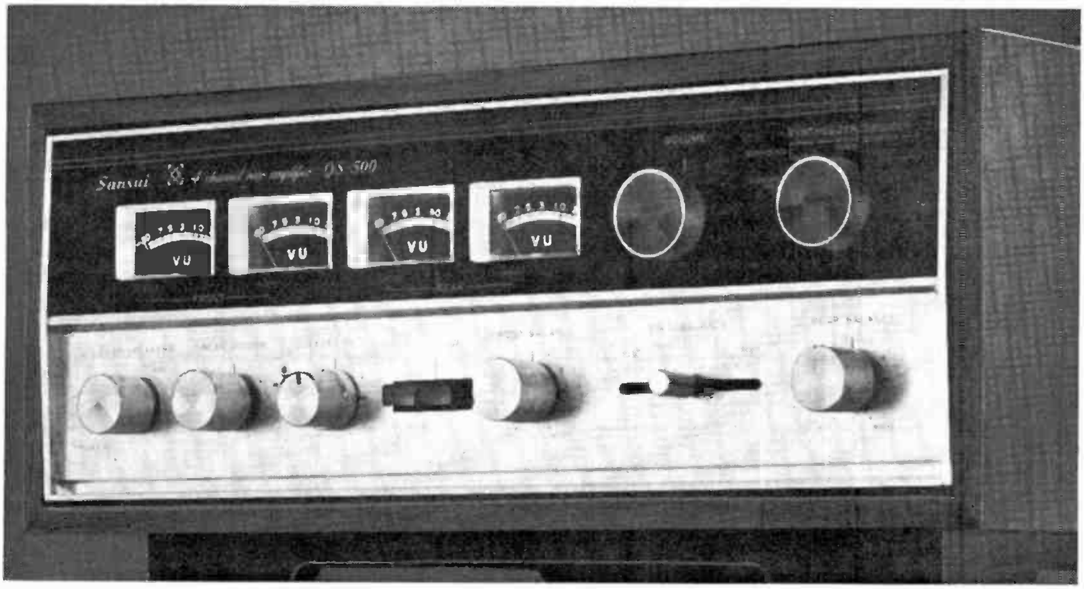
The 30 turns of #28 wire on *T1* are wound directly on top of the coil and in the same direction as the turns on the coil. When wiring *T6*, the oscillator coil, be sure to follow the manufacturer's recommended connections or the converter will not oscillate.

Adjustments. With the power turned on, make sure that all four filaments heat up, and carefully check for the presence of

This bottom view of the tuner shows how point-to-point wiring was used. The adjustment for T6, the oscillator coil, is near top right corner.



if you go for four channel...



you don't have to go for broke

Buy yourself a miracle for as little as $209.95. That's all it takes to get your conventional two-channel stereo to do anything any total four-channel receiver and control center can do, now or in the future.

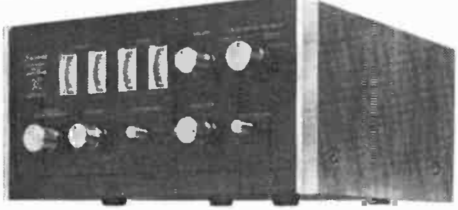
The Sansui QS500 and QS100 converters are complete Four-Channel Synthesizer-Decoder-Rear-Amplifier-and-Control-Center combinations that transform standard two-channel stereo totally. The only other equipment you need is another pair of speakers.

You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $279.95.

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $209.95.



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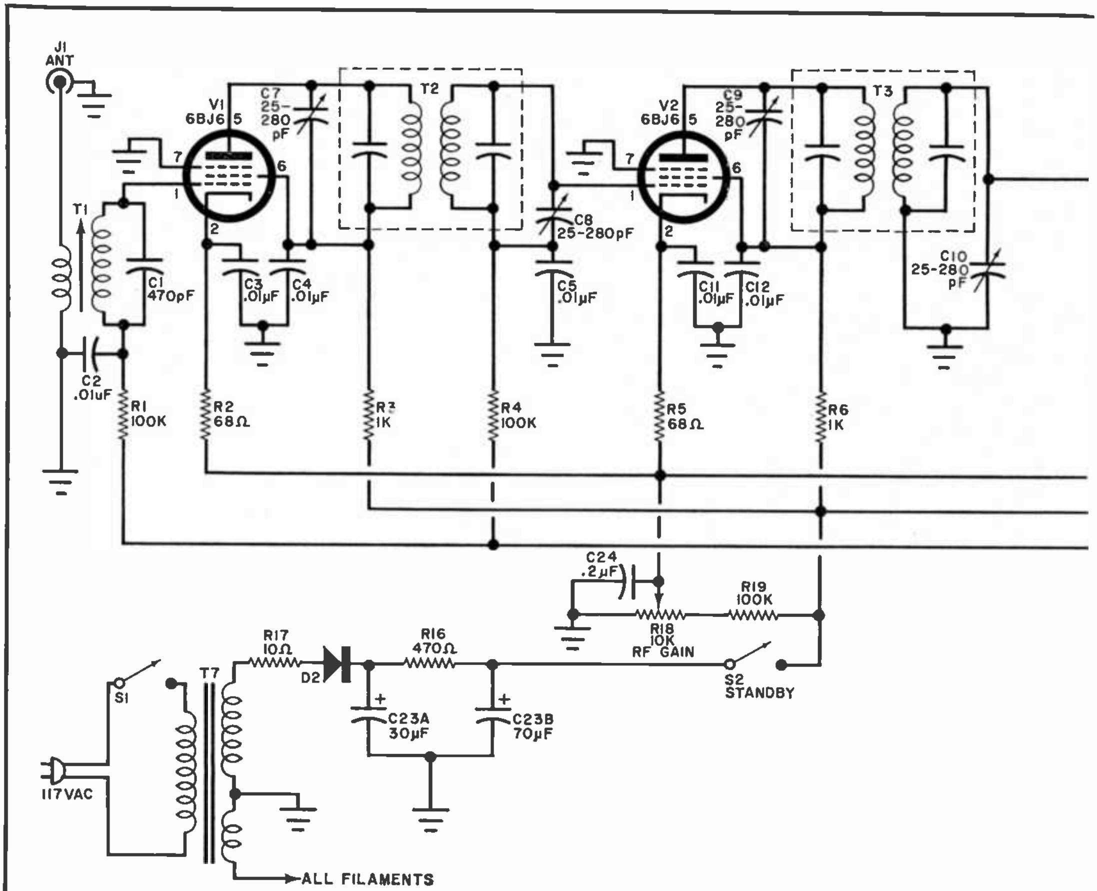

PARTS LIST

C1—470-pF, 500-volt mica capacitor
C2-C5,C11,C12,C16-C19—0.01-μF, 500-volt, disc ceramic capacitor
C6—0.02-μF, 400-volt capacitor
C7-C10—25-280-pF compression trimmer capacitor
C13—150-pF, 500-volt silver mica capacitor
C14—500-pF, 500-volt silver mica capacitor
C15—0.02-μF, 500-volt disc ceramic capacitor
C20,C21—150-pF, 500-volt disc ceramic capacitor
C22—0.01-μF, 400-volt capacitor
C23—Dual 30-μF and 70-μF, 150-volt electrolytic capacitor
C24—0.2-μF, 200-volt capacitor
D1—Signal diode (1N34A or similar)
D2—600V, 750mA rectifier diode
J1—Coaxial connector
J2—Phono connector

plate and screen voltage on the tubes. Connect an audio cable from *J2* to an audio amplifier. The first adjustment is that of *T6*, the oscillator coil. This can be made by using a conventional BCB radio in close proximity to the receiver. Assume you want to tune to 175-kHz. Add this to the i-f frequency (455 kHz) and the result is 630 kHz. Tune the BCB radio to 630 kHz and slowly adjust the slug of *T6* until you hear the signal from the oscillator. Lock the *T6* slug with a jam nut or a drop of cement on the threads.

The other adjustments can be made in one of two ways: if you have a well-calibrated oscillator that tunes to 160-190 kHz, things will be simplified; or if you have built the companion transmitter, you can use it. In either case, connect a VTVM across *C6* (in the agc line) with the negative lead to the line. Now with the appropriate long-wave signal injected into the antenna circuit, you should get some indication on the meter. Adjust *C7*, *C8*, *C9*, and *C10* for a maximum indication. Then adjust the slugs of *T1*, *T4*, and *T5* to further increase the meter indication. You may have to decrease the signal generator output or

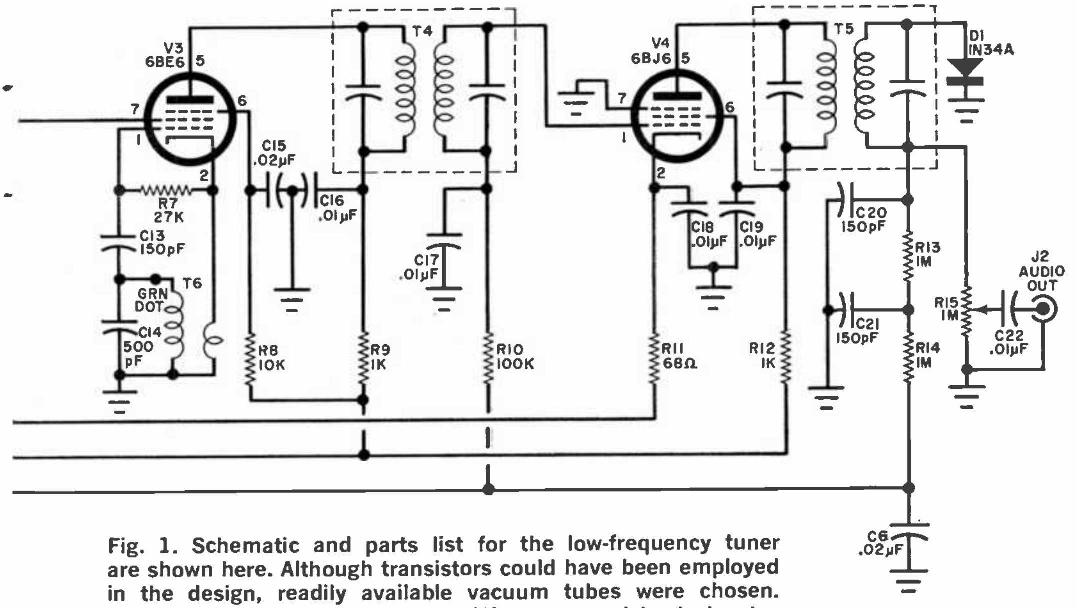

Fig. 1. Schematic and parts list for the low-frequency tuner are shown here. Although transistors could have been employed in the design, readily available vacuum tubes were chosen. Note that two r-f stages (V1 and V2) were used in design because the low power of the transmitter requires a very sensitive tuner. The converter stage is V3, and V4 is the amplifier.

R1,R4,R10—100,000-ohm, ½-watt resistor
R2,R5,R11—68-ohm, ½-watt resistor
R3,R6,R9,R12—1000-ohm, ½-watt resistor
R7—27,000-ohm, ½-watt resistor
R8—10,000-ohm, ½-watt resistor
R13,R14—1-megohm, ½-watt resistor
R15—1-megohm, audio taper potentiometer with switch S1
R16—470-ohm, 2-watt resistor
R17—10-ohm, 1-watt resistor
R18—10,000-ohm, 2-watt linear taper potentiometer
R19—100,000-ohm, 1-watt resistor
S1—Spst switch on R15
S2—Spst slide or toggle switch
T1—TV width coil, 0.5-5 mH (Miller 6313 or similar)
T2,T3—262-kHz miniature i-f transformer (Miller 12H1 or similar)
T4,T5—455-kHz miniature i-f transformer (Miller 12C1 or similar)
T6—Oscillator coil Meissner 14-1028 broadcast type
T7—Transformer; secondaries: 125V at 50mA and 6.3V at 2A
V1,V2,V4—6BJ6 tube
V3—6BE6 tube
Misc.—Chassis (Bud AC406 or similar), 7-pin miniature tube socket (4), knobs, terminal strips, ground lugs, rubber grommets, line cord, mounting hardware, short length of #28 enamelled wire for T1, short length of thin coaxial cable for antenna connector.

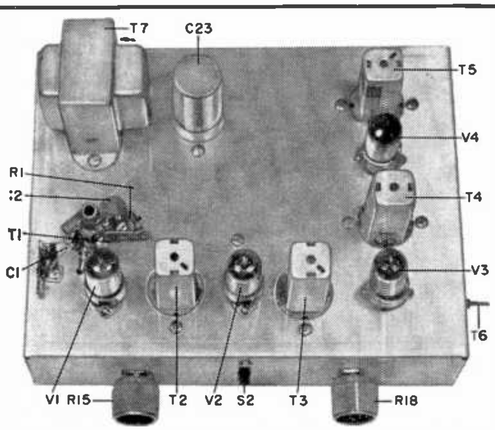

Fig. 2. This view of the top of the tuner shows how components were arranged on chassis for the prototype.

move the transmitter farther away to keep from overloading the receiver.

Operation. With the low-frequency tuner properly aligned and with a long antenna connected to it, adjust the audio gain (*R15*) for a comfortable level and operate the r-f gain control (*R18*) so that the received signal does not overload the receiver. To use the transmitter and tuner together, you can interlock the standby switches. ◈

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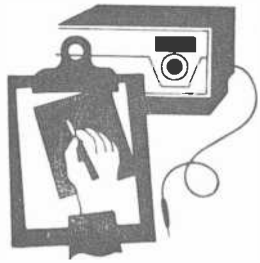
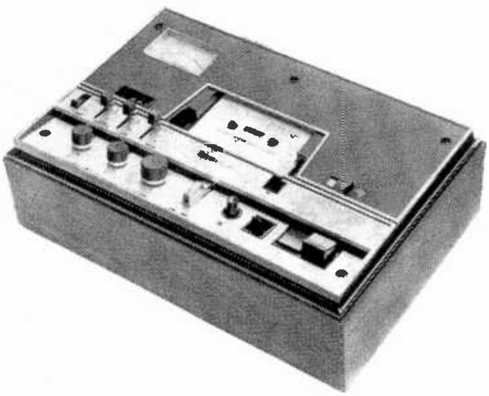


Product Test Reports

ADVENT CASSETTE TAPE DECK (Model 201) (A Hirsch-Houck Lab Report)



The *Advent Corp.* Model 201 cassette tape deck is an improved and considerably modified version of the company's original Model 200. It has built-in Dolby Type "B" circuits to provide a noise reduction figure of from 6 to 10 dB. Like the Model 200, the 201 has switchable bias and equalization for standard and the new chromium-dioxide tape formulations and an illuminated VU meter which can be used to display individual channel signal levels or be left to indicate the higher level of the two channels.

The Model 201 cassette deck, in its walnut base, measures 13⅞" x 9¼" x 4½" and weighs only 13½ pounds. It is priced at $280. An optional external microphone preamplifier can be obtained for an additional $20.00.

Description. The Model 201 deck, unlike most cassette units, is made entirely in the United States.

Pushing the PLAY button powers the motor and the electronic circuits. The STOP button, when activated, shuts off the transport but maintains power on the rest of the system. To disengage power from both the motor and electronic circuits, a separate switch must be operated.

The PAUSE lever, when pulled toward the user stops tape motion instantly without disengaging the recording interlock. Upon releasing the lever, tape motion resumes without the perceptible initial "wow" that is characteristic of most other recorders. Pulling the PAUSE lever slightly to the right locks it in place; a slight push to the left releases it instantaneously.

A separate RECORD button must be depressed simultaneously with the PLAY button to set the deck to the recording mode. A red light comes on when the deck's electronics are ready to record.

The fast-forward and rewind system in the 201 is unique. A spring-loaded lever which is normally centered is pushed to the left or the right to move the tape rapidly in the indicated direction. It does not latch and, as a result, must be held in position during the entire winding operation. However, the deck has by far the fastest high-speed tape movement of any we have seen in a cassette deck; so, the non-latch feature poses no hardship.

The cassette snaps into an open well that keeps it completely visible during operation. An EJECT lever, when activated, pops up the cassette vigorously. When the end of tape travel is reached, the motor stalls and the entire transport shuts down and disengages mechanically to prevent the formation of flat spots on the rubber pressure wheel.

The inputs and outputs (for line level sources only), together with the output level control, an 18-volt dc jack, and a recording-level test button for calibration of the Dolby system are recessed into the left side panel of the walnut base. There are no microphone inputs, but Advent offers an optional external microphone preamplifier which plugs into the 18-volt dc jack to obtain its power.

On the top panel of the deck are two in-

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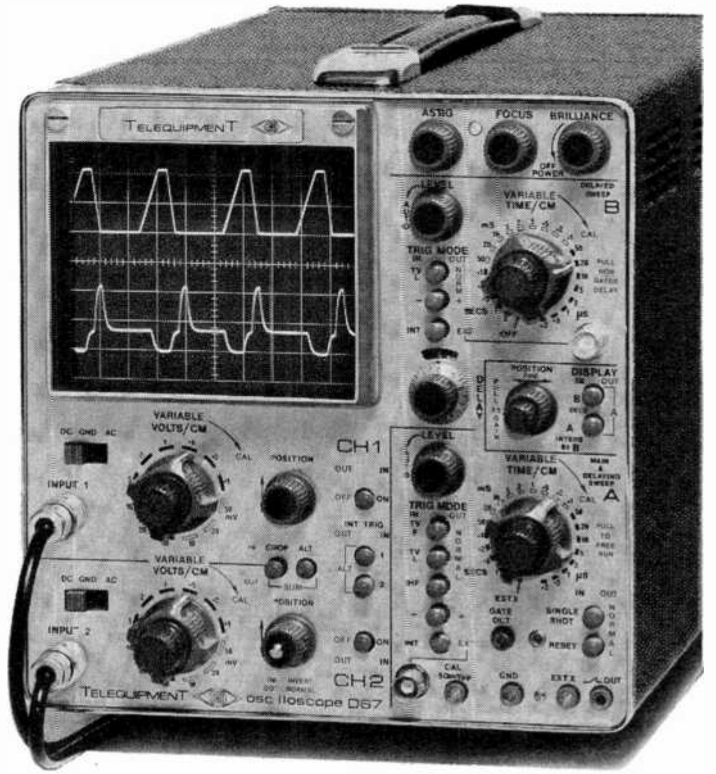

The new Telequipment D67 Oscilloscope offers the performance you have always desired at a price that is several hundred dollars lower than any other comparable model.

In addition to its impressive array of specifications, the D67 has other features not usually found in low-priced scopes: regulated power supplies, FET inputs to keep vertical trace drift to a minimum, fully solid-state design to improve reliability, transistors in sockets to make servicing easier and faster.

Bright displays are obtained by using 10-kV high voltage on the rectangular 5-inch CRT which has a big 8 x 10 cm display area.

A wide range of sweep rates from 2 s/cm to 0.2 μs/cm (40 ns with X5 magnifier), delayed sweep, 3% accuracy and 14-ns risetime, make the D67 ideal for high resolution analysis of pulse sequences. And if some of the pulses are jittery, that won't be a problem because the delayed sweep can be triggered. Those who have a need to view television signals will be pleased with the D67's ability to trigger at TV field and line rates.

Even if portability is not a prime consideration, you are certain to like the D67's light weight—it weighs only 25 lbs.

Telequipment Oscilloscopes are marketed and supported in the U.S. through the Tektronix network of 56 Field Offices and 32 Service Centers. The instruments are warranted against defective parts and workmanship for one year. For more information call your nearby Tektronix field engineer or write: P. O. Box 500, Beaverton, Oregon 97005.

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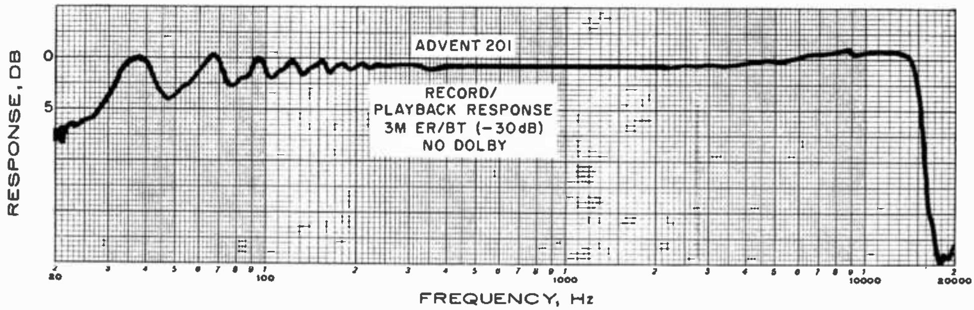

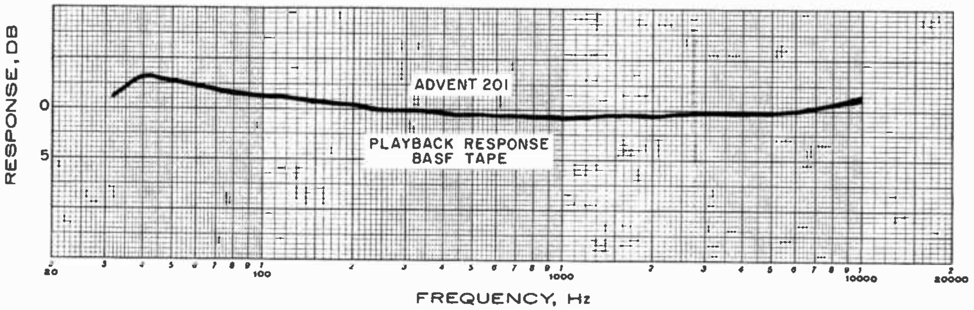

Record/playback (top) and playback only (directly above) curves show the Advent 201 tape deck's very flat frequency response over range of 50-10,000 Hz.

put level controls and a master recording level control which operates both channels simultaneously. Near the controls are a rocker switch which can be set for stereo or mono recording and three lever switches. One of the lever switches is used to turn on and off the Dolby circuits. Another connects the VU meter as desired. And the third switch is used to optimize the recorder for either regular or chromium-dioxide tape formulations, adjusting both bias and playback equalization. On the underside of the deck are screwdriver controls for adjusting bias and Dolby recording levels.

Test Results. In our lab measurements, the overall frequency response on record and playback, using 3M ER/BT tape, tested out at 31-15,000 Hz ±1.5 dB. With other tape formulations, minor differences in high-frequency output can be expected. Using Advocate "Crolyn" tape, frequency response was extended slightly (31-15,500 Hz ±2 dB). Playback response with a BASF test cassette was 100-10,000 Hz ± 1 dB and, at 40 Hz, was +3.5 dB. Unweighted wow and flutter checked out at 0.17 percent. A 0-VU recording level required a 31-mV input, delivering a 530-mV output level.

The signal-to-noise ratio when standard tape was used was 48.5 dB, referred to 0 VU, the standard Dolby level. With the Dolby circuits switched in, the S/N ratio improved to 54 dB. And, using Advocate Crolyn tape, it was 53 dB without and 57 dB with the Dolby circuits switched in.

Distortion at 0 VU was 1.9 percent and did not reach the standard 3 percent reference level until a +3-VU signal was applied. Since the signal-to-noise ratio of a tape recorder is usually expressed relative to the 3 percent distortion level, the Model 201 provided a 60-dB S/N ratio with chromium-dioxide tape—a truly remarkable figure for the narrow track and low 1⅞-ips tape speed. It is equalled by few 7½-ips reel-to-reel recorders.

User Reactions. In listening tests, the Advent Model 201 cassette deck was as impressive sounding as its bench measurements suggested. Noise was inaudible at even very high volume levels. The buyer of a 201 receives a demonstration cassette recorded on his purchased deck from a 15-ips master tape. The only hiss we heard when playing this demo cassette—and then only at very high levels—was transmitted to our recording from the master tape itself.

The overall sound quality obtained from the Model 201 can be described only as superb. This deck sounds as good as most 7½-ips reel-to-reel recorders selling in the rarefied $500 and higher price range. Flutter, usually the weakest link in a cassette system, could not be heard from the Advent 201 cassette deck.

In summary, the Advent Model 201 cassette deck is among the finest such mechanisms we have tested to date. Its frequency response is more than equal to the task of dubbing from discs or FM tuner/receivers. It has lower distortion than most reel-to-reel recorders we have tested and a S/N ratio matched only by a couple of the very best reel-to-reel machines. In addition, it is simple and convenient to operate, and its fast forward and rewind speeds make accessible any portion of a C60 cassette in less than 45 seconds.

Circle No. 75 on Reader Service Card

EICO 4-CHANNEL STEREO ADAPTER (Sound/4 Model EC-4700)

Now that quadraphonic sound is making an all-out bid for a permanent place in the hi-fi market, a number of 4-channel stereo converters are making their appearance. The latest such entry is the Eicocraft Model EC-4700 "Sound/4" stereo adapter made by *Eico Electronic Instrument Co., Inc.*

Unlike the systems which use active circuitry to recover the ambience information present in most two-channel stereo sources, the Sound/4 employs a passive network that requires the addition of only a pair of speaker systems for the rear channels to convert any existing stereo system for quadraphonic sound. An extra stereo amplifier is not needed since the Sound/4 is compatible with all existing 2-channel equipment and program sources. The EC-4700 simply accepts the two present speaker outputs and mixes them to deliver the two conventional front outputs plus the ambience signals required for driving the two rear channel speaker systems.

The adapter can be used with 4-, 8-, or 16-ohm amplifier outputs. A small booklet provided with the unit explains the complete setup, including the very easy method of properly balancing the four speaker system outputs.

The Sound/4's approach to proving the value of quadraphonic sound was tested with a conventional good-quality stereo system to which had been added a pair of low-cost, limited-frequency-response speakers for reproduction on the rear channels. The resulting sound was quite pleasant. The added "ambience" effect from the two speakers to the rear certainly added a new dimension to an already good stereo setup. We conclude that the use of rear speakers that were as good as those in the front would have vastly improved our already pleasant test setup.

The EC-4700 is available in both kit and wired versions. We received the former. It went together quickly and without a hitch. Once the innards are assembled and wired, the entire adapter tucks away into a small plastic box which can easily be concealed behind almost any amplifier or receiver. And for maximum convenience. Eico provides, with their Sound/4's, all the necessary speaker-to-adapter cables needed.

The Sound/4 is priced at $9.95 in kit form, $19.95 factory-wired.

Circle No. 76 on Reader Service Card

MIDLAND SSB/AM TRANSCEIVER (Model 13-873)

The *Midland Communications Co.* Model 13-873 Citizens Band transceiver provides operation on all 23 Class D channels using single sideband or AM. It thus provides all the advantages of SSB operation, while still permitting communication in the AM mode with stations not equipped to handle SSB traffic.

The Model 13-873 is a solid-state CB transceiver capable of a 10-watt peak input power level when operated in the SSB mode. Either upper- or lower-sideband operation can be used, providing 46 working channels instead of the 23 channels to which AM is limited. The carrier input power for AM is 5 watts.

The transceiver has adjustable squelch, fine tuning control (clarifier), noise blanker for superior noise suppression, dual-purpose meter, external-speaker jack, and public-address facility.

Technical Highlights. A total of 31 transistors (three of which are FET's), 65 diodes, and one IC are employed in the transceiver. Except for a common front end (r-f stage, heterodyning mixer, and frequency synthesizer), there are separate receiving sections for SSB and AM. Single conversion to a 7.8-MHz i-f is used for SSB with selectivity and sideband selection obtained with an 8-pole crystal-lattice filter that provides a 350-2700-Hz bandpass and an adjacent-channel rejection and unwanted sideband suppression of 60 dB.

Dual conversion is used for AM, with the 7.8 MHz i-f converted down to 455 kHz through a ceramic filter, providing a 50-dB adjacent-channel rejection figure. Image rejection in either mode is 70 dB.

A performance figure that points up an advantage of SSB over AM is that of the weak-signal sensitivity, which on SSB is 6 dB better than on AM as indicated by the comparative measurements of 0.25 μV on SSB and 0.5 μV on AM for 10 dB S+N/N.

The squelch operates in both modes with an adjustable sensitivity of 0.25-750 μV. The noise blanker is most effective for SSB where it suppresses impulse noise by at least 40 dB. An excellent agc setup maintains a relatively uniform a-f output measured as a 4-dB change with an input-signal change of 100 dB (1-100,00 μV) on SSB and of 80 dB (10-100,000 μV) on AM.

A little over 100 μV is required to obtain an S-9 meter reading. The meter also doubles as a relative output-power indicator during transmit. In either case, it shows a steady reading in the AM mode, but with SSB, it deflects up and down according to the modulation level. A transmitter indicator lamp responds in a similar manner.

For SSB transmissions an initial 7.8-MHz carrier signal is obtained from a crystal-controlled oscillator that also serves as a BFO to provide carrier re-insertion on received SSB signals. The filter method of SSB generation is employed, using a balanced modulator where the carrier is nulled out. This leaves suppressed-carrier double-sideband signal, one sideband of which is subsequently rejected by the same 7.8-MHz filter used in the SSB receiving section.

The resulting SSB signal is converted to the CB range by heterodyning it with oscillator signals from the frequency synthesizer. The synthesizer employs 14 crystals which are used in combinations of two for producing different frequencies in the 19.2-MHz ranges as required for heterodyning to each CB channel and the particular sideband. Three r-f amplifiers, including the power amplifier, raise the SSB signal level to a peak-power output level of 4 watts when the transceiver is operated from a 13.6-volt dc source.

The unwanted sideband and the carrier suppression were both found to be 60 dB. The distortion products which are primarily indicative of the possible broadness of the signal and the maintenance of good unwanted-sideband suppression at maximum output were at least 22 dB down. This is about par for the course with transistors.

For AM operation, the synthesizer's output signal is heterodyned with the 7.8-MHz carrier oscillator signal (otherwise used for SSB) to provide an on-channel AM carrier signal that goes to the same r-f amplifier as used for SSB. In this case, both the driver and p.a. are collector-modulated by the a-f output stage of the receiver. On AM, the transceiver put out a 3.5-watt carrier with modulation limited to 85 percent.

When used for SSB, the receiver must

be tuned to the exact frequency of the transmitted signal; otherwise, the signal at the receiver will have an unnatural voice sound. This is handled by the fine-tuning (clarifier) control which shifts the frequency ±550 Hz. It alters both the receiver and the transmitter frequency so that, when an SSB signal is properly tuned in, transmissions can be made precisely on the same frequency. The end result is that intercommunication between two or more stations may be held right on frequency without the need for constant retuning.

Since the transmitter frequency is controlled as described, the tolerance of the crystals must be held closer than usual, so that the clarifier adjustment will not result in operation outside the legal tolerance of ±0.005 percent. With the Midland unit, the maximum deviation at the extreme settings of the clarifier held within 0.0022 percent on all channels.

Although designed for mobile service, the transceiver can also be employed as a base station when powered by an accessory ac-powered 12-volt dc supply.

The Midland Model 13-873 CB transceiver, including push-to-talk microphone, dc power cable, mounting bracket, and hardware sells for $369.95.

Circle No. 77 on Reader Service Card

KOSS RED-DEVIL STEREO HEADPHONES (Model KRD-711) (Hirsch-Houck Lab Report)

Stereo headphones are available in many styles and are marketed over such a wide price range that many people have difficulty in deciding which ones to buy. As with most products, there is a rough, but not rigid, relationship between list price and quality in the headphone market. But the price "spread" among stereo headphones is so great that most buyers settle for some medium-priced unit which they hope will prove to be satisfactory.

The *Koss Electronics Inc.* Model KRD-711 "Red Devil" phones are one example of good quality units available at low cost. Falling near the lower end of the Koss price scale, they nevertheless have many of the sonic qualities of much more expensive phones.

The earpieces are a bright red, molded plastic (hence the name Red Devil). The headband, molded from red polypropylene plastic and fitted with a foam-padded top, is a simple but comfortable design. The removable ear cushions are of neoprene foam construction, fitting snugly but comfortably over the ears and effectively excluding external noises.

Because of its construction, the Red Devil is unusually lightweight, 12 ounces (less cord). The coiled cord extends to 10 ft and is fitted with a standard stereo phone plug. The nominal impedance of the Red Devil is 20 ohms per channel—which means that the phones can be driven from the speaker outputs of any amplifier in which the average program level does not exceed 5 volts.

We made measurements of the frequency response and impedance of the Red Devil, using a homemade coupler to simulate the human ear cavity. The frequency response, measured in this manner, is usually more irregular than it seems to be in a subjective evaluation; but it does tend to show trends in response.

The output in the range from 20 to 1000 Hz was very smooth and uniform within ±3 dB, attesting to the effectiveness of the ear seals. It rose at higher frequencies (with the expected irregularities due to the coupler) and was still very strong at 17,000 Hz—which is well above the 15,000-Hz calibration limit of our microphone.

The measured impedance was higher than the specified 20 ohms, averaging about 280 ohms at the low and middle frequencies and about 500 ohms at 20,000 Hz. Sensi-

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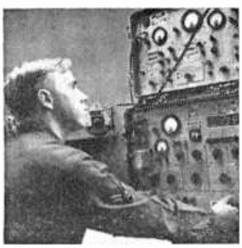
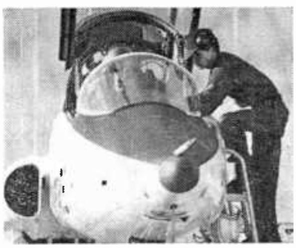


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tivity, as with most stereo headphones, was more than adequate for high-volume listening with any amplifier. At the very high level of 114 dB, distortion was only 1.0 percent at 400 Hz.

In listening tests, by itself and in comparison with a number of other phones (most of which were more expensive), the Red Devil proved to be one of the best sounding of the group. In fact, its sound quality was remarkably close to that of the top-of-the-line Model PRO-4AA phones made by Koss. Apparently, the Koss people have engineered the Red Devil for low-cost production without sacrificing quality. This makes the KRD-711 one of the best sounding stereo headphones at or near their price of $29.95. (Note: Koss is currently offering a jet-black version of these headphones as their Model K-711 at the same price. Their performance and construction are identical to those of the Red Devil.)

Circle No. 78 on Reader Service Card

SIMPSON DIGITAL VOLTOHMMETER (Model 460)

While examining a large pile of brand-new test equipment, some of which we first previewed at the National Electronics Week show held in Miami Beach last year, we happened upon the *Simpson Electric Co.* Model 460 portable digital VOM. Its price tag of $395 seemed a bit steep, but we did not let that deter us. In fact, it made us curious to find out just why almost $400 was asked for the instrument.

Having used an elderly Model 260 meter-movement VOM made by Simpson in our lab for quite a number of years, and knowing that it had proven to be a very good meter, we expected much of its 1971 relative, the Model 460. After using the 460 for a while, we feel that it lives up to the rigid standards set down by its now classic relative.

Operating Ranges. The ranges of the new DVOM cover just about any need you are likely to encounter on your testbench. There are five dc and five ac voltage ranges from 200 mV full-scale to 1000 volts full scale. The 200-mV range has a 100-megohm input resistance, the 2-V range has 1000 megohms, while the other three ranges drop down to 10 megohms each. The five ac voltage ranges have an input impedance of 1 megohm at 150 pF. The five ac and dc current ranges have a 200-μA to 1000-mA (one ampere) capability, all with 3-ampere overload protection.

Of the six resistance ranges, the 200-ohm range uses 2-mA test current, the 2K range uses 200 μA, the 20K range is 20 μA, the 200K range is also 20 μA, the 1-megohm range is only 2 μA, and the 20-megohm range is 200 μA.

All together there are a grand total of 26 of the most useful test ranges.

The non-blinking 3½-decade readout display uses the popular single-plane seven-segment readouts that are easy to read. Because the 460 has automatic polarity seeking, either a "+" or "—" sign will be displayed on the left side, dependent on the polarity of the voltage applied to the probe tip.

Measurement accuracy is also high. Dc voltage measurements are within 0.1%, ac is from 0.5% between 40 Hz and 10 kHz and 1% from 10 to 20 kHz. Dc current measurements are within 0.2%, while ac current is measured within 0.7% of the reading.

Resistance measurements are within 0.5% except for the 20-megohm range which is 1%. All of the above readings are ± 1 digit. Overrange capability is 150% to protect the instrument from mishaps.

Special Features. Having used digital multimeters before, we were surprised by this one on a couple of points. First, it contains its own rechargeable nickel-cadmium batteries that can provide up to seven hours of truly portable operation. When the 460 is plugged into the ac power line, even while it is being used to make measurements, its internal batteries are automatically being charged. Second, this is the first digital instrument we have seen that also contains an analog meter (1½ inches, edgewise mounted) that displays peaks and nulls at a glance during alignment procedures. (Try that on most other DVOM's and see how difficult nulls and peaks are to locate.)

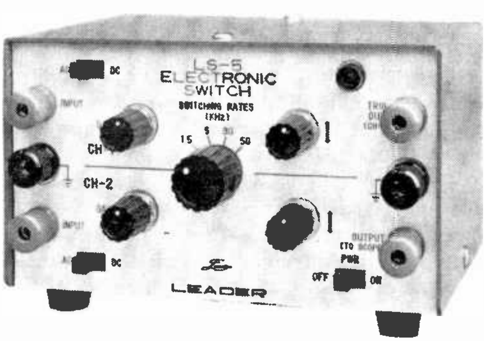
As an added bonus, the analog meter is also used in conjunction with a front-panel pushbutton to test the battery at any time. The meter scale is suitably marked. Finally, the 460 has an automatic polarity selector circuit that means that fumbling with test leads or switches, while your nose is buried in the equipment under test, has become a thing of the past.

Mechanically, this American-made instrument measures 8½" x 7⅞"x 4" and weighs just 6 pounds. It comes in a pleasant-looking aluminum case that has been engineered to resist shocks. There is a convenient cable storage slot and a cover. The handle uses knurled set knobs, and doubles as a tilt-stand base. In normal bench use, the instrument rests on four rubber feet. Each input is clearly marked as are the function and range switches. Zero adjustment (when needed) can be made through a small hole in the front panel.

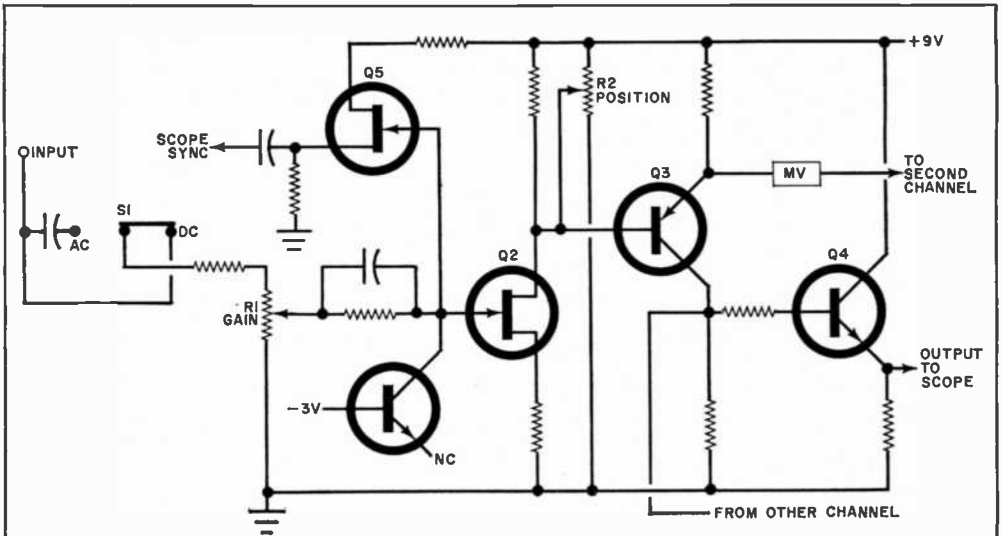
In terms of convenience, capability, and versatility, the Simpson Model 460 is, hands down, one of the finest digital multimeters we have had the pleasure of using both on the bench and in the field.

Circle No. 79 on Reader Service Card

LEADER ELECTRONIC OSCILLOSCOPE SWITCH (Model LS-5)



If you work with an oscilloscope, you are already aware of how important it is as a piece of testbench equipment. You know also how much of a problem it can be when



One channel of the dual system. FET stage Q2 is protected by a diode-connected bipolar while switching takes place in the common transistor amplifier Q3.

you try to "see" what goes on between the input and output of a particular circuit. Because of changing signal levels and the need for sometimes constant readjustment of the scope controls, it becomes a bit tedious to keep swapping the scope leads between test points.

Then, too, when working on digital equipment, it is necessary to know the relationships between the various pulses running through a particular circuit. There is no convenient way this can be determined when using a single-beam scope.

Now, with the *Leader Instruments Corp.* Model LS-5 electronic switch, you can hook up test leads to both input and output points of a circuit, or between any two logic points, and display both signals simultaneously on a single-beam scope with the capability of positioning each trace as desired on the scope face. This solid-state switcher provides a choice of four switching frequencies— 1.5, 5, 30, and 50 kHz, to avoid "breaking up" the displayed trace regardless of the harmonic relationship between the input signal being viewed and the selected switching speed.

Frequency response is dc to 300 kHz and 2 Hz to 300 kHz in the ac mode. Each channel has its own ac-dc selector switch. Input impedance is 100,000 ohms, and each channel has a gain of two. Both gain and positioning controls are provided for each of the two switched channels. The electronic switch also provides a trigger pulse (derived from the signal on channel 1) to lock the external oscilloscope to the viewed signal.

The partial schematic shown here gives the basic operation of one channel. (The two channels are similar.) After passing through the ac-dc selector switch, the signal is passed to gain control *R1* and the gate of FET input stage *Q2*. Diode-connected transistor *Q1* protects the sensitive gate against accidental overvoltage which could puncture the gate junction of the FET. The output of the FET is coupled to a conventional bipolar transistor amplifier, *Q3*. The vertical position of the input signal (on the scope screen) is determined by the source bias of *Q2*, determined by the setting of position control *R2*. The output of *Q3* is made via emitter follower *Q4*, which also accepts the switched signal from the other stage.

Transistor *Q3* is switched on and off by a square wave generated in a switched-speed multivibrator. The two outputs of the latter are arranged so that, while one stage is operating, the other stage is turned off. The external scope then displays first one signal, then the other, at such a rapid rate that they both appear to be on at one time. The scope sync signal is taken off via FET stage *Q5*, with this signal fed to a front-panel connector.

The power source is a full-wave bridge

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followed by a pair of transistor voltage regulators.

Built with the usual high-quality mechanical construction featured in all Leader instruments, this excellent addition to any workbench also incorporates a special mounting bracket to facilitate direct mounting on almost any scope. The instrument is 5¼" x 4" x 3⅛", and weighs 3 pounds. It retails for $69.95.

Circle No. 80 on Reader Service Card

JFD ALL-CHANNEL TV ANTENNA (Stellar-2001)

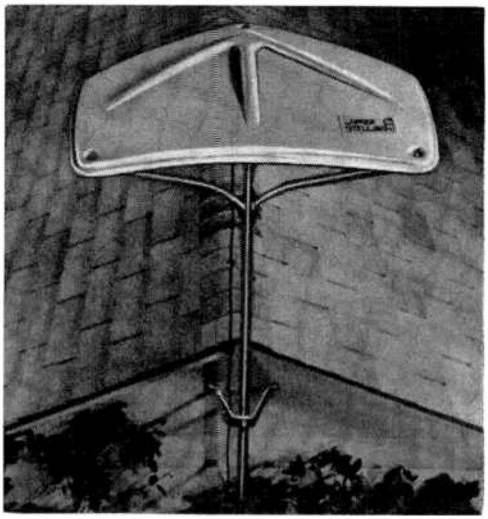
Over the years, TV receiving antennas have been getting bigger and bigger. The more sophisticated antennas sport dozens of rod-like elements and metalwork that looks like something out of a Baroque dream.

With the introduction of the Stellar-2001, *JFD Electronics Corp.* is reversing the trend in antenna design. Instead of resembling the end product of a child's construction set, the Stellar-2001 has a futuristic spade shape that measures only 34" wide by 27¾" long and a mere 3¾" thick. The antenna itself is not spade shaped; it is the all-plastic weatherproof shell enclosing the "antenna" that accounts for the wing-like shape. Aside from compact size and neater appearance, the great advantage of the Stellar-2001 is its almost nonexistent wind loading effect.

Weighing only five pounds, the new vhf/uhf antenna can be installed almost anywhere by one person. It can be mounted flat against a roof, on the usual 1¼"-diameter mast, or even inside an attic. All mounting hardware, plus a liberal supply of weatherproofing adhesive that is used to seal screw entries through a roof, are supplied with the antenna.

Technical Details. According to the people at JFD, the innards of the Stellar-2001 contain a large printed-circuit device that takes the place of conventional aluminum elements plus a built-in low-noise solid-state amplifier. Power for the amplifier is fed up the same coaxial cable down which the TV signal travels to the receiver. A small power supply that mounts on the back of the TV receiver is included with the antenna. The power supply can be mounted via a pair of built-in tabs, or you can peel away the protective backing and firmly press the exposed adhesive surface against the back of your TV cabinet.

A high signal-to-noise ratio is maintained by amplifying the signal directly at the antenna, properly matching the amplifier to the actual antenna, using an amplifier that has linear characteristics, and using reactive filters so that overloading the active elements is virtually impossible. The combination signal-splitter/power supply package has provisions for both vhf and uhf connections to the TV receiver; another separate output is also provided for feeding a second receiver.



This new look in TV antennas features a PC antenna and low-noise solid-state amplifier. Wind loading is very low.

Coaxial cable (75-ohm) is used between the antenna/amplifier and the signal-splitter/power supply. However, the splitter/supply package's output is rated at 300 ohms to provide the proper impedance match to TV receiver input terminals.

Use Tests. We installed the Stellar-2001 on a short, stubby mast in the same area as a far larger log-periodic antenna array. Switching back and forth between the two antennas showed little, if any, difference in signal quality. The real test, however, came with big-wind Doria which hit the east coast last August. We (and many of our neighbors) lost aluminum elements from our log-periodic antenna and also had degradation in signal quality due to the severe rain causing leakages in the antenna. Switching to the Stellar-2001, we found that the picture was perfectly steady and showed no signs of the violence nature was stirring outside.

Although not a deep-fringe antenna, the Stellar-2001 provided satisfactory reception almost 50 miles away from the TV transmitting antenna complex. But more important is the fact that this new antenna has good looks—rather handsome, in fact—that will not begin to show aging for a very long time.

Price of the Stellar-2001 is $75.00. It is also available as the Stellar-2001K, which is identical but also includes 50 ft of 75-ohm coaxial cable fitted with a weather boot, for $85.00. Both antennas, of course, include all mounting hardware, brackets, and weather sealer, plus excellently written and illustrated mounting and hookup instructions.

Circle No. 81 on Reader Service Card

Out of Tune

Product Test Reports, January 1972. In our report on the Pioneer PL-12A Record Player, two serious errors appear in the second paragraph, left column, on page 80. The high-frequency resonance noted was in the vicinity of 15,000 Hz (not 1500 Hz); channel separation reduced to between 2 and 8 dB above 12,000 Hz (not 1200 Hz). Our sincerest apologies for our goof.

"VHF Frequency Converter," December, 1971. The IC used should be CA3018 not CA3023. The M6970 can be substituted.

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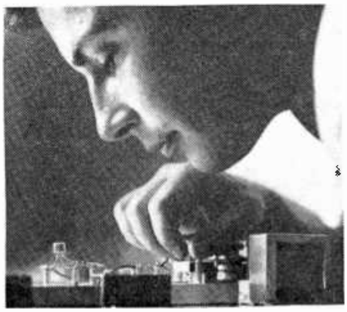
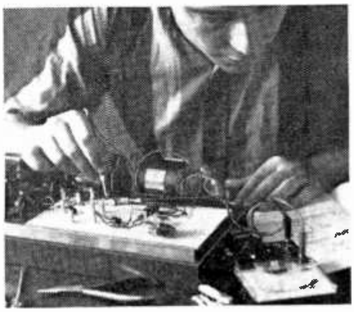
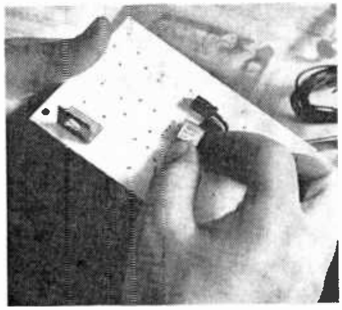


Working with basic single transistor circuit — Student learns best installation and troubleshooting techniques. He has constructed a basic single transistor circuit, first step toward understanding more complex solid-state circuitry.



Observing transistor operating as shunt-fed amplifier — Student has installed an oscillator and shunt-fed amplifier. He takes various measurements and observes the transistor operating as an amplifier. This is a typical solid-state circuit.



Assembling integrated circuit on a printed circuit board — Circuit is identical to one used in latest IBM System 360 computers. Student is constructing an oscillator combined with a Darlington pair output amplifier.

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CIRCLE NO. 9 ON READER SERVICE CARD

Television Scene

By Forest H. Belt

Trinitron—Still A Mystery?

DESPITE a rash of advertising, there are still people who don't know what a Trinitron is. A few think it's some kind of TV set. Others know it's something special from Sony, but they're not sure what.

The Trinitron is a picture tube for color television. Sony introduced the first color receiver using a Trinitron several years ago, a 7-inch model that never got into production. But more recently, both 9- and 12-inch versions have been imported in quantity. And just this past winter, a 17-inch model appeared in the U.S. The "large-screen" Trinitron resembles its predecessors, but incorporates definite changes.

The Trinitron CRT is touted as being simpler than American color tubes. The advantage isn't all that obvious to a viewer; but inside the cabinet, the Trinitron operates with comparatively few circuits. For example: Any color set has critical adjustments to register the primary red, blue, and green rasters accurately on top of each other. The term is *convergence*, and the object is to keep colors from fringing black-and-white pictures. An ordinary color set, American or Japanese, has seventeen convergence adjustments. A receiver using the Trinitron has only a half-dozen or so.

Credit for simplification goes to the way the Trinitron picture tube is structured. It

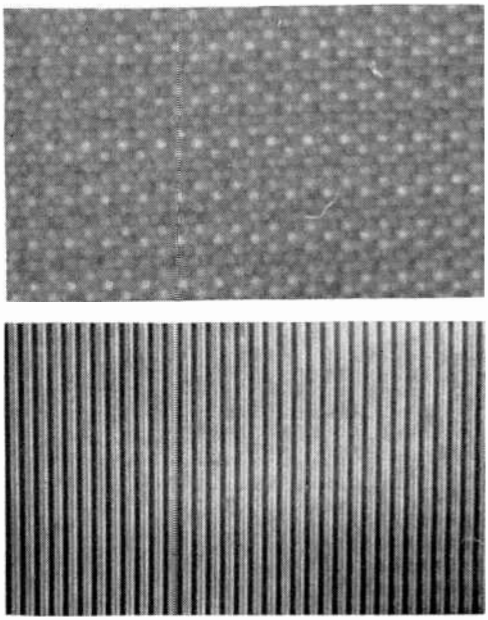


Fig. 1. Standard triad dot pattern (top) and Trinitron stripe pattern.

differs from the usual picture tube in several important ways: (1) The Trinitron phosphor screen is deposited in narrow vertical stripes instead of tiny dots. (2) The mask behind the Trinitron phosphor is a grille of vertical slots instead of a shadow mask of round holes. (3) The Trinitron emits three beams, one for each primary color, but from only one electron gun; the ordinary color CRT has three separate guns. (4) The beams in a Trinitron are side-by-side whereas in a conventional color tube they are spaced in a triangular relationship. (5) Special plates converge Trinitron beams electrostatically; a conventional color CRT converges electromagnetically, with a yoke of coils around the neck of the tube. (The newer large-screen Trinitron uses a convergence yoke, controlled by only three adjustments.)

Stripes Instead of Dots. First, consider the phosphor. Compare the two photos in Fig. 1. The dots arranged triangularly belong to the phosphor of a conventional color tube. Each triad of dots contains one red dot, one green, and one blue.

The stripes in the other photo are a Trinitron phosphor. Each stripe is one color. They line up red, green, blue, red, green, blue, and so on.

Either kind of phosphor needs some sort of mask between it and the source of the beams. Otherwise, any electron beam could "splatter" onto adjacent dots or stripes, thus activating the wrong color. In the conventional picture tube, a perforated metal screen (Fig. 2A) confines the size of each beam. Because the metal sheet "shades" the edges of the beams, the name *shadowmask* has become accepted.

The Trinitron electron beams get similar treatment. The masking metal screen (Fig. 2B) contains vertical slots rather than round holes. Sony calls the mask an *aperture grille*. The phosphor stripes are very narrow compared to the beams. Each beam spreads across two slots in the grille. But the angle at which each beam strikes the grille slot nevertheless directs it to the correct phosphor stripes.

How this works is illustrated in Figs. 3 and 4. Back in the Trinitron electron gun, the red and blue beams bend, cross, and aim outward, while the green beam remains straight. As they pass between the convergence plates, the red and blue beams are directed back toward the center axis. If convergence is correct, all three beams cross again precisely at the aperture grille.

You can see the effect on individual beams in Fig. 4. The green beam, coming through straight, strikes the slotted masking grille exactly perpendicular. The wide beam spreads over two of the aperture slots—and then some—but the metallic grille blocks all except what can get through those two slots. The aperture grille positioning lets the green beam straight through to illuminate two green phosphor stripes.

The red beam, having been bent outward and then back inward, strikes the aperture grille from an angle. The slots—

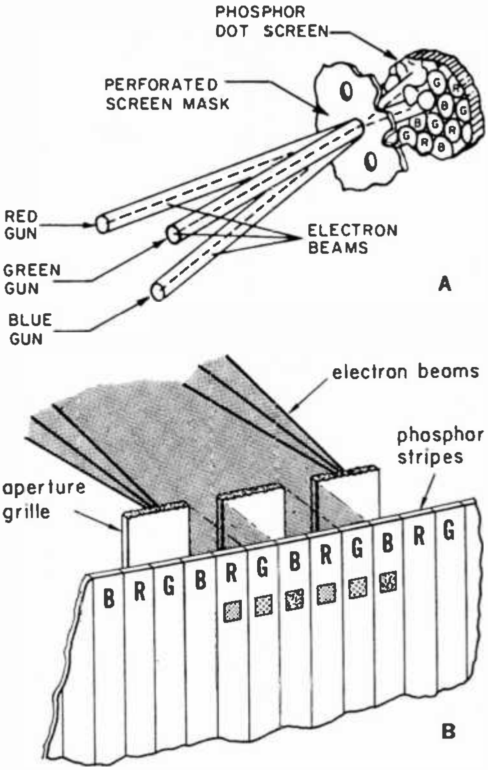
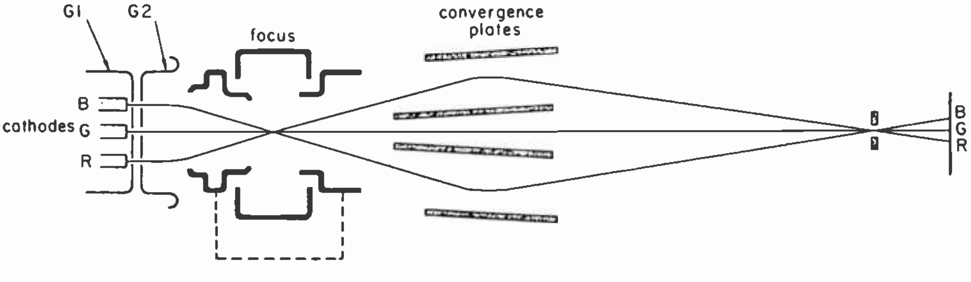


Fig. 2. At top is shadowmask scheme; below, Trinitron CRT aperture grille.

Fig. 3. The gun in a Trinitron emits and controls all three color beams; in ordinary color-TV picture tube, three separate guns are used to make beams.



the same ones that let two green beam-segments through—pass only enough red beam to illuminate two red stripes of phosphor. The angle of the red beam just suits the positioning of the red stripes with respect to the grille openings, and the red beam does not touch green or blue stripes.

The blue beam approaches from the angle opposite the red. The slotted aperture passes two beams just wide enough, and at the correct angle, to hit only blue phosphor stripes.

Of course, all the while, the three beams are being swept from side to side and from top to bottom to form a raster. As you view the front of the Trinitron picture tube, the picture looks about like it does on any regular color CRT—unless you inspect it closely. Then you can see the individual lighted vertical stripes, just as you can see individual phosphor dots on the screen of a conventional color tube if you look closely.

Three From One. The sketch in Fig. 3 shows the gun structure of a Trinitron. Conventional color picture tubes have three separate electron guns, each with its own heater, cathode, grid 1, grid 2, and focus anode. The three heaters share common base connections, and all three focus anodes go to one base pin. But the other elements in all three guns have their separate base connections.

In early Trinitrons—the 9- and 12-inch—only the cathodes are separate. Grid 1 is common to all three cathodes, and thus controls the intensity of all three beams simultaneously. You can imagine how this trims grid-circuit requirements. Only one pin connection serves all three beams. And grid 2 circuitry is cut two-thirds also, since the G2 pin is common to red, green, and blue beams.

Focus circuitry differs from that in conventional color sets, but not in number of connections. Ordinary color CRT's require several thousand volts for focus. Not so, the Trinitron. Only a few hundred volts is needed. Focus supply circuitry can therefore be simple by comparison.

And Easy Adjusting. Beyond the novelty of generating and controlling three electron beams with only one gun, the Trinitron's most spectacular advantage lies in convergence. In 9- and 12-inch Trinitrons, special plates control the crossover point for the three beams. Ideally, crossover

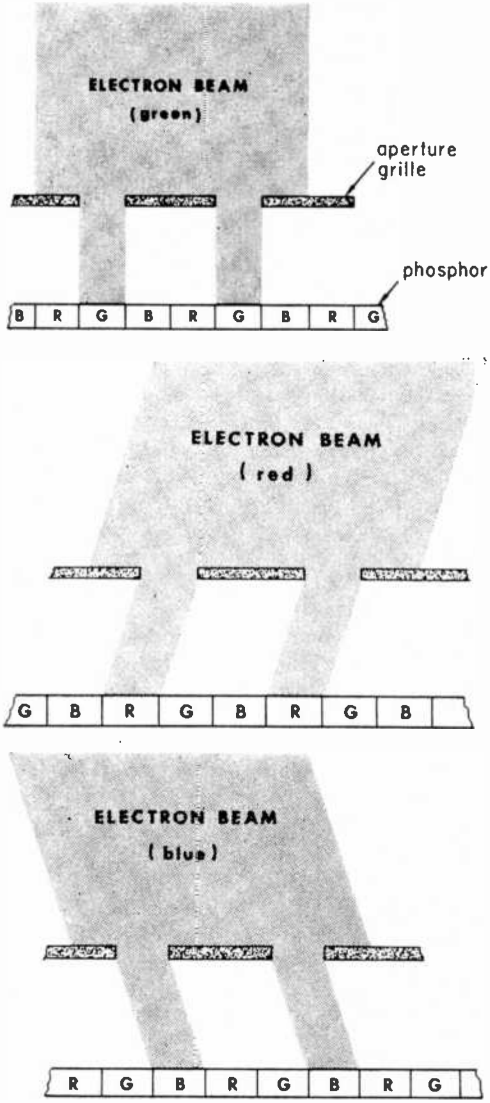


Fig. 4. In Trinitron, the angle of each beam determines which phosphor it hits. Beam is larger than stripes; so that it hits two at the same time.

occurs precisely at the aperture slot.

A high-voltage dc field between the convergence plates bends the beams accurately while they are aimed at the center of the phosphor screen. But remember, the beams are constantly being swept back and forth. To make sure they cross accurately out near the edges, a special signal voltage (parabolic in shape) also drives the convergence plates. Timed to fit each horizontal sweep, the parabolic signal adapts convergence crossover to the curvature of the phosphor screen and aperture grille.

Compared to a typical color tube, the Trinitron converges with extreme simplicity. Because the phosphor is striped instead of dotted, slight vertical misconvergence hardly matters. So, adjustments are reduced to a bare minimum. Once mechanical (static) convergence is adjusted with four neck magnets, a mere two controls shape the parabolic signal for dynamic convergence. It takes four magnets plus thirteen controls to converge other color tubes.

A new 17-inch Trinitron gives up some of the simplicity of small-screen models. For one thing, the electron gun is more complicated. Each cathode has a control grid (G1) of its own. That necessitates extra circuits, and alterations in the way video and color signals are fed to the Trinitron. Otherwise, the gun in the larger Trinitron hasn't been changed much.

Scanning the wider screen also brought problems that necessitate more elaborate convergence. The plates inside the tube still get high dc for basic convergence, but no parabolic signal. Instead the 17-inch Trinitron has a small yoke of convergence coils around the picture tube neck. Even so, adjustments are much simpler than for conventional picture tubes. A mere half-dozen controls does the entire job.

Whither Color CRT's? The Trinitron is the first drastic change in picture-tube technology since color television came on the market. It represents a major step toward making color receivers easier to adjust and repair. Trinitron chassis represent the start of a design trend to minimize critical stages, which in the long run eliminates nuisance maladjustment. Other sections of both color and monochrome receivers could benefit from similar attention.

Meanwhile, what else can be done for picture tubes? The most sought-after innovation is a flat screen, with little thickness. The Trinitron design boasts short neck length as well as small neck diameter. But the front-to-back dimension of Trinitron receivers subtracts little from other designs. Whoever comes up with a picture tube under 6 inches from screen to socket will have taken a giant step toward the ideal of a hang-on-the-wall color picture tube. ◈

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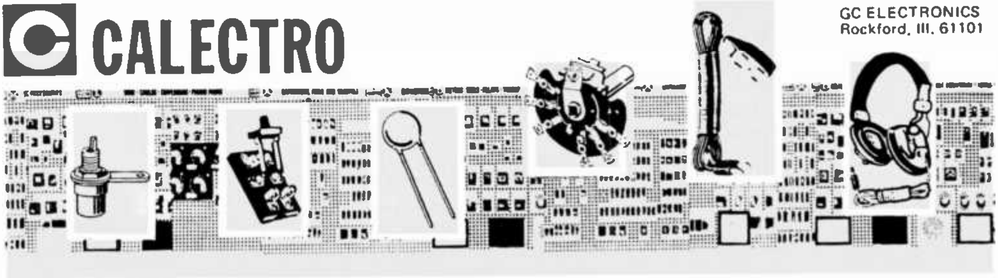

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Iowa City: Hagen Elect. Inc.
Mason City: Team Electronics #10
Sioux City: Molstad Dist. Co.
Sioux City: Team Electronics
Waterloo: Team Electronics #20

KANSAS

Coffeyville: Norman Electronics
Garden City: Team Electronics #46
Hutchinson: Lett Elect. Inc.
Hutchinson: Team Electronics #54
Manhattan: Acme
Mission: Heathkit Electronic Center
Olathe: Santa Fe Electronics
Topeka: Seabrook Radio & TV
Topeka: Team Electronics #64
Wichita: Amateur Radio Equipment
Wichita: Cliffs Wholesale Elect.
Wichita: Lafayette Radio
Wichita: Team Electronics #48
Wichita: Team Electronics #53

KENTUCKY

Covington: Holub Dist. Co.
Latonia: Holub Lafayette
Lexington: Tel-Rad-Elect. Ind.
Paducah: Paducah Elect. Supply
Paducah: Warren Radio

LOUISIANA

Alexandria: House of Elect.
Baton Rouge: Davis Elect. Supply
Baton Rouge: Sterling Elect.
Gretna: Sterling Elect.
Metairie: Pelican Elect. Supply
Monroe: C & O Elect.
New Orleans: Columbia Radio Supply
New Orleans: Shuler Supply Co.
Shreveport: Industrial Elect. Supply
Sulphur: Lafayette Assoc.
W. Monroe: Brooks Supply

MAINE

Bangor: Consumer Electronics
Rockland: Amateur Equipment Co.
South Portland: Lafayette Assoc.
Waterville: Lafayette Assoc.

MARYLAND

Aberdeen: Harco Electronics
Baltimore: Amateur Radio
Baltimore: American Dist. Co.
Baltimore: Henry O. Berman Co.
Bethesda: Empire Electronics Supply
Lexington Park: Bill Raleys Sales Center
Ocean City: Lafayette Radio
Rockville: Capitol Radio Wholesalers
Rockville: German Hi Fi Centers
Rockville: Heathkit Elect. Center
Salisbury: Lafayette Radio Elect.
Towson: Baynesville Elect.
Wheaton: Electronic Dist. Inc.

MASSACHUSETTS

Billerica: Lafayette Radio Associate
Boston: O'Donnell Elect. Supply
Boston: Yankee Electronics
Greenfield: Sdylee Elect. Supply
Hyannis: Lafayette Radio
Hyannis: Lafayette Radio Elect.
Lawrence: Malco Elect. Inc.
Lexington: Wholesale Elect. Supply
Medford: Medford Music
N. Adams: Elect. Supply Center
N. Dartmouth: Lafayette Radio
N. Dartmouth: Radio Shack Assoc.
Northampton: C & I Dist. Inc.
Peabody: Cramer Electronics
Peabody: Tee-Vee Supply Co.
Pittsfield: Pittsfield Radio Co.
Pittsfield: Seiden Sound-Lafayette
Raynham: David Dean Elect.
Springfield: Del Padre Elect. Dist.
Wellesley: Cramer Hi-Fi
Wellesley: Heathkit Electronics
West Newton: A. W. Mayer Co.
Worcester: Wholesale Electronics
Worcester: Worcester Radio Dist.

MICHIGAN

Ann Arbor: Pentronics Inc.
Ann Arbor: Radio-Tronics
Bay City: Bay TV Lafayette
Bay City: Radio-Tronics
Benton Harbor: Colfax Distributing
Birmingham: Nutronics Inc.
Dearborn: West Side Radio
Detroit: Barton Electronics
Detroit: Coomes Dist.
Detroit: Electronic Parts Co.
Detroit: Heathkit Elect. Center
Detroit: Radio Elect. Supply Co.
E. Detroit: Heathkit Elect. Center
Escanaba: Team Electronics #74
Flint: Shand Electronics Inc.
Grand Rapids: Radio Parts Inc.
Grand Rapids: Radio-Tronics
Iron Mountain: J & R Electronics
Jackson: Fulton Radio Supply
Kalamazoo: Electronic Supply Corp.
Kalamazoo: Kaltronics Inc.
Kalamazoo: Radio-Tronics
Kalamazoo: Warren Radio
Lansing: Fulton Radio
Livonia: Northwest Elect.
Livonia: Robbie Electronics
Menominee: Team Electronics #29
Midland: Radio Parts Co.
Muskegon: Elect. Dist.
Muskegon: Western Elect. Supply
Niles: Niles Radio Supply
Port Huron: Main T. V. Supply
Royal Oak: Reno Radio
Saginaw: Philso Parts & Service
St. Joseph: Heathkit Electronics
Southgate Center: Radio-Tronics
Sterling Hgts.: L.R.E. Electronics
Traverse City: Dynatronics Inc.
Warren: J K Electronics
Ypsilanti: Radio-Tronics

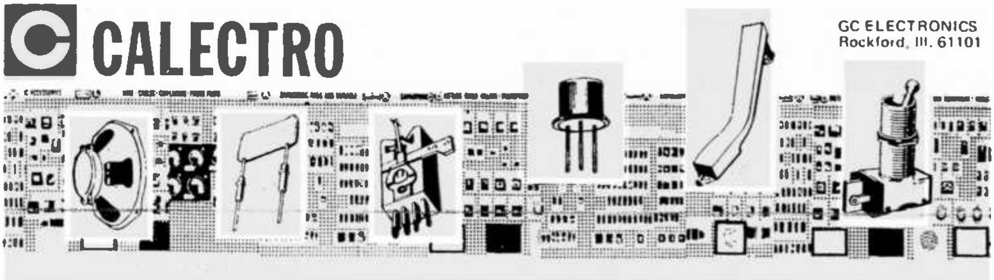
MINNESOTA

Brooklyn Center: Schaak Electronics
Duluth: Northwest Radio
Duluth: Team Electronics #41
Edina: Schaak Electronics
Fridley: Allied Radio Corp.
Hibbing: Team Electronics #24
Hopkins: Heathkit Electronics Center
Mankato: Team Electronics #23
Minneapolis: Allied Radio Corp.
Minneapolis: Electronics Center Inc.
Minneapolis: Schaak Electronics (2 locations)
Minneapolis: Team Central
Minneapolis: Team Electronics #1
Minneapolis: Team Electronics #5
Minneapolis: Team Electronics #13
Moorhead: Team Electronics #14
Rochester: Schaak Electronics
Rochester: Team Electronics #3
Roseville: Schaak Electronics
St. Cloud: Team Electronics #4
St. Paul: Allied Radio Corp.
St. Paul: Schaak Electronics
St. Paul: Team Electronics #2

CIRCLE NO. 21 ON READER SERVICE CARD

CALECTRO

GC ELECTRONICS
Rockford, Ill. 61101



St. Paul: Team Electronics #44
St. Paul: Team Electronics #66
W. St. Paul: Team Electronics #58
Willmar: Team Electronics #25

MISSISSIPPI
Columbus: Bluff City Dist. Co.
Greenville: Bluff City Dist. Co.
Greenville: Electronic Workshop
Greenwood: Parham Electronics
Hattiesburg: Gillilands Teague Elect.
Jackson: Lafayette Assoc.
Jackson: Swan Electronics Inc.
Meridian: Hooper Elect. Supply
Pascagoula: May Elect. Dist. Co.
Tupelo: Bluff City Dist. Co.
Tupelo: Mid Southern Electronics

MISSOURI
Cape Girardeau: Suedekum Elect. Supply
Columbia: Missouri Cable Co.
Grandview: Truman Corner RCA Sales
Joplin: Four-State Electronics
Kansas City: Manhattan Radio & Equip. Co.
Kansas City: Radiolab
Kansas City: Team Electronics #50
Kansas City: Team Electronics #63
Poplar Bluff: Tri-State Elect.
St. Joseph: Acme Radio
St. Louis: Heathkit Electronics
St. Louis: Van Sickle Radio Co.
Sikeston: Baileys Elect. Supply
Springfield: Lafayette Assoc.
Springfield: Norman Electronics
Springfield: Team Electronics #57

MONTANA
Billings: Team Electronics #33
Bozeman: Team Electronics #45
Great Falls: Lafayette Assoc.
Great Falls: Team Electronics #35
Havre: Northern Electronics
Missoula: Electronic Parts
Missoula: Northwest Dist.
Missoula: Team Electronics #37

NEBRASKA
Gering: Corr & Johns Radio TV
Lincoln: Team Electronics #27
Omaha: Omaha Electric
Omaha: Team Electronics #28
Omaha: Team Electronics #34
Omaha: Team Electronics #47
Scottsbluff: D & H Electronics
Scottsbluff: Joachim Radio Supply

NEVADA
Las Vegas: Lafayette Radio Elec.
Las Vegas: Metcalf Electronics
Reno: Dunlap Electronics
Reno: Lafayette Electronics

NEW HAMPSHIRE
Concord: Evans Radio Inc.

NEW JERSEY
Bayonne: J & E Electronics
Berlin: Midstate Radio Supply
Bloomfield: Berger Electronics Supplies
Bricktown: Parts Unlimited
Camden: Resco
Chatham: Music World Elect.
Cherry Hill: Dee's of N.J.
Cherry Hill: Resco
Denville: Lashen Electronics Inc.
Englewood: Gorman Bros.
Fair Lawn: Goodman-Shaw, Inc.
Fair Lawn: Heathkit Electronics
Hackensack: Nidisco Inc.
Hanover: State Electronic Pts.
Jersey City: Nidisco Inc.
Kearny: Kearny Electronics
Newark: Parts Unlimited
Northfield: Rainbow Electronics
Paramus: Leonard Radio
Passaic: Nidisco Inc.
Rahway: Quad Parts
Red Bank: Monmouth Radio Supply
Ridgefield: Nidisco Inc.
Rockaway: Lafayette Radio & Elect.
Springfield: Federated Purchaser
Springfield: Route Elect. Inc.
Trenton: Jackson Dist. Co.
Trenton: Nidisco Inc.
Union City: Nidisco Co.
Wanamassa: Reyal Electronics

NEW MEXICO
Albuquerque: Electronics Parts Co.
Albuquerque: 4Tronics
Albuquerque: Sterling Electronics
Clovis: Electronic Parts
Farmington: Lektronix Supply
Las Cruces: Mannie's Elec. Supply
Santa Fe: Sepco Inc.

NEW YORK
Albany: Lafayette Radio (3 locations)
Albany: Seiden Sound
Amherst: Healthkit Electronic Ctr.
Bayside: Jean Electronics
Bellerose: S & R Electronics
Bethpage: S & R Electronics
Binghamton: Morris Electronics
Bronx: Bay Elect. Dist.
Bronx: Post Tronics Corp.
Brooklyn: Brooklyn Electronics
Buffalo: Dymac Inc.
Buffalo: Purchase Radio Elect. (3 locations)
Buffalo: Radio Equipment Corp. (3 locations)
Commack: S & R Electronics
Corning: Chemung Electronics
Dunkirk: Barker-Higbee
Elmira: Chemung Electronics
Elmira: JPB Specialty Co.
Farmingdale: Harrison Radio Corp.
Flushing: Allen Electronics
Flushing: Jean Electronics
Glenn Falls: Seiden Sound
Hempstead: Davis Electronics Corp.
Herkimer: Herkimer Electronics
Hicksville: Electronics City
Ithaca: Lafayette Assoc.
Jamaica: Harrison Radio Corp.
Jamaica: Jean Electronics
Jamestown: Warren Radio
Kingston: Lafayette Radio
Lake Grove: Towne Camera & Elect.
Lindenhurst: Barstan Electronics
Merrick: Electronics Unlimited
Newburgh: Action Audio Inc.
New Hyde Park: Electronic City
New Paltz: Vista Camera
New York: Adson Radio & Elec.
New York: Consolidated Radio
New York: Harrison Radio
New York: Heathkit Radio
New York: Hurley Electronics
New York: Midway Radio & TV Corp.
New York: Sylvan Wellington Co.
Niagara Falls: Market Radio & TV
Niagara Falls: Radio Equipment
Olean: Radio Equipment Corp.
Patchogue: T & M Electronics
Peekskill: Action Audio
Plattsburgh: G & F Elect.
Plattsburgh: Lafayette
Poughkeepsie: Higgins & Sherr Elect.
Poughkeepsie: Lafayette
Riverhead: D & S Electronics
Rochester: Heathkit Electronics
Rochester: Rochester Radio Supply
Rome: Rome Electronics
Schenectady: Seiden Sound
Staten Island: Electronic Dist. Corp.
Tonawanda: Purchase Radio
Troy: Trojan Electronics
Vestal: Hart Electronics
Wappingers Falls: Lafayette Radio
Westbury: Heathkit Elect. Center
West Seneca: Purchase Radio
Woodbury: Harvey Radio Co.
Woodside: Boro Elect. Inc.

NORTH CAROLINA
Asheville: Baker-Electronics, Inc.
Asheville: Freck Radio & Supply
Charlotte: Dixie Radio
Charlotte: United Electronic Supply
Concord: Mac Victor Elect. Supply
Durham: Vickers Elect. Supply
Gastonia: Shiflet Dixon Inc.
Greensboro: Lafayette Assoc.
Greenville: Pair Electronics Inc.
Hickory: Freck Radio & Supply
New Bern: Lafayette Radio Elect.
Raleigh: Lafayette Electronics
Shelby: Freck Radio
Statesville: Electronic Center
Statesville: Mac Victor Elect. Supply
Winston-Salem: Lafayette Radio
Winston-Salem: 21st Century Elect.

NORTH DAKOTA
Bismarck: Team Electronics #30
Grand Forks: Team Electronics #26
Mandan: John Iverson Co.
Minot: John Iverson Co.
Minot: Team Electronics #32

OHIO
Akron: Fox Radio Parts Co.
Ashtabula: Morrisons Electronics
Cincinnati: Holub Lafayette Store
Cincinnati: Newark-Herrlinger
Cincinnati: United Radio Audio Ctr. . . (2 locations)
Cleveland: Communications World
Cleveland: Fox Radio Parts
Cleveland: Heathkit Electronics
Cleveland: Warren Radio Co.
Defiance: Dick DeWolfe Elect.
E. Liverpool: Television Parts Co.
Lancaster: Lafayette Radio Electronics
Lima: Hutch & Son
Mansfield: Fox Radio Parts
Mansfield: J. R. Electronics
Mansfield: Servex Eelctra Dist.
Marion: Servex Electra Dist.
Minster: Gudorf & Moorman
Sandusky: Servex Electra Dist.
Sebring: Collins Dairy Store
Springboro: Franklin Electronics
Toledo: Fox Radio Parts
Warren: REM Elect. Supply
Washington Court House: Hutch & Son
Woodlawn: Heathkit Elect. Center
Wooster: Servex Electra Dist.
Youngstown: Armies Electronics
Youngstown: Clark Electronics
Zanesville: Thompson Radio Supply

OKLAHOMA
Bartlesville: Cummins Elect. Supply
Enid: Radio Shack
Midwest City: Radio Supply
Oklahoma City: Radio Supply Inc.
Oklahoma City: Sterling Electronics
Oklahoma City: Sterling Home Elect.
Oklahoma City: Webb Electronic Sales Inc.
Stillwater: Hamilton Electronics
Tulsa: Lafayette Assoc.
Tulsa: Team Electronics #77

OREGON
Eugene: Thompson's Lafayette
Portland: Electronic Supermarket
Portland: Electronic Wholesale Mart
Portland: H & R Radio Supply
Portland: Northwest Radio Supply
Portland: Portland Radio Supply
Salem: Wasson's Lafayette

PENNSYLVANIA
Allentown: Federated Purchasers
Altoona: Diamond Electronics
Ambridge: Television Parts Co.
Bristol: Powell Electronic Sales
Butler: Bacher Electronics
Butler: Television Parts Co.
Chambersburg: ABC Electronics
Edwardsville: Arlans #87
Erie: Mace Electronics
Erie: Warren Radio

MAC'S SERVICE SHOP

Getting the Most from your Service Dollars

By John T. Frye, W9EGV, KHD4167

IT WAS coffee break time at Mac's Service Shop. The owner and his redheaded assistant, Barney, were seated side by side on the service bench, while Matilda, the office girl, was enthroned on a high stool where she could keep an eye on the front door. She had baked and brought in a big platter of what she called "man cookies"—huge sugar sprinkled affairs almost the size of 45-rpm records—and these were disappearing fast along with the coffee.

"You know," Barney mumbled with a full mouth, "I don't see how a girl with such a tart disposition can bake such sweet and tasty cookies."

"Watch your smart Irish tongue or you'll taste no more of them," Matilda retorted.

"All right, you two," Mac interrupted quickly; "I want your opinions about something. Last night I read that in 1970 this country passed a milestone: for the first time the cost of services accounted for more of the gross national product than did manufactured goods. What's more, the U.S. Department of Labor predicts that by 1980 seven out of every ten workers will be engaged in service rather than manufacturing."

"How about that!" Barney exclaimed. "It looks like we're in the right business."

"I'm not so sure that's altogether good," Matilda said thoughtfully. "It seems to me the production of manufactured goods actually contributes to the real wealth of the country, while services make a necessary but more intangible and hard-to-measure contribution. Some services, I'm sure, add nothing to the nation's wealth."

"I understand what's bothering you," Mac said with a nod. "I've some reservations of my own about an economy that's becoming more and more service-oriented. But be that as it may, it seems evident we're going to be putting out more money for service than we put out for manufactured articles. Since such a high percentage of our income is going to be spent for service, it would seem to behoove us to give some thought as to how we can get the best return on those service dollars."

"That seems logical," Matilda agreed. "After all, we have magazines and books devoted to explaining how to get the most value for the dollars we spend for *things*. Perhaps we need something similar to tell people how to get the most value for money spent for *service*."

"Say, whose side are you on?" Barney demanded, reaching for another cookie. "Don't forget we're in the service bsuiness."

"We, as well as everybody else, are also in the consuming business," Mac reminded him. "But I like Matilda's idea about telling the customer how to get the most for his service dollar. We may not be able to help much with the plumber, electrician, dentist, doctor, or automechanic but we should be able to tell how to get the most out of dollars spent for radio and TV service."

Pick a Good Technician. "The first thing to do is pick a good service technician," Barney led off, "and that's not easy. To coin a phrase, 'Only another technician knows for sure.' The layman lacks the technical knowledge necessary to evaluate the work a TV technician performs. He is likely to be much more impressed by the simple problem of locating a shorted capacitor quickly than he is by a brilliant job of tracking down an elusive intermittent condition calling for complete mastery of theory plus a great deal of experience.

"However, there are some things a customer can look for in selecting a service shop. Has it been in business long? Is it well equipped? If the state has licensing, is there a license hanging on the wall and do the technicians wear license badges? If the state has a certification program, how many of the shop technicians are certified? Are any of them graduates of factory training schools or of other recognized training institutions?

"Read the advertising carefully. If the word 'Free' is tossed about recklessly, look out. Are parts and labor both guaranteed or only parts? For how long? Finally, if the customer knows one honest and capable service technician in any mechanical field, ask him to recommend a TV technician. A good mechanic usually recognizes and respects capable work in an adjacent field."

What Customer Should Do. "Now let me tell what the customer should do before he calls us," Matilda urged. "The first thing he should do is get out his operator's manual and read it carefully. Is the set plugged into an active socket? Is the antenna attached properly? Are the controls correctly set? Is the circuit-breaker closed? If everything checks out and the set still will not function, a service technician should be called.

"Before calling, however, the caller should get together pertinent information: what is the make, model, and serial number of the defective unit? Is it connected to the cable or to an indoor or outdoor antenna? Exactly what is the complaint? Is it with the picture, the sound, or both? Is only the color at fault? In what way is reception abnormal? Is this condition present on all channels or on only some? Which ones? Is the trouble always there or it is intermittent? If the latter is true, how soon does it appear after the set is turned on? If it goes away by itself, when does that happen? Does anything you do to the set change the condition? Did you see or smell any smoke around the set? Was there a popping, snapping sound? When will you be home so the technician can call?"

"Hey, Matilda, that's pretty good," Barney admitted with grudging admiration. "With the answers to those questions, the technician should be able to make a shrewd guess as to the trouble and have proper service information and parts with him when he calls. That saves his time and the customer's money."

"Yes, and the customer can save more time and money by having everything ready for that call," Mac suggested. "I mean all the stuff should be removed from the top of the set; adequate lighting should be provided; and the kids should be corralled in another part of the house."

"Hear, hear!" Barney applauded. "And the customer herself should not try to entertain the service technician with a lot of small talk. Anything that diverts his attention from what he is doing simply increases the time necessary to do it. If she wants to sit over in a corner and watch, that's fine, but a good way to squander her money is to keep peppering the technician with questions such as 'What is that thing? What makes it do that? How much longer will it take you to fix it? Are you sure it isn't the color power tube as my cousin Willie thinks?' Neither should she regale the technician with a detailed recital of experiences she has had with other 'incompetent and crooked technicians.' She might be giving him ideas!"

"When the job is done, she should receive a dated and itemized bill," Matilda added. "Before paying that bill she should make sure the set is operating satisfactorily on all channels. The original complaint should be stated on the bill, especially if it was intermittent in nature. Then if the trouble comes back after the technician leaves, it will be a matter of record that the complaint was not corrected. On the other hand, the technician cannot be held responsible for an entirely new trouble that shows up later."

"That brings us to the matter of trusting the service technician," Mac said. "My own practice is to pick a man I think I can trust and then to trust him until I am convinced that trust is misplaced. We all know that a radio and TV service technician can deceive a customer in dozens of different ways *if he is so inclined*. We also know that if he charges what his knowledge is worth, he does not need to resort to such shabby business to make a good living. Human nature being what it is, there is always a tendency to meet expectations. If someone obviously distrusts you and expects you to try to cheat him, his hostility arouses your own, and there's always the temptation to give him the business just to prove you can. If your ethics do not permit this—and ours do not—you still do not give him any breaks. On the other hand, you have to be a dirty dog to take advantage of a customer who trusts you and treats you with friendliness and respect. You're much more likely to throw in a few little extra touches in servicing the receiver of such a customer."

Putting it all Together. "Okay, let's put all this together," Matilda said, plucking a pencil from Mac's jacket pocket and starting to jot shorthand on the back of a service tag. "Americans are spending more money for service than they do for merchandise. That means getting the most for their service dollars is becoming increasingly important. They can do this by (1) picking a service shop as carefully as they do a new car or a new living room suite, (2) calling for service only when they are sure they need it, (3) having all pertinent information at hand when they call for service, (4) having things ready for the technician when he arrives, (5) allowing him to work with a minimum of distraction, and (6) trusting him and his judgment. While we've been thinking in terms of radio and TV service, the same general principles apply to all kinds of service, from dealing with auto mechanics to doctors."

"That's a good summary, Matilda," her employer said, "but now the coffee and cookies are all gone, perhaps we'd better quit talking about service and start practicing it."

"It sure is tough working for a doggone slave driver," Barney muttered, starting to gather up the coffee cups. ◈

Picture streaked? Call Speedy TV Shop for immediate service.

Electronics Library

IC PROJECTS FOR THE AMATEUR & EXPERIMENTER

This book, put together by the staff of 73 Magazine, offers the reader an opportunity to learn about integrated circuits by doing. It contains complete details on the operation and construction of 35 IC projects for the hobbyist, experimenter, and student. Detailed are such items as a digital counter, audio mixer, signal and marker generators, code-practice oscillator, audio filter, ac switches, and many more. In addition to schematic diagrams, the book is illustrated with photographs, waveforms, and some printed circuit board drilling and etching guides.

Published by Tab Books, Blue Ridge Summit, PA 17214. 192 pages. $6.95 hardbound, $3.95 softbound.

STEREO IN YOUR HOME

by Walter G. Salm

This book reviews many of the developments in stereo since it was popularized in the late 1950's. It covers the entire spectrum of stereo and offers tips on how to install systems, make recordings, evaluate equipment, and what to look for when buying equipment. Discussions are included on how stereo and tape recorders work, commercial recordings are made, tapes and records are produced, and FM and TV antennas can be used in a stereo system. For those interested in 4-channel stereo, a discussion of 8-track cartridges is included.

Published by Vertex, Auerbach Publishers, Inc., 1101 State Rd., Princeton, NJ 08540. Hard cover. 231 pages. $8.95.

RCA RECEIVING TUBE MANUAL, RC-28

Containing some 100 pages more than in the previous edition, this revised and updated manual covers more than 1600 tubes. Included for the first time are technical data on industrial receiving tubes and new entertainment-type receiving tubes. Data for monochrome and color TV picture tubes are presented in chart form. Comprehensive text and circuit sections, the latter containing 35 schematic diagrams and parts lists, are included as always.

Published by RCA Commercial Engineering, Harrison, NJ 07029. Soft cover. 784 pages. $2.50.

COBRA ON GUARD.

The Cobra 880 Base Station – Solid State CB Two Way Radio with Exclusive Channel 9 Scan-Alert

New Cobra 880 combines a lot of good ideas into one package. It combines Cobra's famous rugged construction with total solid state design to give long life and reliable performance. Adds AC or DC operation to keep working in all power situations. Leaf digital clock with automatic turn-on and turn-off features. And puts you on guard – with Scan-Alert! With Scan-Alert, you'll be able to work your own channels and guard Emergency Channel 9 – at the same time.

Scan-Alert is a Cobra exclusive that alternately changes the channel of the receiver from your operating channel to Emergency Channel 9. The Channel Indicator light and the Channel 9 indicator light flash alternately. As Scan-Alert automatically switches between frequencies. When a signal is received on either Channel 9 or the selected channel, the receiver automatically locks on the active channel. The receiver resumes scanning after the transmission is completed. And if you want to respond to a Channel 9 call, just slide one switch, without upsetting your channel selector setting. The Cobra 880 combines normal and emergency guarding – and makes it easy.

Here are some more good ideas in the Cobra 880:

. 23 Channel operation with crystal frequency synthesizer ☐ RF Gated Noise Blanker and Automatic Noise Limiter ☐ Illuminated Channel Selector ☐ Combination Relative Power, SWR and S meter ☐ Dual Conversion Receiver, with FET RF stage ☐ Dynamic microphone, with coiled cord and plug ☐ P.A. and external speaker jacks ☐ Transmitter modulation indicator light ☐ Meets FCC requirements

$229.95

COBRA 880

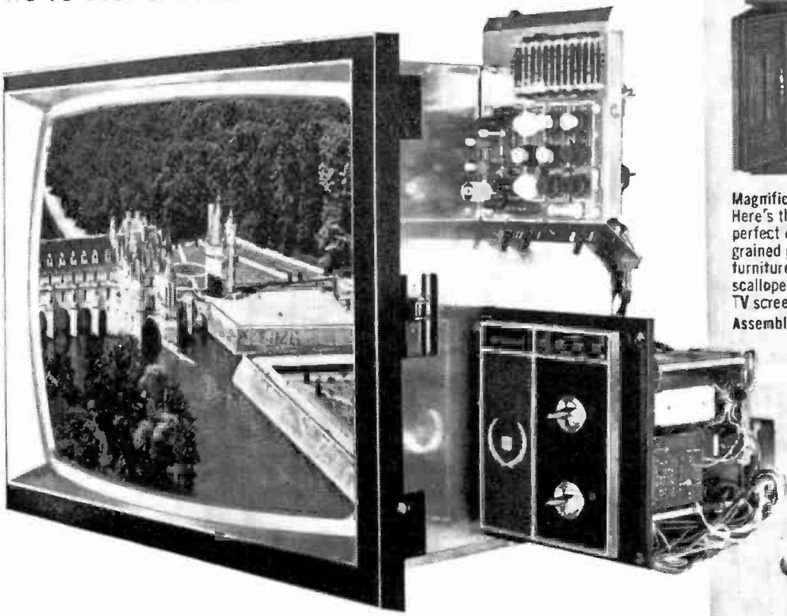
Product of DYNASCAN CORPORATION
1801 W. Belle Plaine • Chicago, Illinois 60613

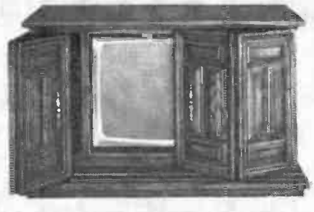
See your local CB Dealer or write us for more information.

CIRCLE NO. 6 ON READER SERVICE CARD

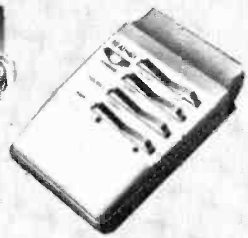
More kits than ever...over 350...all in your

The most advanced color TV kit we've ever offered.





Magnificent Mediterranean Console. Here's the finest TV cabinet we offer, a perfect choice for a GR-900. Has deep-grained pecan veneers on hand-rubbed furniture grade hardwood solids. Two scalloped double-hinged doors hide the TV screen when not in use.
Assembled GRA-405-25, 100 lbs. 179.95*



Wireless Remote for your GR-900. The ultimate in armchair viewing. Gives you eight-function across-the-room control of on/off, three preset volume levels, power tuning (up or down), color, tint, UHF/VHF channel selection. Also activates Custom Wall Mount doors.
Kit GRA-900-6, 6 lbs. 79.95*

New Custom Wall Mount. Touch a button on the frame or on your Heathkit Remote Control unit and the folding tambour doors open to reveal your color TV. Kit includes everything needed to build your Heathkit GR-371MX or GR-900 into a wall.
Kit GRA-402-25, walnut finish, 50 lbs. 114.95*
Kit GRA-407-25, unfinished, 50 lbs. 109.95*

The new Heathkit GR-900 25V Color TV has UHF/VHF detent tuning & varactor UHF tuner, angular tint control — more features than any other color TV kit! Better performance than any other set.

UHF/VHF detent power tuning. Push a button and you scan the channels in either direction with detent action locking in on VHF channels 2-13 and any 12 preselected UHF stations. A pushbutton selects either UHF or VHF mode, and a lighted dial indicates tuner position. And you can have full remote-control selection too for just a few dollars more.

New voltage-controlled varactor UHF tuner and specially designed VHF tuner with MOS Field Effect Transistor contribute to better fringe-area reception, increased sensitivity.

New angular tint control. A switch now gives you either "normal" or "wide angle" color demodulation to reduce tint and flesh tone change when changing stations and when programs change. Other deluxe features include "instant on" operation with override for conventional on/off operation; automatic fine tuning; adjustable tone control, and an output for playing TV audio through your stereo hi/fi system.

Exclusive Heath MTX-5 ultra-rectangular tube. It's the largest color screen you can buy anywhere, with a full 25 inch meas. diag., 315 sq. in. viewing area. You see virtually everything the station transmits, in the corners and at the sides. The specially etched face plate cuts glare, and reflection, increases contrast without sacrificing brightness, and each dot is projected through a matrix screen to stand out crisply against a solid black background.

Modular solid-state circuitry. Plug-in circuit boards and plug-in transistors make assembly, adjustment and servicing easy. There are 46 transistors, 57 diodes and four ICs — making this one of the most reliable sets we've ever designed.

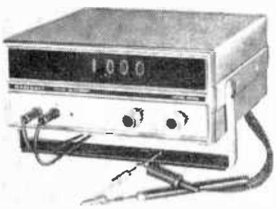
Other features include automatic chroma control, adjustable video peaking, adjustable noise limiting and gated AGC.

Exclusive Heath self-service built-ins. Your Heathkit GR-900 includes built-in dot generator, tilt-out convergence panel for set-up and periodic adjustments. A handy volt-ohm meter included in the circuitry helps you check your work during assembly, and can be used in conjunction with the manual for any servicing. Like all Heathkit color TVs, the GR-900 gives you complete installation flexibility. There are four beautiful Heath cabinets to choose from plus the new built-in electronic wall mount with hide-away tambour doors. Or you can custom install your GR-900. We think you'll agree, the GR-900 is truly the most impressive color receiver we've ever offered.

Kit GR-900, TV less cabinet, 125 lbs. 599.95*

FREE '72 HEATHKIT Catalog

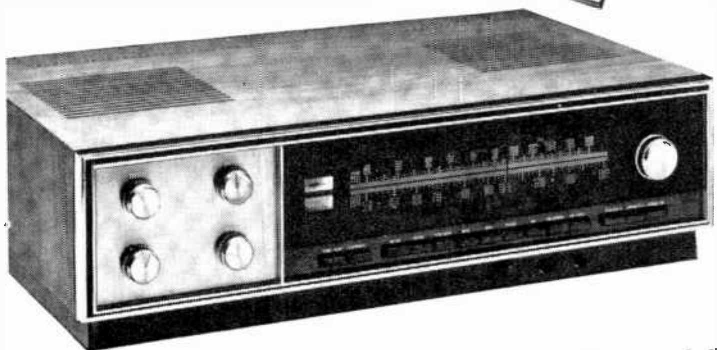
The better-than-ever '72 Heathkit Catalog has the world's largest selection of fun-to-build, money-saving electronic kits...including color TV, stereo/hi-fi, organs, home appliances, engine tune-up tools, radio control, portables, shortwave, marine gear, metal locator, instruments, hundreds more. If you don't have this catalog, you've missed seeing over 50 new kits, introduced since the last edition. Send today for your free copy.

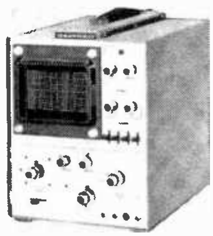


New Heathkit Digital Multimeter 229.95*

A kit-form multimeter that meets lab specs. Has 3½ digits for 100 uV resolution on the 200 mV range, 1V on 1000 V. Five overlapping ranges measure voltage from 100 uV to 1000 V on DC (either polarity); 5 ranges cover 100 uV to 500 V on AC; 10 ranges measure 100 nA to 2A AC or DC; and 6 ranges measure resistance from 0.1 ohm to 20 megohms. Input impedance is approx 1000 megohms on 2V range, 10 megs on higher ranges, with overload protection built-in. DC calibrator supplied permits 0.2% accuracy without external equipment. Can be lab calibrated to 0.1%. For lab performance at a budget price, order your IM-102 today.

Kit IM-102, 9 lbs. 229.95*





New Heathkit 10 MHz Triggered Sweep Scope. 229.95*

Here's a five-inch triggered sweep scope at a price you can't afford to pass up. Has DC-10 MHz response, calibrated attenuator, 50 ns sweep rate with magnification, AC-DC coupling, 50 mV sensitivity. It's the ideal instrument for general service and design work...and its quality design, easy assembly, simple operation and self-service capability make the Heathkit 10-103 one of the greatest scope values on the market today. Order one for your shack, shop, lab or classroom, now.

Kit 10-103, 37 lbs. 229.95*

The most powerful and sensitive stereo receiver they've ever tested.

Heathkit AR-1500 AM/FM/FM-Stereo Receiver — ranked by independent experts as the best ever. Here's 180 watts dynamic music power, 90 watts per channel into 8 ohms, 120 watts per channel into 4 ohms. Less than 0.1% intermod distortion, less than 0.25% harmonic distortion. FM selectivity greater than 90 dB, outstanding phase linearity, separation, and low distortion result from two computer-designed 5-pole LC filters. A 4-gang 6-tuned circuit front end offers rock-solid stability, 1.8 uV sensitivity, 1.5 dB capture ratio and 100 dB image and IF rejection. Automatic FM squelch is both noise and deviation activated, fully adjustable for sensitivity.

The AM section, overlooked in most receivers, boasts 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 for good overload characteristics, proper AGC action, no IF alignment and high-fidelity performance. The AR-1500 is an easy kit to build, ten plug in circuit boards, two wiring harnesses and extensive use of pre-cut wiring with installed clip connectors make assembly fun. Built-in test circuitry uses the signal meter to make resistance and voltage checks as you go. Other features include Black Magic panel lighting that hides the dial markings when the 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 auxiliary sources — all with individual level controls. The AR-1500 is the critics choice, and with no reservations, the best stereo receiver we've ever designed.

Kit AR-1500, less cabinet, 42 lbs. 379.95*

ARA-1500-1, walnut cabinet, 6 lbs. 24.95*

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Prices & specifications subject to change without notice.
*Mail order prices; F.O.B. factory. CL-429 R

CIRCLE NO. 24 ON READER SERVICE CARD

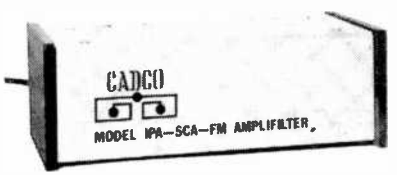
New Products

WELTRON CASSETTE RECORDER MOTOR

Recently introduced by the *Weltron Co.* is a new dc replacement motor for cassette recorder and player decks. Model 70-700 operates on 6-9 volts dc with a clockwise rotation. The universal cassette motor operates at 2320 rpm at 6.5 volts or 2400 rpm at 9 volts. Address: Weltron Co., 514 E. Peabody St., Durham, NC 27702.

CADCO SINGLE-CHANNEL FM PREAMP

A high-gain, ultralow-noise single-channel FM preamplifier, Model IPA-SCA-FM, has been announced by *Cadco Systems*. This is a 22-dB gain indoor mounting single-channel amplified filter designed to boost weak off-the-



air signal levels for main channel and SCA channel uses. The preamplifier has a 1.3-dB maximum noise figure and 3 dB bandwidth products of ±500 kHz. The unit has its own built-in 117-volt ac power supply and 75-ohm input and output. Address: Cadco Systems, 4444 Classen Blvd., Oklahoma City, OK 73118.

LAFAYETTE ELECTROSTATIC HEADPHONES

The Model F-2001 electrostatic stereo headphones available from *Lafayette Radio Electronics Corp.* deliver three octaves of sound beyond conventional phones. The F-2001 has a self-energizer with speaker/phone switch and color-coded speaker cables. The energizer converts audio signals into dc polarizing voltages which charge the diaphragm. Also included is an adjustable vinyl cushioned headband. Frequency range of the headphones is 5 Hz to 35,000 Hz; mpedance 4-16 ohms. Address: Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, NY 11791.

CORNELL-DUBILIER ANTENNA ROTOR

A new economy-priced rotor, the Model AR-20, has just been introduced by *Cornell-Dubilier Electronics*. The antenna rotor system has many of the best features of rotors in the company's line. The rotor itself is housed in a heavy-duty die-cast aluminum enclosure, painted gold to match modern color antennas. Quick unit mounting is made possible through positive-grip U-bolt clamps on the aluminum housing. And a positive braking system is featured. The control is fully automatic and of the same type used with the well-known AR-22 rotor. After the desired direction is set, the unit stops automatically and with greater accuracy. The dial face is illuminated when the system is in operation. Address: Cornell-Dubiler Electronics, 150 Avenue "L", Newark, NJ 07101.

TOYO 4-CHANNEL CARTRIDGE PLAYER

Four discrete channels of sound, through four separate amplifiers, are featured in the Model 707 "Qaudio" cartridge tape player made by

Toyo Radio Co. of America, Inc. The system is also fully compatible with existing 2-channel stereo material, and with the addition of Toyo's Model QC-1 4-channel decoder, will matrix out the ambience information to provide the two rear channels for 4-channel stereo from a 2-channel source. Featured are pushbutton mode selector, automatic and manual program selection for both 2- and 4-channel operation, rear balance control, and phase selector switch to keep front and rear speakers in-phase with each other. An optional cassette adapter is also available to allow the Model 707 to play conventional cassettes. Address: Toyo Radio Company of America, Inc., 1842B W. 169th St., Gardena, CA 90247.

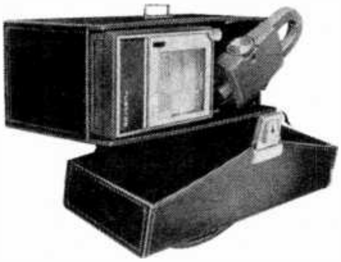
CB UNIT FROM DYNASCAN

Dynascan Corporation has introduced a new mobile CB two-way radio with an exclusive emergency channel 9 "Scan Alert." This feature enables the operator to simultaneously monitor channel 9 and any of the other 22 channels of his choice. The Cobra 28 has a full 5 watts of input power with Dyna-boost speech compression, r-f noise blanker, automatic noise limiter, PA system output, delta tune, channel

indicator lights, power/S meter, as well as IC's and FET's to reduce cross-modulation. The unit measures 2⅓" x 6" x 8½" and weighs only 4½ pounds. It operates on 12 volts dc, but may be used with an optional power pack on 117-volt ac. Address: Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, IL 60613.

RUSTRAK AC VOLT-AMP RECORDER

A low-cost recorder that measures both ac voltage and ac current has been introduced as the Model 230 by *Rustrak Instrument Div.* of Gulton Industries, Inc. The recorder is furnished with a clamp-on transducer and a leather



carrying case witth handle. The single instrument is designed to read and record three voltage and three current ranges. Voltage ranges are 0 to 150, 300, and 600 volts at 60 Hz with an accuracy of 3 percent full-scale. Current ranges are 0 to 25, 100, and 300 amperes at 60 Hz with accuracy of four percent full-scale. The clamp-on transducer has a built-in dial to facilitate easy switching of ranges and functions. The recorder, plus transducer, clip leads, carrying case and 2 rolls of paper, is priced at $159.00. Address: Rustrak Instrument Div., Gulton Industries, Inc., Municipal Airport, Manchester, NH 03103.

LOW-COST LASERS FROM METROLOGIC

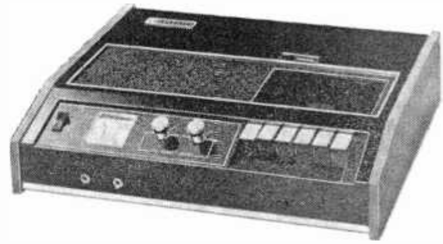
Two new aluminum cathode, helium-neon lasers developed by *Metrologic Instruments* feature longer life and low cost, thanks to the aluminum cathode which provides constant power output and high beam positional stability. The tubes, designated MT 710 and MT 711, have power outputs of 1.5 mW and 2.4 mW, respectively. The company is guaranteeing 9000 hours or one year of operation with the new units. Address: Metrologic Instruments, Inc., 143 Harding Ave., Bellmawr, NJ 08030.

TENNA 2-WAY MOBILE RADIO

An inexpensive emergency 2-way radio for motorists was recently announced as their "HELP 9" by *Tenna Corp.* The HELP 9 represents a practical method of providing security and safety by providing 2-way voice communication on channel 9 of the Citizen's Band reserved by the Federal Communications Commission for emergency calls. It is designed to place the motorist in immediate contact with help in cases of accidents, car failure, or criminal action. HELP 9 features simplicity of operation, with a single on/off/volume control. Transmission or receipt is governed by a thumb switch on the microphone. Address: Tenna Corp., 19201 Cranwood Pkwy., Cleveland, OH 44128.

HEATHKIT CASSETTE DECK KIT

The *Heath Company* has announced their entry into the cassette age with the introduction of their Model AD-110 cassette deck kit. The AD-110 has six pushbuttons that control all



tape functions, separate level controls and meters, tape counter, automatic shutoff, and record safety interlock. Technical specifications match or exceed those of many open-reel machines that operate at 3¾ ips. The all-solid-state circuitry employs a two-transistor dc motor regulator and an IC voltage regulator in the amplifier circuit. The transport mechanism comes preassembled for easy kit assembly. Optional microphones are also available. Address: Heath Co., Benton Harbor, MI 49022.

PIONEER REVERBERATION AMPLIFIER

To supplement existing stereo systems, *U.S. Pioneer Electronics Corp.* offers the Model SR-202W solid-state reverberation amplifier.

The reverb amp blends signals from music sources with a reverb effect that adds greater acoustic realism. The SR-202W can be used to supply a variety of effects. A five-position mode selector can be set to add reverb to speakers only or to the recording sound of a tape deck. Reverb can be used without altering the sound recorded on tape and can be omitted simply by setting the selector to off. A front-panel indicator shows the amount of reverberation selected by setting a separate time control. Address: Pioneer Electronics, 178 Commerce Rd., Carlstadt, NJ 07072.

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The microphone that came with your AM/SSB set wasn't made for single side band. Turner makes one that is. The only one. We call it Sidekick 100. Sidekick 100 has a dynamic cartridge with an integrated-circuit amplifier which provides low impedance and a perfect match for the latest AM/SSB transceivers. You'll get full modulation and a powerful signal every time. Sidekick 100 also is the best match for any conventional AM transistorized transceiver on the market. This handsome new microphone is chrome and black with all the features it takes to provide outstanding performance. Rugged, die-cast metal case. 300-3,000 Hz frequency response range. Touch-to-talk front bar with slide lock for extended transmission. Self-contained 9-volt battery. Output level −23 db. Get more out of single side band. Put the Sidekick 100 into it. Write for details. Turner Division. Conrac Corporation. 909 Seventeenth Street N.E., Cedar Rapids, Iowa 52402. Telephone (319) 365-0421.

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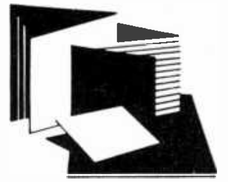
CIRCLE NO. 47 ON READER SERVICE CARD



New Literature

CHEMTRONICS 1972 CATALOG

Complete descriptions, general and unusual applications, illustrations, tables, and pricing for all products are featured in the 12-page, 1971-1972 catalog from *Chemtronics Inc.* Listed are such items as tuner sprays, circuit coolers, insulating sprays, contact and control sprays, cleaners and conditioners for tape heads, electronic glues and cements, solder, and paint sprays. Address: Chemtronics Inc., 1260 Ralph Ave., Brooklyn, NY 11236.

AMPEX CASSETTE BROCHURE

A 6-page brochure, No. T694, describing the 362 series extended-frequency blank audio cassettes is available from *Ampex Corp.* The 362 series is a high-performance cassette that delivers up to six times more sound in the upper-frequency range than do standard cassettes. Address: Ampex Corp., Stop 7-13, 401 Broadway, Redwood City, CA 94063.

SPERRY METERS AND TESTERS

A. W. Sperry Instruments Inc. recently announced the release of their latest comprehensive folder, No. PF-45. Described in the folder is the company's complete line of snap-around volt-ohm-ammeters, master electrical kits, multitesters, and accessories. Address: Sperry Instruments, 245 Marcus Blvd., Hauppauge, NY 11787.

RCA LASERS AND IR DIODES

"Gallium-Arsenide Injection Lasers and Infrared-Emitting Diodes" catalog (OPT-100A) has just been made available by *RCA Solid State Div.* It contains data on the RCA line of room-temperature infrared-emitting diodes, single-diode lasers, injection-laser arrays, and stacked-diode lasers. Data on gallium-aluminum-arsenide laser diodes and arrays, and cryogenic laser arrays, are also included in the 12-page revised catalog. Characteristics, operating considerations, and applications of all listed devices are given. Address: RCA Commercial Engineering, Harrison, NJ 07029.

BEARCAT MONITOR BULLETIN

The all-new "Bearcat III" scanning monitor receiver is illustrated and described in a two-page bulletin (No. 1071) available from *Electra Corp.* The bulletin fully describes the FM public safety/business band receiver and presents information on plug-in r-f modules and crystals. A complete list of technical specifications and a price/band coverage table for all one- and two-band models of the Bearcat III are also provided. Address: Electra Corp., 300 South Country Line Rd., Cumberland, IN 46299.

DYNASCAN DESCRIBES 21 INSTRUMENTS

Dynascan Corp. has just released a new catalog describing the B&K line of test equipment for electronics servicing, laboratory, and industrial applications. A total of 21 instruments, encompassing a wide range of equipment from a 100 percent Mutual Conductance Tube Tester to a new DC-to-10-MHz triggered sweep oscilloscope, are described. Address: Dynascan, 1801 W. Belle Plaine Ave., Chicago, IL 60613.

ALCOLITE INDICATOR SPECIFICATIONS

Specifications, ratings, and physical dimensions of the Alcolite "Elfin" 7-segment neon indicator are detailed in Catalog EL-77 put out by *Alco Electronic Products, Inc.* Of special interest is the section describing Elfin New Generation Hybrid Circuits for Cold-Cathode Neon Displays. Address: Alco Electronic Products, Inc., Lawrence, MA 01843.

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FREE! bargain catalog. Fiber optics, LED's, transistors, diodes, rectifiers, SCR's, triacs, parts. Poly Paks, Box 942, Lynnfield, Mass. 01940.

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ROCKETS: Ideal for miniature transmitter tests. New illustrated catalog. 25¢. Single and multistage kits, cones, engines, launchers, trackers, rocket aerial cameras, technical information. Fast service. Estes Industries, Dept. 18-K, Penrose, Colorado 81240.

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SENCORE, B&K Test Equipment Unbelievable Prices. Free Catalog and Price Sheet. Fordham Radio, 265 East 149th Street, Bronx, N.Y. 10451.

ELECTRONIC Ignition. Various Types. Information 10¢. Anderson Engineering, Epsom, N.H. 03239.

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ANTIGRAVITY, experiment and theory; Rushed—$2.00. U.S. Inquiries. Intertech 7A5, Box 5373, Station-F, Ottawa, Canada.

LEARN the facts of electronics and your privacy. Send for the Tron-X Manual, P.O. Box 38155, Hollywood, CA 90038. $5.95.

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100	.40	.70	1.00	1.20
200	.70	1.10	1.40	1.60
300	.90	1.35	1.80	2.00
400	1.10	1.60	2.60	2.40
500	1.50	2.00	2.20	2.80

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PRV	1A	3A	30A	12A
100	.06	.09	.30	.50
200	.07	.16	.35	.80
400	.09	.20	.45	1.20
600	.11	.30	.70	1.50
800	.15	.40	.85	1.80
1000	.20	.55	1/10	2.20

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Silicon Control Rectifiers

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50	.25	.28	.60	
100	.30	.38	.85	3.50
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500	.80	.85	1.70	
600	.90	1.20	1.90	11.00

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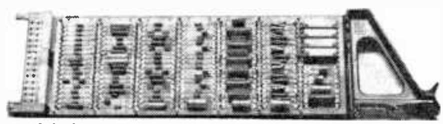

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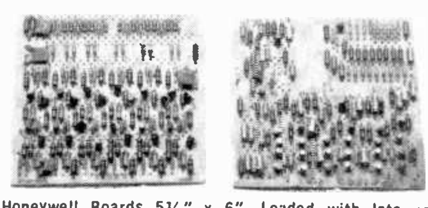

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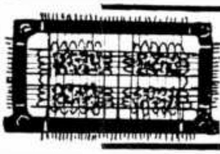

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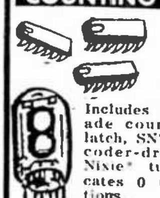

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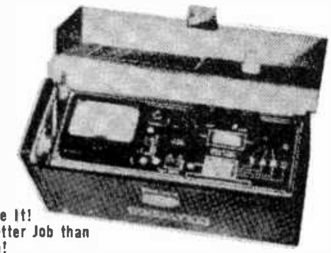

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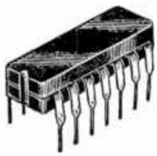

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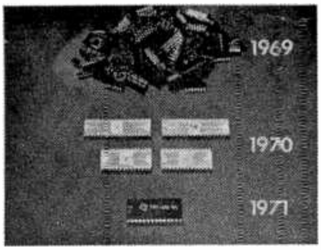

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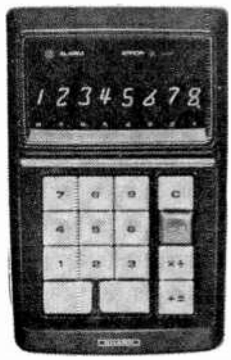

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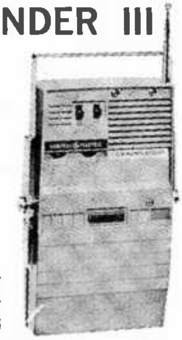

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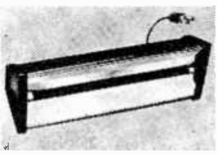

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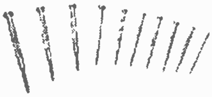

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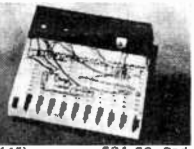

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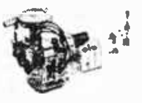

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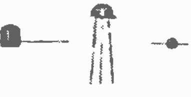

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