Electronics World

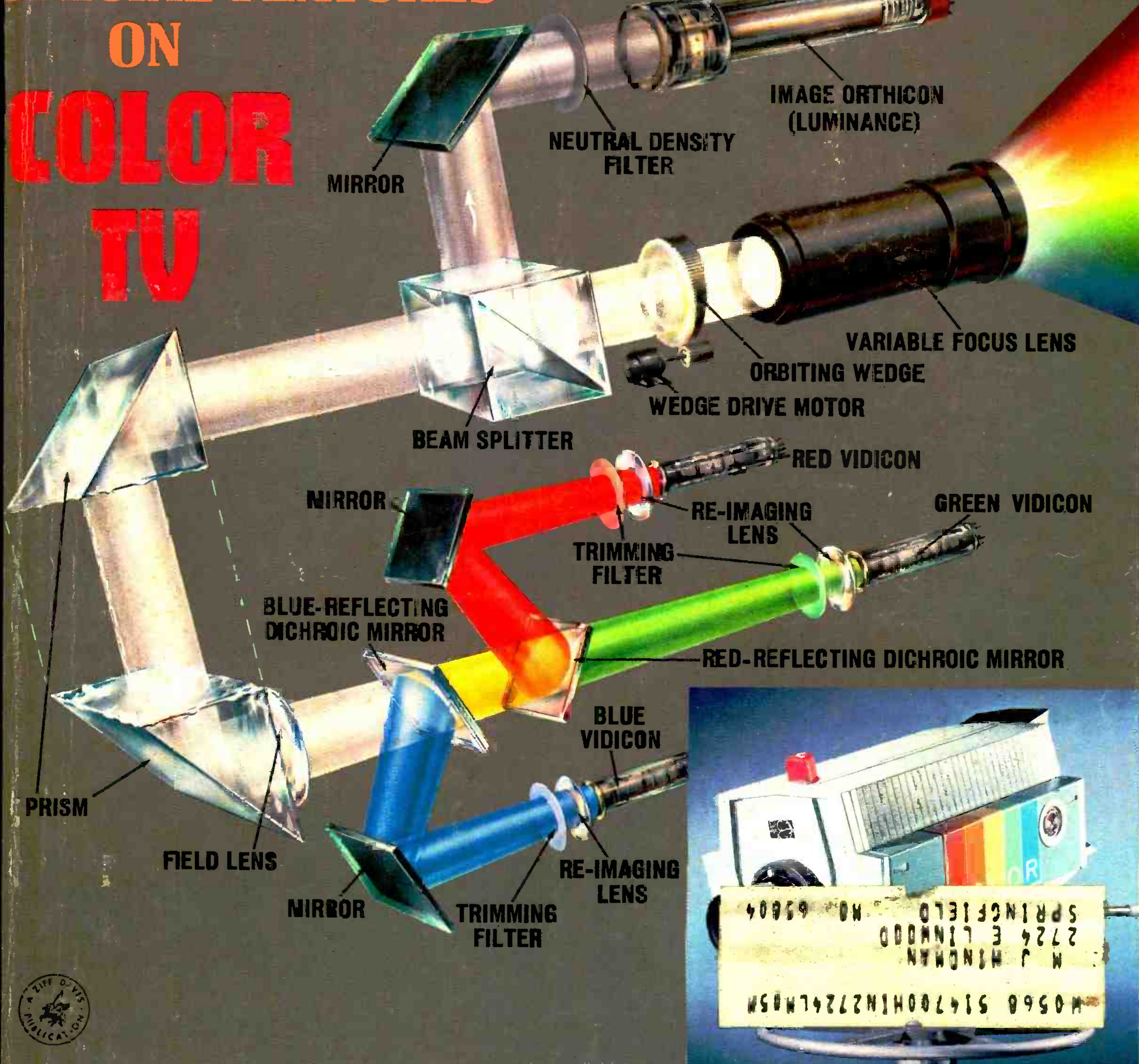
DECEMBER, 1966
60 CENTS

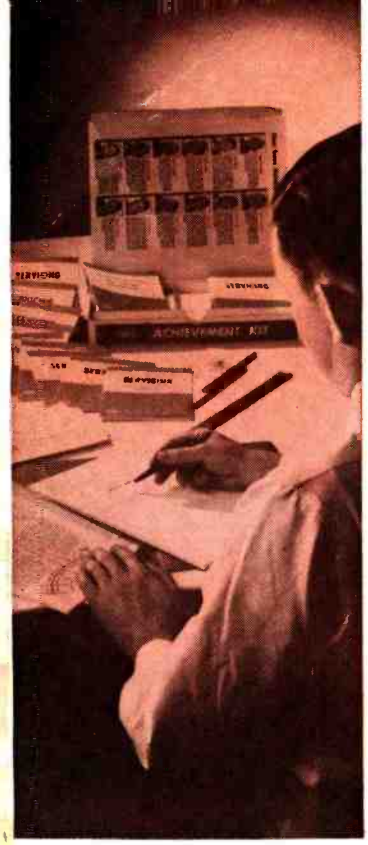
ELECTRONIC METAL LOCATORS: Basic Types and Design Factors

FIRST INTEGRATED-CIRCUIT PHONOGRAPH

CRYOGENIC LIQUID LEVEL CONTROLS

SPECIAL FEATURES ON COLOR TV





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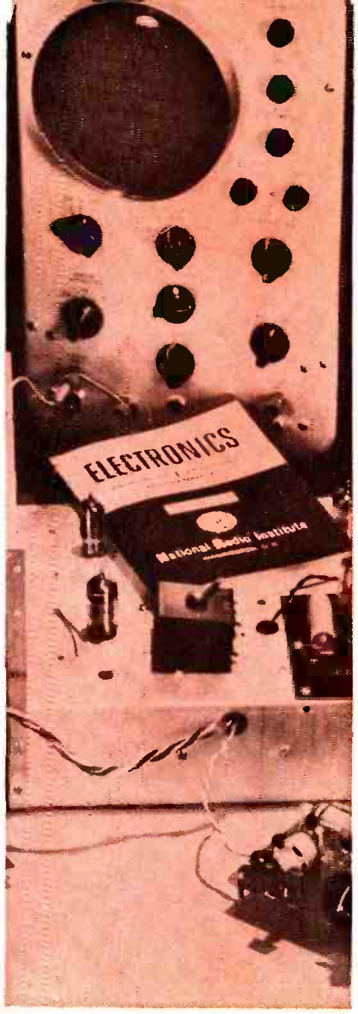

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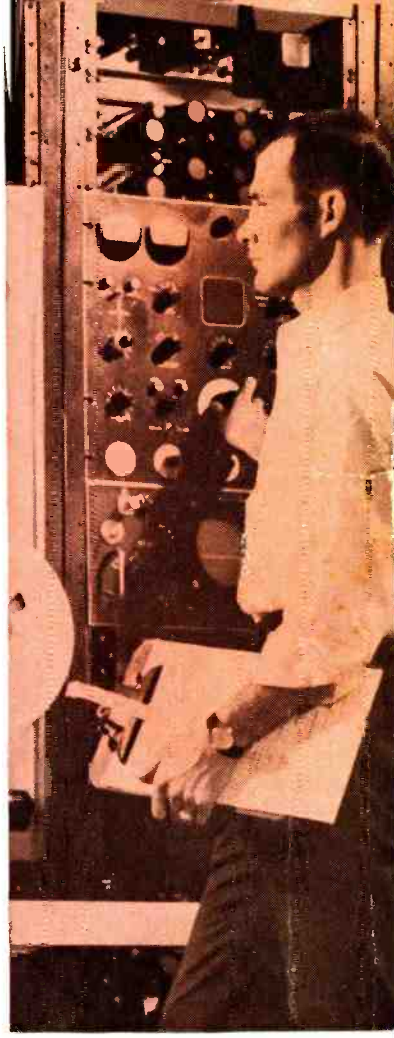

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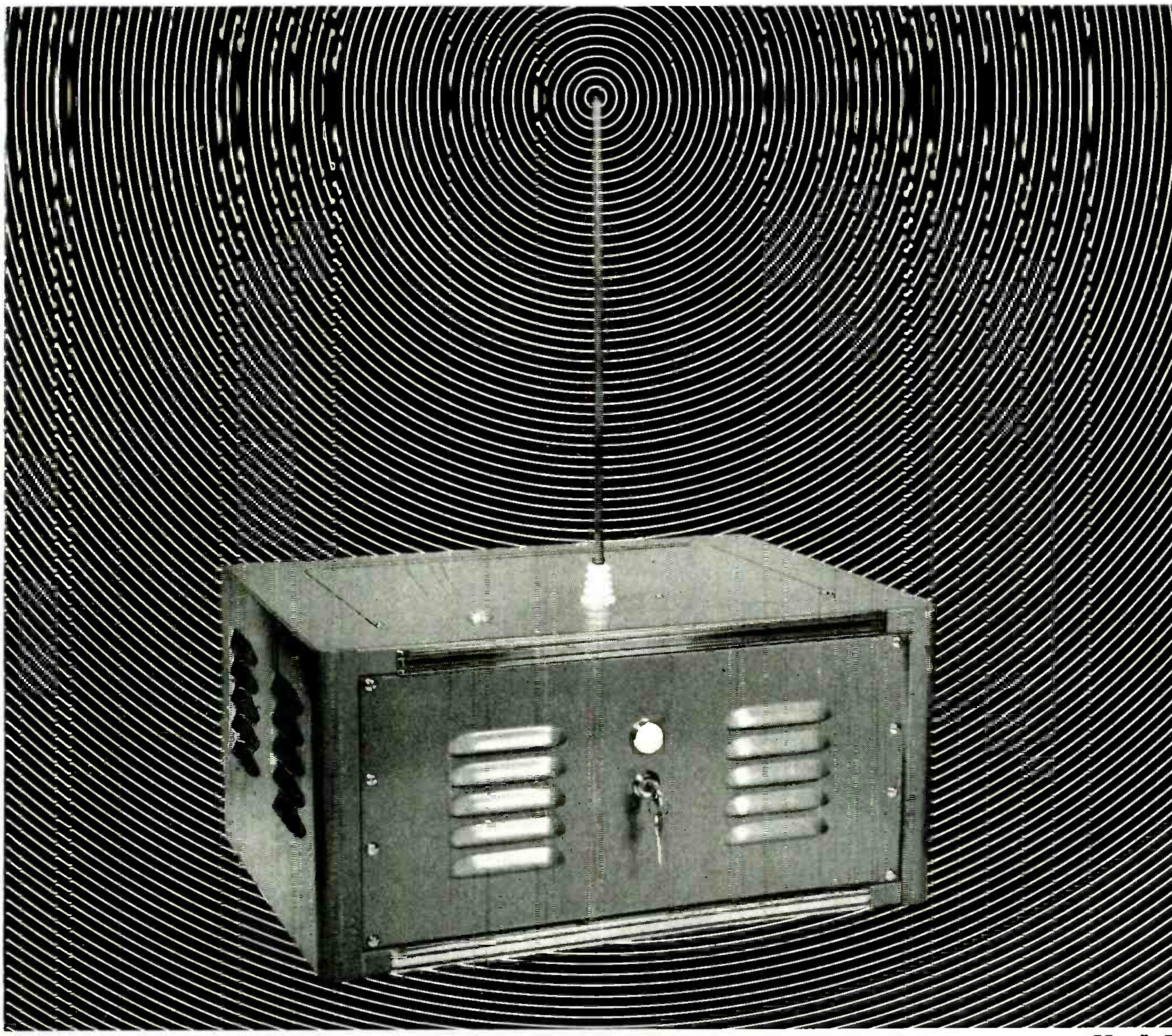

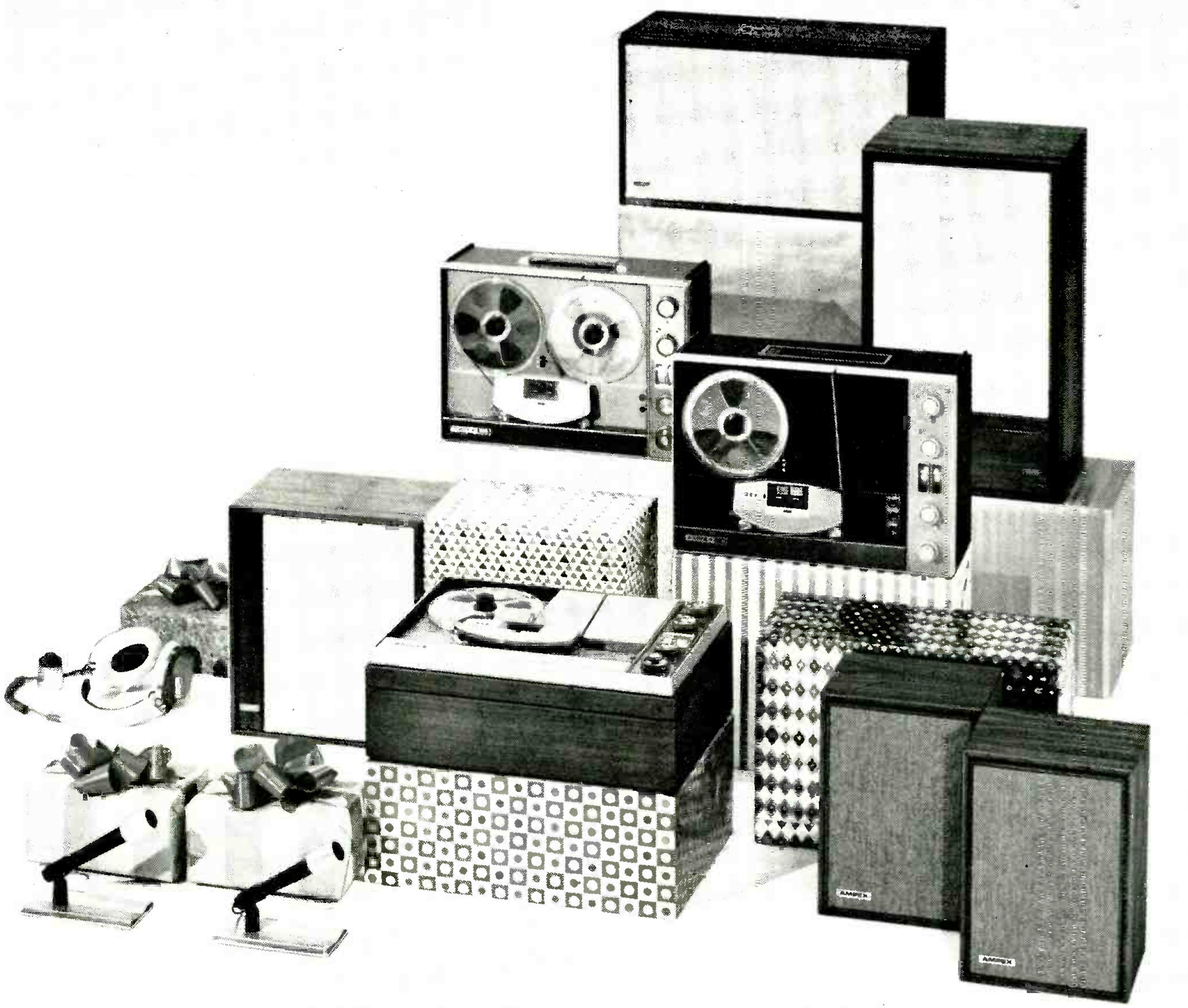

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CIRCLE NO. 84 ON READER SERVICE CARD

THIS MONTH'S COVER shows the optical details of the latest four-tube color camera used by NBC. Complete operation of this independent luminance camera is discussed on page 30 of this issue. It is the purpose of this camera to furnish a high-quality color and monochrome picture. Because of its independent luminance channel, for long periods of monochrome operation, the chroma channels can be turned off without degrading the picture. The photo at the lower right illustrates the low-silhouette shape of the new camera made possible by the use of completely transistorized circuits. (Illustration: Otto Markevics.)

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MONTHLY FEATURES

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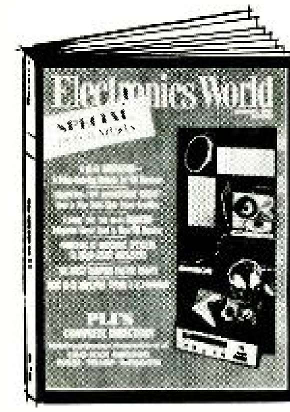
COMING NEXT MONTH



SPECIAL FEATURE ARTICLES ON:

HI-FI

Problems of Matching Speakers to Solid-State Amplifiers—Since the output of any solid-state amplifier varies with load, it is important that speaker impedances be taken into account to obtain ultimate performance. Vic Brociner of H. H. Scott tells how it should be done, and gives some advice on adding speakers to your hi-fi system.

Solid-State Amplifier Directory—A complete listing of commercially available models along with their electrical specs, physical dimensions, and prices.

A First for the Hi-Fi Industry: Integrated Circuit Used in New FM Receiver—Details on the new Heath receiver which uses a pair of IC's as the i.f. amplifiers . . . the first such application in component hi-fi.

A Hi-Fi Innovation: A Pulse-Counting Detector for FM Tuners—An in-depth discussion of the new circuit being used in the Fisher TSM-1000 FM stereo tuner. A completely new principle, involving a delay line, insures linear bandwidth of 10 MHz.

Operational Amplifier for Hi-Fi—Bart Locanthi of James B. Lansing Sound, Inc. describes the new "T-circuit" which is being used in the JBL SA-600 solid-state power amp. It is a computer-type wideband operational d.c. amplifier.

The Great Damping Factor Debate—What do the numbers really mean and do very high damping factors have any noticeable effect on performance? Read it and see.

New Hi-Fi Amplifier Terms & Definitions—With much of today's hi-fi equipment solid-state, a whole new vocabulary is involved in listing amplifier specs.

HIGH-SPEED PUNCHED-CARD READERS
A new generation reads data at up to 2000 cards per minute by means of photoelectric techniques and then encodes input data into computer language.

DEVELOPMENTS IN CRT PHOSPHORS
Much brighter displays, transparent phosphors, phosphors that change color, long-persistence types, and rare-earth phosphors are just a few examples of the changes being made in all cathode-ray tubes.

All these and many more interesting and informative articles will be yours in the January issue of ELECTRONICS WORLD . . . on sale December 20th.

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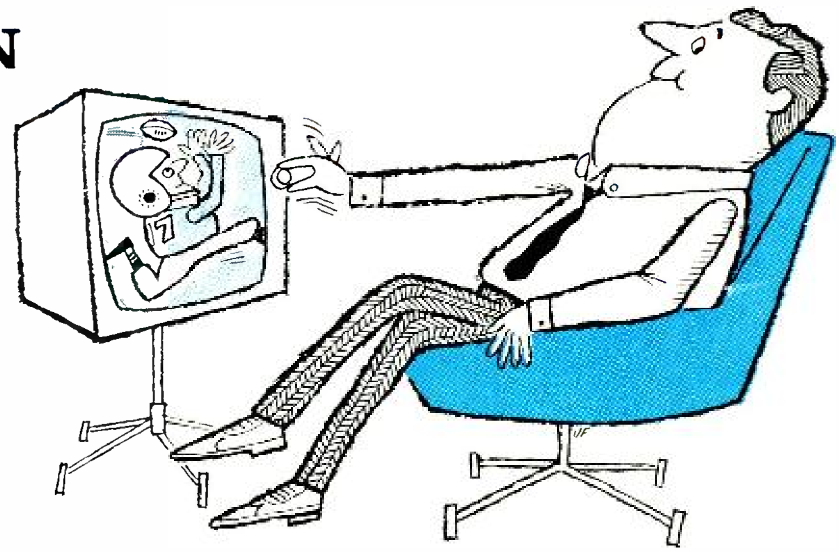
GET SUPERIOR 82-CHANNEL COLOR TV RECEPTION WITH

NEW BELDEN 8290

SHIELDED PERMOHM* LEAD-IN



Until the introduction of Belden 8290 Shielded Permohm TV lead-in cable, there were serious limitations in the effectiveness of the various lead-in cables available, whether twin lead or coaxial.

Here Robert E. Sharp, electronic engineer of the Belden Manufacturing Company, discusses the problems and the reasons why Belden 8290 Shielded Permohm is the all-purpose answer for 82-channel and color TV reception.

Q. *What problems have been experienced in using twin lead cables other than 8290?*

A. Most installers have found out that using flat ribbon or tubular 300 ohm line for UHF and color installations is unsatisfactory. When these lines encounter dirt, rain, snow, salt, smog, fog, or industrial deposits, the impedance drops abruptly, the attenuation soars and the picture is lost.

To overcome this problem, Belden developed its 8285 Permohm line which encapsulates the flat twin lead in a low loss cellular polyethylene jacket. This keeps all of the surface deposits out of the critical signal areas—regardless of weather conditions.

Although this was a major improvement, there still remained the problem of electrical interference signals from automotive ignition systems, reflected TV signals and extreme electrical radiation which could be picked up by the lead-in to create ghosts and static lines in the picture.

Q. *Then, is this why many people recommend coaxial cable as TV lead-in?*

A. Yes. Because of the incorporation of a shield, coaxial cable has an advantage over unshielded twin lead.

Q. *Then, why isn't coaxial the total answer?*

A. Coaxial cable has much higher db losses per hundred feet than twin lead. Although the shield in coaxial cable does reduce lead-in pick-up of interference signals, it is not as effective as a 100% Beldfoil* shield.

Another way to put this is that 8290 delivers approximately 50% of the antenna signal through 100 feet of transmission line at UHF while coaxial cable can deliver only 15% to 20%, frequently not enough for a good picture. Even at VHF, the higher losses of a coaxial cable may be intolerable, depending on the signal strength and the length of the lead-in.

The following chart spells this out conclusively. We have compared RG 59/U Coax to the new Belden 8290 Shielded Permohm. All 30 ohm twin leads, under ideal weather conditions, have db losses similar to 8290.

CHANNEL	MC	db LOSS/100' 8290	db LOSS/100' COAX (RG 59 Type)
2	57	1.7	2.8
6	85	2.1	3.5
7	177	3.2	5.2
13	213	3.5	5.9
14	473	5.4	9.2
47	671	6.6	11.0
83	887	7.7	13.5

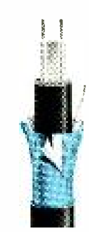
Capacitance: 8290—7.8 mmf/ft. between conductors
Coax—21 mmf/ft.
Velocity of Propagation: 8290—69.8%
Coax—65.9%

Q. *Won't the use of matching transformers improve the efficiency of a coaxial cable system?*

A. No! The efficiency is further reduced. Tests show that a pair of matching transformers typically contribute an additional loss of two db, or 20% over the band of frequency for which they are designed to operate. Incidentally, transformer losses are not considered in the chart.

Q. *How does 8290 Shielded Permohm overcome the limitations of other lead-ins?*

A. 8290 is a twin lead with impedance, capacitance, velocity of propagation and db losses which closely resemble the encapsulated Permohm twin lead so that a strong signal is delivered to the picture tube. At the same time, 8290 has a 100% Beldfoil shield which prevents line pick-up of spurious interference signals. In short, 8290 combines the better features of twin lead and coaxial cable into one lead-in.



Q. *What about cost?*

A. In most cases, 8290 is less expensive than coax since matching transformers are not required. The length of the lead-in is also a factor in the price difference. The cost of coaxial cable installations can vary tremendously, depending upon the type and quality of matching transformers used. If UHF reception is desired, very high priced transformers are required.

Q. *Is 8290 Shielded Permohm easy to install?*

A. Yes! Very! It can be stripped and prepared for termination in a manner similar to 300 ohm line without the use of expensive connectors. It also can be taped to masts, gutters or downspouts, thus reducing the use of standoffs. There is no need to twist 8290 as the shield eliminates interference problems. It is available from your Belden electronic distributor in 50, 75, and 100 foot lengths, already prepared for installation, or 500' spools.

8-11-5

Belden

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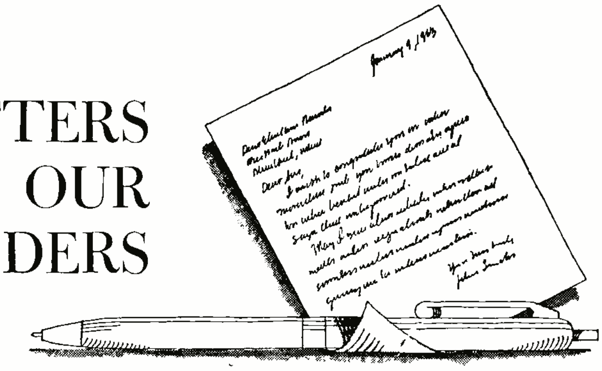
CIRCLE NO. 123 ON READER SERVICE CARD

LETTERS FROM OUR READERS



CLASS-D AMPLIFICATION

To the Editors:

I have noted the correspondence between Reader Robert W. Schoening and Author Donald E. Lancaster (ELECTRONICS WORLD, September, 1966) with some interest. It is apparent that Mr. Schoening, in common with many others, is guilty of nothing more than a lack of a complete understanding of the complex energy-transfer cycle required for successful operation of class-D circuits. Author Lancaster is guilty of a sin of omission or two in not being perfectly lucid in his explanations. Actually, Reader Schoening made some very good points which would have been cleared up had Mr. Lancaster been able to treat the subject in greater depth.

At this point, let me inject my *bona fides*: In 1964, while an electronics engineer for *Ling Electronics, Inc.*, Anaheim, California, I built and successfully operated an audio amplifier using class-D (at this time it was not known as class D but was generally described as "time-modulated switching mode") solid-state techniques which produced an output from d.c. to 3 kHz at full power. Full power, in this case, was *2000 watts!* Measured efficiency (with true-r.m.s.-reading meters) was 89%.

During the development of this amplifier, several novel circuits were devised which are the subject of a patent application now under study by the U.S. Patent Office and jointly held by two other men, one of whom is still employed by *Ling* in the capacity of Vice President of Engineering. Due to the restrictions imposed by patent laws, a paper describing this development has never been published.

To answer Reader Schoening on one point: You are quite right in that energy is stored by the filter and returned to the generator. However, the energy must be returned to the *power supply* part of the generator, not the switch, if high efficiency is to be maintained. This is the role of the free-wheeling diode which is an integral part of every switching-mode design.

A Fourier analysis of a time-modulated switching-mode waveform shows that the theoretical efficiency is 100%. However, due to semiconductor switching losses and inability to build inductors with infinitely high "Q" and capacitors with infinitely low D in the real world, actual efficiencies can only approach this figure—as in my case, 89% at 2 kW. Reader Schoening, class D does not stand for "dead" as you suggest; it stands for "desirable."

T. R. PARKHILL
Senior Project Engineer
Ultek Corp.
Mountain View, Calif.

* * *

VARACTOR DIODE APPLICATIONS

To the Editors:

The article "Varactor Diode Applications" by Donald E. Lancaster in your June, 1966 issue covers wide ground but still doesn't exhaust possible varactor uses.

We have just announced a differential d.c. amplifier that uses varactor diodes to achieve exceedingly low current offset and drift performance; at the same time, the amplifier harnesses the varactor's ultra-low voltage and current noise at near d.c. frequencies. Additional benefits, all stemming from the varactor input circuit of the new amplifier, are 10,000 megohms input impedance, 160 dB common-mode rejection ratio, and ±300 volts common-mode rating. What semiconductor amplifier can accept inputs 300 volts above or below ground?

The new amplifier, designated the Model 301, uses a varactor bridge instead of a conventional differential transistor input stage. The varactor is excited by a 10-MHz oscillator (carrier oscillator) included in the unit's 3-cubic-inch package. Operation is very simple. Owing to the variation of varactor capacitance with applied voltage, the varactor bridge can easily be unbalanced with minute input signals. Input current as low as 10^{-13} ampere will unbalance the bridge, feeding a proportion of carrier signal out to the following a.c. amplifier stage. After demodulation and further d.c. amplification, the unit develops an output that is a replica of the original input, amplified one million times, and remarkably free from unwanted noise.

The varactors provide noise performance in this circuit several orders of magnitude better than conventional

transistors at d.c. (where so-called "one-over-F" noise is the major bugaboo) and also outperform FET's.

An application in which this varactor technique is mandatory lies in seismographic sensing, where the most minute earth tremors must be distinguished against a background of amplifier noise. The lower the noise, the smaller the earth tremors the amplifier can detect.

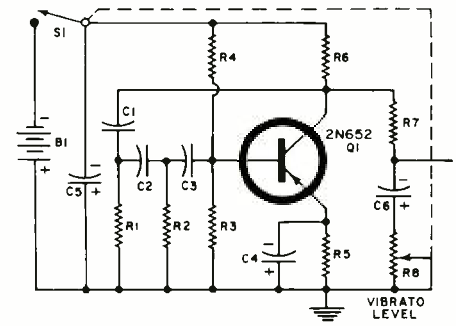
RAY STATA
Vice President, Sales
Analog Devices, Inc.
Cambridge, Mass.

° ° °

SIMPLIFIED TREMOLO

To the Editors:

I would like to bring your attention to an error that was made in my article "Simplified Tremolo" which appeared on p. 89 of your October issue. The diagram shown below clearly indicates the correction. Note that resistor $R4$



should go to the base and not to the collector of Q1 as shown originally. Resistor $R6$ is the collector load in this case and not $R4$.

WILLIAM R. SHIPPEE
La Porte, Ind.

° ° °

SELECTING INDICATOR LIGHTS

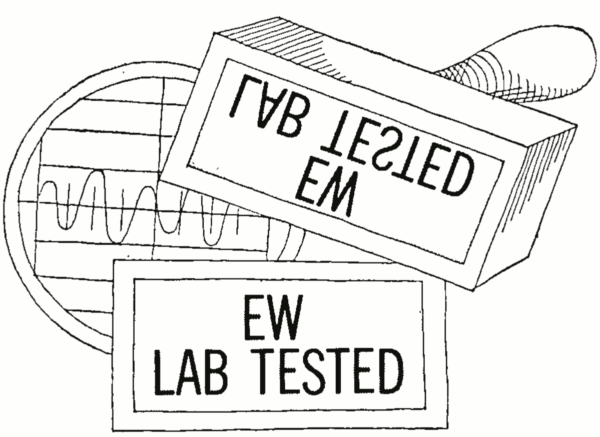
To the Editors:

As a manufacturer of indicator lights, we read with great interest the article "Selecting the Proper Indicating Light" in your August issue. Naturally, Author Walker's definition of "proper" includes only lights made by his organization, and he omits such popular types as the economical and long-lived unit-construction neon pilot lights, among others.

His criticism of the T-2 slide-base lamps is particularly unfortunate. T-2 slide-base lamps are the most reliable indicator lamps presently available and have proved vastly superior to the T-3¼ miniature bayonet-base types in many applications. Miniature sockets (½" mounting holes) are available, light output and efficiency are high, and with proper sockets there is no difficulty in either insertion or removal.

Among substantial users of these lamps are *Western Electric* and *IBM*, who are concerned with reliability since they service their own equipment.

BERNARD SCHNOLL, Gen. Mgr.
Industrial Devices, Inc.
Edgewater, N.J. ▲



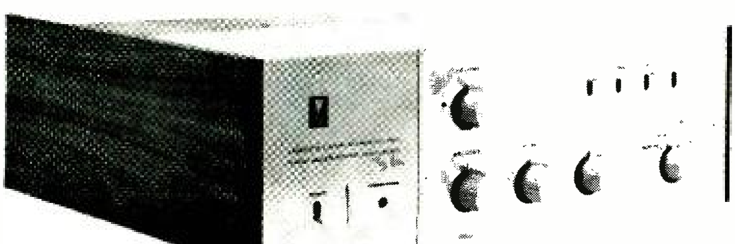
HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

JBL SA-600 Stereo Amplifier
Uher 9000 Tape Deck/Preamps

JBL SA-600 Stereo Amplifier

For copy of manufacturer's brochure, circle No. 26 on Reader Service Card.



THE *James B. Lansing* SA-600 is an integrated stereo amplifier of exceptional quality. It sets new standards of performance for integrated amplifiers and, in general, equals or surpasses the best amplifiers we have previously tested, vacuum tube or solid state.

The SA-600 uses silicon transistors throughout. Feedback in the equalization and tone-control stages reduces distortion in this part of the amplifier to vanishingly low levels. The power amplifiers feature what the manufacturer calls the "T-Circuit." In effect, this is a push-pull, direct-coupled amplifier comparable to the operational amplifiers used in analog computers. The negative feedback loop around the entire power amplifier section is effective down to d.c., resulting in negligible phase shift and distortion throughout the whole audio-frequency range covered by the amplifier.

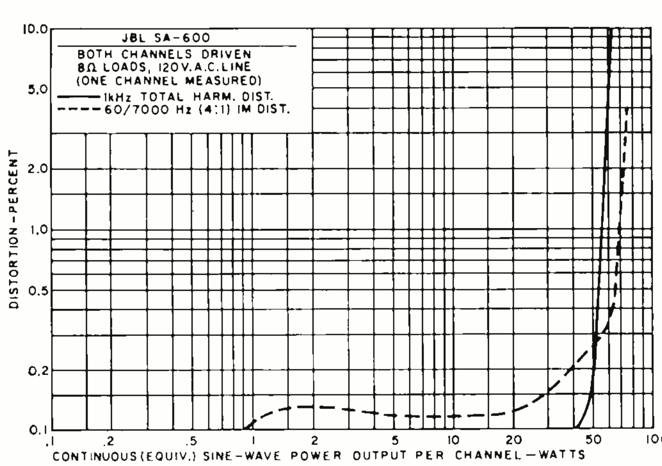
The power amplifiers, which use complementary-symmetry stages, are operated from balanced positive and negative power supplies, permitting direct coupling to the loudspeakers without blocking capacitors to limit response or degrade damping factor at the lowest frequencies. The output stages are designed to withstand short circuits while driven, with no effect other than a possible blown line fuse if the condition persists. *JBL's* confidence in the reliability of the SA-600 is evidenced by a two-year guarantee covering parts and labor.

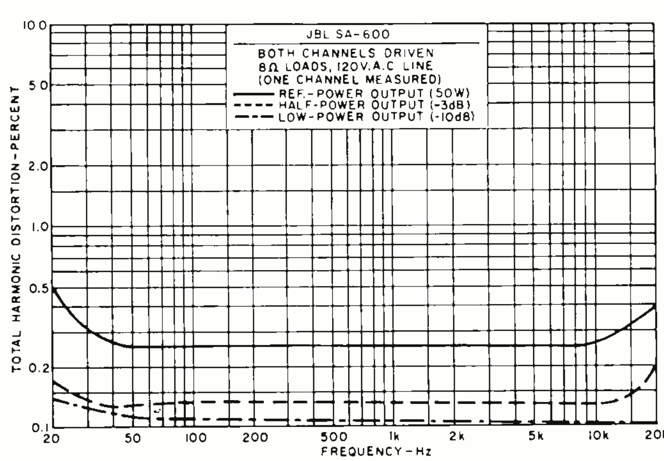
The design of the SA-600 is very simple, uncluttered, yet attractive. It has received awards for excellence from a functional standpoint. It has knobs for the essential controls: volume, balance, bass and treble tone controls, and the input selector. Toggle switches select loudness compensation, stereo/mono, tape monitoring, and a special balance test position. The latter switch connects the two speakers in series across the two outputs so that they receive the "difference" signal only. If a mono program is played through the amplifier in this condition, no signal will be heard when the two channels are in balance. The null is clearly audible and the adjustment is quicker and more accurate than the usual methods of channel balancing.

All the signal inputs and accessory sockets are located underneath the amplifier. The speaker connections are in the rear, recessed so that the amplifier can be installed with little or no wiring visible. The input selector has positions for tape head, phono, tuner, and auxiliary. A switch under the amplifier allows the tape head equalization to be changed to RIAA so that two magnetic pickups can be connected to the unit.

Performance specifications of the amplifier are most impressive. It is rated to deliver 40 watts per channel, both channels operating, from 20 to 30,000 Hz. The distortion is rated less than 0.2% at 80 watts total output (or less) from 20 to 20,000 Hz. IM distortion is rated at the same value. At one watt output (a usual listening level, where many transistor amplifiers have appreciably higher distortion), the SA-600 is rated for 0.1% total harmonic distortion or 0.05% intermodulation distortion.

There are extensive specifications on





Sony has developed the world's finest audio transistors...

here's the proof

Many manufacturers have made fairly good transistor amplifiers. Until now nobody has made a great one. And everybody knows the reason: distortion. Unfortunately, most transistor amplifiers distort in a very special way. Not so much at top power, but rather more at normal listening levels where it hurts most.

The Sony TA-1120 integrated amplifier and TA-3120 power amplifier are the first high-powered transistor units to really overcome the problem of distortion. At all power levels, at all frequencies distortion is kept below that of the finest tube amplifiers. The TA-1120 and TA-3120 both provide 120 watts IHF at 8 ohms, both channels operating. Distortion, at rated output, is 0.1%. And at normal listening levels it is even less, 0.05% at ½ watt. In addition, they have achieved an extraordinarily high damping factor, better than 70 at 1000 cps to assure clean, low-frequency power response. Frequency response is practically flat from 10 to 100,000 Hz (+0 db/—1 db). For safety's sake, an SCR (silicon controlled rectifier) protects the power transistors against accidental shorts and other overloads.

The integrated amplifier, the TA-1120 features a sensible arrangement of the front-panel controls for the greatest versatility and ease of operation.

We believe that these are the first great transistor power amplifiers. How can Sony do what other manufacturers couldn't? Sony is a pioneer in transistors. With first after first. Such as the tunnel diode. Transistor television. And the all transistor video tape recorder. The point is that Sony knows transistors. To the nth degree. And designed new, advanced types especially for the driver and output stages of these amplifiers. And silicon transistors are used throughout. They are the most stable. The TA-1120 integrated amplifier, $399.50. A handsome oil-finish walnut enclosure is optional. The power amplifier, TA-3120. $249.50.

Visit your Sony high fidelity dealer and make him prove that Sony is worth the money. Make him compare it with the finest tube amplifiers. We think you'll end up with a Sony. For a free brochure write:

All prices suggested list.

SONY® Corp. of America, 47-37 Van Dam St., Long Island City, N.Y. 11101 Dept. H hum and noise, transient response, overload recovery, and other parameters, which add up to a remarkable amplifier. It was evident that the residual distortions of our test instruments would be the limiting factor in many of our measurements. A preliminary check confirmed this, as the residual distortion in our instruments was approximately 0.1%. The harmonic distortion we measured was less than 0.1% up to more than 40 watts per channel, into 8 ohms. Its power into 16-ohm loads is about 80% of the rated 8-ohm level, while it will deliver 150% of rated power into 4 ohms for brief periods of time.

The curve of distortion *versus* frequency at fixed power is usually performed at rated power. In this case, we could not measure any distortion at rated power, so we made this test at 50 watts output, measuring about 0.25% distortion over most of the frequency band. At half power or less, we were once more in the vicinity of the residual distortion of the test equipment that we employed.

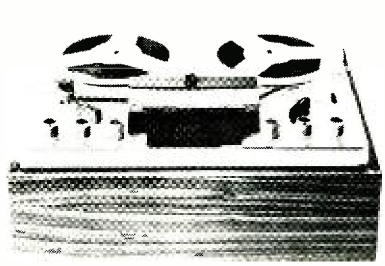
The frequency response was perfectly flat from 20 to 20,000 Hz. RIAA equalization was also well-nigh perfect, and NAB tape equalization had only a slight roll-off below 50 Hz. The amplifier has extremely high gain on all inputs, yet had the lowest hum and noise we have ever measured on an integrated amplifier. On the phono inputs it was 66 to 75 dB below 10 watts (better than 80 dB below full power), and on the high-level inputs it was an almost unmeasurable 100 dB below 10 watts. The uncanny quietness of the SA-600 was further proved when we connected a magnetic cartridge to it and, with gain at maximum, could hear no hum *or* hiss in the speakers.

In use tests, the amplifier was as good as one would expect. It was a truly transparent amplifier, with outstanding clarity. We appreciated the complete absence of noise, freedom from switching transients, and the overall silky smoothness of the operating controls.

Obviously, this sort of performance does not come cheaply. However, the *JBL* SA-600 is certainly worth every cent of its $345 (including cabinet) price tag. One can hardly imagine a significantly better amplifier, or one which will obsolete this beautiful instrument. ▲

Uher 9000 Tape Deck/Preamps

For copy of manufacturer's brochure, circle No. 27 on Reader Service Card.

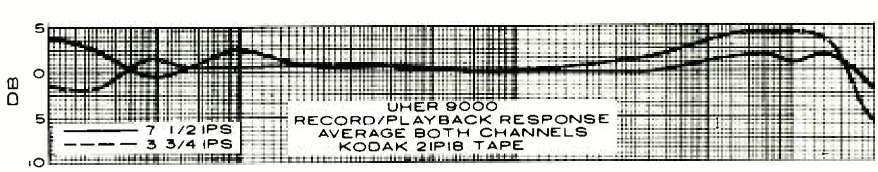


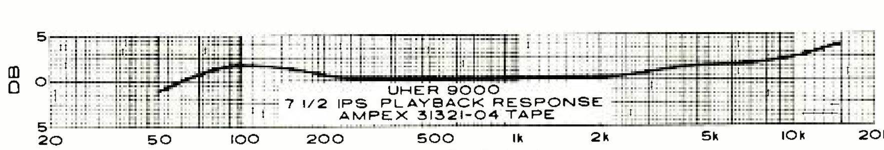
THE *Uher* 9000 stereo tape deck with matching preamps is compact, light (24 pounds), and unusually flexible. It is an all-solid-state, four-track, two-speed recorder, with three heads and independent stereo record and playback preamplifiers.

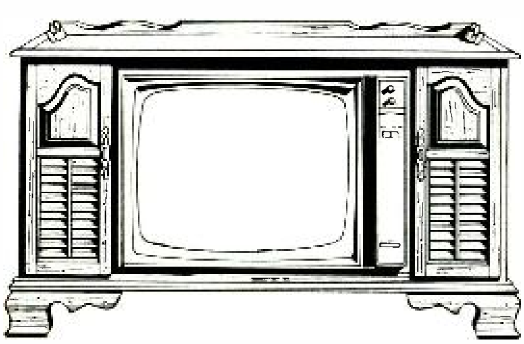
The unit is housed in a wooden case with a hinged plastic cover. The recorder has no speakers or power amplifiers and is intended to be permanently installed as a component in a high-fidelity system. It accepts reels up to 7 inches in diameter. A tape-tension arm minimizes flutter and actuates an automatic shut-off if the tape breaks or runs out. There is a four-digit counter with push-button reset. Turning the speed selector to either 7½ or 3¾ ips actuates the recorder which is then ready for immediate use.

The tape transport is controlled by piano-key levers. The pause lever stops and restarts the tape motion instantly. A red record-safety button must be depressed with the start lever to make a recording. An input selector switches the record-amplifier inputs to the radio, phono, or microphone inputs. Illuminated meters indicate the recording level. A momentary-contact push-button connects the outputs to either the input of the record-amplifiers or to the monitor head's playback amplifiers to facilitate comparison of the incoming program with that being recorded.

There is no playback level control







since this function is delegated to the external amplifier. It does, however, have a level control for the headphone monitor output.

The last control on the deck is a five-position function selector. It permits mono recording or playback on either channel, stereo operation, or "multi-play." The latter is the familiar sound-on-sound in which one channel is copied onto the other, together with new program material. Either channel may be so transferred to the other. The switching flexibility of the recorder makes this possible without requiring external patching cables

Among the many unique features of this recorder is a control which allows trimming the playback head azimuth to optimize reproduction of tapes made on other machines. An index mark simplifies returning this adjustment to its normal setting. In addition, there is a three-position switch that allows adjustment of the machine's playback equalization to either of two European playback characteristics or the NAB curve.

In our laboratory measurements, the over-all 7½ ips record/playback frequency response was within ± 2.5 dB from 20 to 20,000 Hz on one channel. The other channel had a similar response to about 13,000 Hz and dropped off to −6 dB at 20,000 Hz. At 3¾ ips, the first channel was within ± 2.5 dB from 20 to 3500 Hz, rising to +7.5 dB at 13,000 Hz and falling to −2.5 dB at 20,000 Hz. The second channel was within ± 2.5 dB from 20 to 13,000 Hz. Needless to say, this is excellent response for a recorder operating at 3¾ ips. The playback response at 7½ ips with the *Ampex* 31321-04 tape was within ± 2.5 dB from 50 to 15,000 Hz.

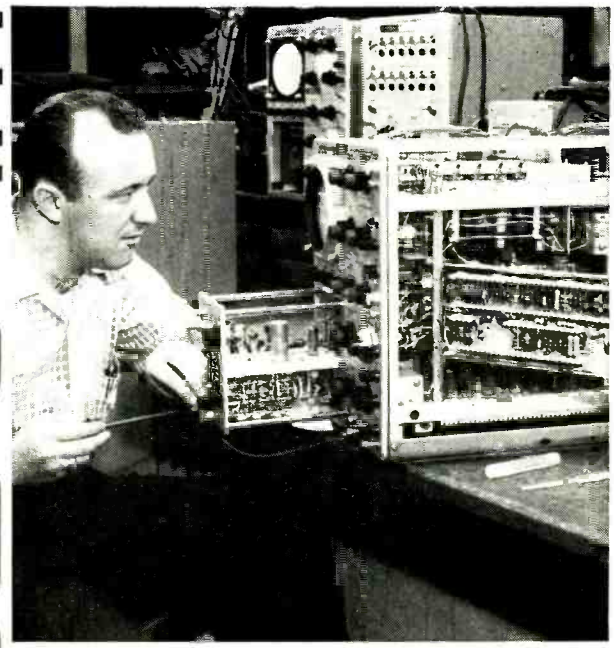
Wow and flutter were 0.05% and 0.085%, respectively. The signal-to-noise ratio was about 45 dB, with the noise consisting almost entirely of hiss —hum was very low. The distortion (combined record/playback) was quite low for recording levels of −5 dB or less; at 0 dB the over-all distortion increased.

All the inputs and outputs, located in the rear, use European connector jacks whose mating plugs are not readily available in this country. The jacks are identified by symbols whose meaning we determined only after reference to the schematic diagram of the recorder.

The recorder is basically an excellent machine whose full potential would be realized with a somewhat clearer instruction manual. We understand that such an improved manual is being prepared and will be available to all future purchasers.

The *Uher* 9000 tape deck/preamps instrument sells for $400.00. ▲

TAKE THE FIRST BIG STEP TOWARD A REWARDING CAREER IN ELECTRONICS



Mail card to RCA Institutes today

Thousands of well paid jobs for Electronics Technicians are unfilled now

RCA Institutes Can Train You—At Home—And Help You Qualify For This Work

It's a sad, but true, fact that today, with so many men yearning for better jobs and better incomes, thousands of well paid jobs are unfilled in the vast electronics industry.

Many of the men who could fill these jobs—that is, men with the aptitude and native interest to enjoy a career in electronics—are handicapped because for one reason or another they have not had the opportunity to train themselves for these lucrative positions.

This technician controls the audio portion of the program.

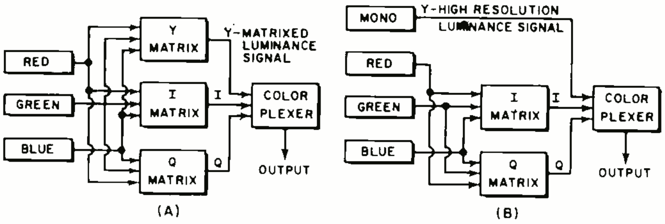


Fig. 1. (A) Operation of a three-tube color camera. (B) In a four-tube camera, luminance is generated independently.

could be tolerated in a monochrome television system.

Synchronization timing error must be reduced to a minimum. For example, the maximum timing error of vertical framing that can be tolerated during a program switch cannot exceed the time of half a TV line, or 32 microseconds. On special effects, dissolves, wipes, etc., the timing tolerance on kinescope blanking must be maintained within .05 microsecond to avoid visible picture shift on the home screen. Finally, in color TV, the phase of the 3.58-MHz color subcarrier during such an operation must be maintained to within 3°, or approximately 3 nanoseconds, to avoid a noticeable shift in color.

A typical color studio will contain one or more color cameras, color VTR's, a film or slide pickup, and, in the case of network operations, a remote feed input. Each piece of electronic equipment must be supplied with various electrical signals such as blanking, burst flag, sync, and horizontal and vertical drives. As each piece of equipment is located at the end of various lengths of interconnecting cables, each cable must be provided with delay networks so that all electronic equipment will be in exact phase relationship.

The system gets even more complex when more than one studio is to be used. A practical limit for such "piggyback" operations for even a large network station is three studios. Beyond this number, the switching of the delay networks, coupled with the possible video delays, becomes inordinately complicated and expensive. The addition of new distribution amplifiers, new cameras and film chains, or any other change that may affect pulse or video timing must be very carefully studied. The mixing of cameras of different manufacture or the integration of color and monochrome cameras can create knotty problems.

Color Cameras

There are two basic color cameras in use at present. These are the three-tube and four-tube varieties. Operation is shown in Fig. 1. In the three-tube version (Fig. 1A), three image orthicons are used to generate the *I*, *Q*, and *Y* (monochrome) signals. This system has been used for many years and has produced quite acceptable color pictures. However, there are some disadvantages. Unless the three image orthicons are exactly aligned (registered) as far as optics and sweep linearities are concerned, the picture as received on a black-and-white color set will be somewhat blurry, while the color pictures received on a color set will be edged with color fringes. A considerable amount of research and experimentation has gone into trying to produce a better three-tube camera.

With the introduction of the separate luminance channel four-tube color camera (shown in Fig. 1B), much better monochrome and color pictures have resulted. Details of the operation of the independent-luminance color camera are explained fully in the Cover Story, page 30.

Because of the advantages of the four-tube camera (cost notwithstanding, which can reach as high as $75,000), it is very probable that most color pickups of the future will use this system.

Modern color cameras employ slightly different lensing than the older cameras. Now, zoom lenses having ranges of 10:1 are in common use in studios and are utilized almost exclusively in outdoor programs. These lenses cost about $9000 each and are motor-controlled by the camera operator. However, in the area of "soap operas" and some panel and interview shows, the turret-lens system, with its necessary close-up lens, is used.

In most outdoor sports programs (baseball, football, etc.), optical "range extenders," special long-range zooms having very long focal lengths are used to cover the very large areas involved. Three types of optical range extenders are employed, which vary from 2.4 to 24 inches, 3.2 to 32 inches, and 4.8 to 48 inches focal length. It is this latter lens that is used for those centerfield shots in baseball games.

Optical trimming filters to compensate for changes in outdoor light are not used because they result in some loss of light, especially in the late afternoon. Indoor sports are usually played under fixed lighting conditions, and these lights are balanced for proper video reproduction. Sufficient control is provided by the camera and studio electronics to compensate for any color changes occurring during a game. These controls also adjust for dark, rainy day or other types of poorly illuminated coverage.

Color-Film Pickups

A modern color-film pickup is essentially similar in operation to the four-tube independent-luminance color camera shown on the cover and explained in the Cover Story. The major electronic difference is the use of four vidicons, with the luminance channel using a special larger vidicon rather than the type of image orthicon employed in the camera. Like the camera, the color-film pickup has provisions for disabling the chroma vidicons for extended periods of monochrome operation. Resolution of the film pickup is 800 lines minimum at the center, reducing to 700 lines minimum at the corners.

Table 1. The growth of network color-television program hours during the period from 1954 through 1967.

	1954	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64	'65-'66	'66-'67
NBC	68	216	486	647	668	725	1035	1650	1910	2150	2135	4200	4500
CBS	46	46	74	53	24	10	5	—	—	4½	4	800	2000
ABC	—	—	—	—	—	—	—	—	35	120	200	600	1500

Automatic electronic circuits constantly monitor the output signals and can provide white- and black-level corrections to compensate for density variations in slides or motion picture film.

The film projector employed in conjunction with the electronics is a high-quality unit using a color-corrected light source for film illumination and a special mechanical arrangement to convert the film frame speed to that required for color TV. Special lenses are provided to convert the "wide-screen" type of film to the 4:3 aspect ratio needed in television.

Color VTR

The video tape recorder (VTR) as used in color broadcasts is essentially the same high-speed (1500 ips), four-head, transverse system amply covered in past issues of this magazine. The color VTR differs in that it includes an automatic timing corrector to remove any residual jitter or timing errors that would disturb the extremely phase-and-amplitude-sensitive color signal. Such errors can occur due to any skewing, quadrature distortion, or jitter present on the recorded tape. A higher FM deviation frequency is used in the playback system to reduce any moiré "beats" and improve the signal-to-noise ratio.

In the event of tape "dropout" caused by irregularities on the tape surface which appear as streaks on the TV screen, a special circuit incorporating a one-scan-line delay (storage) line automatically supplies the video signal by substituting the stored information from the previous scan line. The viewer will not be aware of the substituted signal because of the similarity between successive scan lines. The stored video is supplied on demand through a fast-acting diode switch. A sensing circuit in the dropout compensator continuously monitors the output signal and actuates the diode switch whenever a dropout occurs.

Special alignment tapes containing both monochrome and color test patterns and test signals are used to keep a constant check on the VTR.

Color Control

A considerable number of behind-the-camera people are responsible for a show that may have only one performer or have many performers. In over-all charge is the director who has prime responsibility for the entire production in lighting, video, and sound. It is he who issues the orders and acts as the general to the army.

Below the director is the technical director who is responsible for proper over-all color and black-and-white operation. It is the technical director who switches cameras on cue from the director.

Below the technical director is the video supervisor (called "Captain Video" in the trade) who acts like a first sergeant by overseeing all cameras at the request of the technical director and who is also responsible for making sure that all color cameras are equally matched before the program starts.

At the camera itself is the camera operator who has control of camera focus and luminance level (color cameras use a monochrome-camera electronic viewfinder, as the chroma burst is not inserted until the composite signal has entered the control room). The camera operator also sets up his camera field of view to meet the requirements of the program director.

When a color studio is first put into operation, the lighting director sets up the studio lighting in accordance with the program needs. Then the technical director fits the required lenses to the cameras in use and has each camera adjusted to black-and-white test patterns covering *gamma*, resolution, and distribution (linearity) patterns. Meanwhile, in the control room, an electronically generated color test pattern (containing bars of *I*, *Q*, *R*, *B*, *G*, yellow, cyan, and magenta) is used to set up the various color monitors

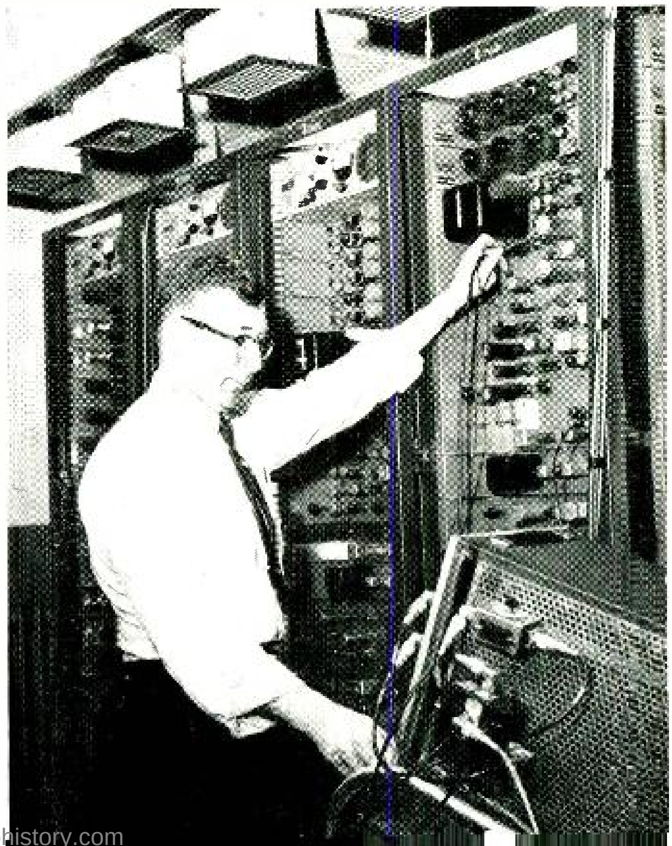
The people responsible for the general studio operations, camera switching, and program control use the control room as their base of operations. They are in constant touch with every phase of operations during the program being televised.

in conjunction with a vectorscope and oscilloscope to make sure that all monitors are operating correctly. As no color burst is supplied to the camera electronics, it only reproduces a black-and-white picture. However, once the camera is in balance for a good monochrome picture, its chroma components are then approximately correct and only need minor adjustment.

The cameras are then placed in close proximity to each other and all are simultaneously focused on a "color girl" for exact chroma alignment. This is the industry-wide procedure for making the final chroma touchups to the cameras.

The "color girl," usually a fair-skinned strawberry blonde, wears a bluish dress having a neutral color near the neck to avoid unwanted color reflection on the neck and chin. Each camera sees the girl from approximately the same angle and same illumination level. The video supervisor then adjusts the chroma components of each camera so that each camera and associated monitor show the identical

The awesome array of electronics required for proper color operations requires steady maintenance using the very latest in test equipment. Here a technician adjusts a colorplexer.



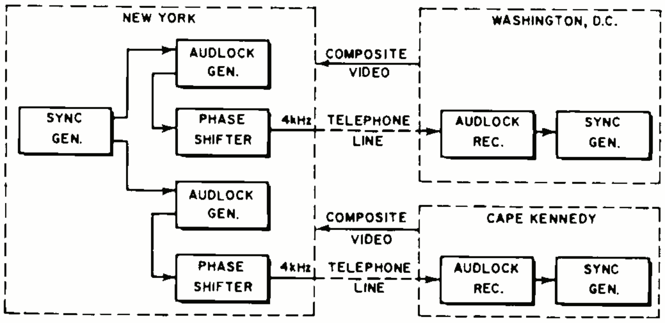


Fig. 2. The remote sync generators have their outputs controlled by a variable-phase audio tone so that all stations are in exact sync regardless of the distance between them.

image coloration. The cameras are then ready to go "on the air" for either live or taped telecasts.

Illumination

In studio operations, it is not important what type of light is used, provided it is sufficient to produce good scene illumination and is not a mixture of daylight and incandescent lamps. These two types of lamps produce different light characteristics as they have different light-emitting frequencies.

The amount of light falling on the subject rather than general scene illumination is measured, using a commercial light meter. In the event of a slight lack of light, the camera lens iris can be opened and the camera electronics can be adjusted to compensate.

Color Transmitter

Very little happens to the parameters of the color signal at the transmitter and antenna system. The transmitter manufacturer guarantees that his transmitting system will conform to FCC specifications for color broadcasting. However, a vector oscilloscope is used at the transmitter video input, in conjunction with a color test pattern originating at the studio, to insure that there are no phase errors occurring in the transmission of the signal from the studio to the input of the transmitter. The transmitter and antenna system is tested at frequent periodic intervals for compliance with FCC color specifications.

When a transmitter does not function according to the specs, then maintenance is performed during non-program hours to bring the transmitter up to performance standards for the next broadcasting day.

Color Problems

Quite often, when a televised color program is being viewed, some slight color differences can be seen between color cameras located within the same studio, between tape and/or film recorded pickups, and between local and remote live pickups.

In fact, it is sometimes possible to see a slight change in color as a person passes in front of a camera. Some of this slight change is caused by a barely measurable variation in brightness (illumination) on the subject, which in turn will appear to the viewer as a small color change. Note, for example, that on a color receiver, a slight alteration in brightness control setting will produce a slight change in subject color, even though the chroma controls are not touched. Some other effects are caused by a possible optical illusion produced by changes in background color as the subject crosses the stage. Additional effects are caused by other phenomena such as polarization of light reflected off the subject under certain circumstances. As an example of this, when a person having dark hair is backlighted, slight green streaks will appear in the hair.

Other color problems arise because of the extreme difficulty in matching the lighting and camera setup conditions exactly from scene to scene or between two or more studio locations. This is particularly true when switching between cameras viewing a scene in a controlled illumination studio and another camera viewing an outdoor scene having direct sunlight and shade interference.

Quite often, some small color differences are noticed when a local studio switches to a remote studio that may be located hundreds or thousands of miles away. Such differences occur because of the near impossibility of exactly matching illumination levels between the studios, because of slight variations in camera or tape machine electronics, and as a result of slight differences in the color engineers' response to color.

The difficulty in maintaining proper color balance between local and remote studios becomes even more complex when it is considered that parts of the program may be traveling along an intermixed coaxial and microwave relay system that is several thousand miles long. This system is leased by the network from a common-carrier supplier and all precautions are taken to insure that a minimum of differential phase and/or amplitude error creeps in.

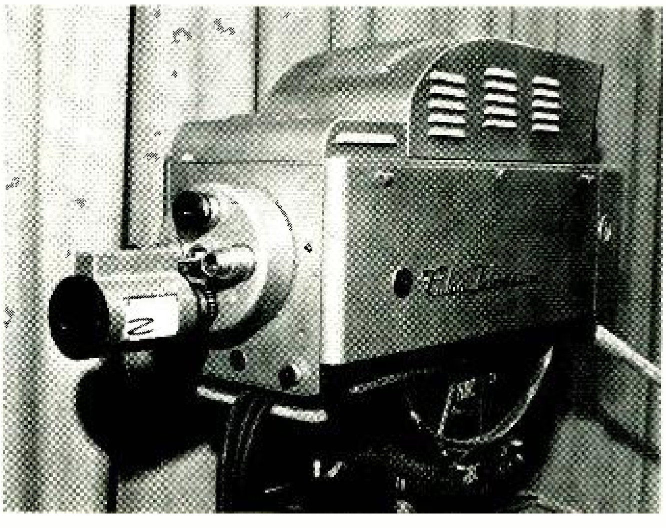
Color quality is usually measured three times daily—morning, afternoon, and evening. Network stations transmit a special vertical-interval monochrome and color test signal during all network broadcasts. This signal takes up two of the 525 lines required in the raster generation and occurs during the vertical retrace interval, out of sight of the viewer. Network affiliates use special test equipment to extract this signal from the program material at prescribed time intervals, analyze it, and photograph it for their program records. If at any time the vertical-interval test signals show that the color signal coming from the network is not up to standard, then the long-line maintenance section is notified to begin corrective measures.

Interested viewers can inspect this vertical-interval test signal by adjusting the vertical hold control of their TV set until the horizontal, black vertical-interval bar is in view. The test pattern is a series of white dots and bars located two to three scanning lines before the beginning of the picture. A detailed analysis of this test signal will be found in the April, 1964 issue of this magazine.

It often happens that a program may consist of material originating at several extremely remote studios such as Washington, D.C. and Cape Kennedy, Florida, with program control required in New York. In such a situation, it is necessary to switch and dissolve to each pickup point without picture disturbances.

The basic problem is to time the program sources from Washington and Cape Kennedy to arrive in New York coincident with the New York sync (*Continued on page* 68)

A typical color-TV studio camera uses a selection of lenses including the zoom type. All are controlled by the camera operator who is, in turn, controlled by the program director.



Carrier Generator for SSB Reception

By C. DOUGLAS RASMUSSEN
Syracuse University Research Corp.

Design of a stable variable-frequency r.f. oscillator to be added to communications receiver for better SSB operation.

SINGLE-SIDEBAND communications have increased by leaps and bounds in the past several years. This popularity, partly a function of necessity, encompasses amateur radio as well as commercial and marine communications. This article describes a technique and a device capable of providing SSB reception capabilities for receivers without internal beat frequency oscillators and for receivers whose local oscillators exhibit poor frequency stability.

A carrier is generated by a simple, one-transistor, battery-operated oscillator and, after attenuation, is added to the incoming sideband at the receiver antenna jack. SSB capability can be added to a receiver not normally capable of SSB reception, without receiver modification.

The circuit described, actually a variable frequency oscillator replacing the receiver's b.f.o., provides coverage for SSB demodulation in the 80-, 40-, and 20-meter amateur bands. This same circuit configuration, powered by a single flashlight cell, has been used from 2 to 25 MHz.

Conventional AM receivers have been used for years for SSB demodulation. The most important aspect of carrier replacement at the receiver is the relative position of the carrier with respect to the sideband. For optimum results, the frequency of the carrier reinserted at the receiver must be within 20 Hz of that of the transmitter. If the replaced carrier is within 50 to 100 Hz for voice modulation, the demodulated audio will remain intelligible but will be irritating to the operator's ears. Any deviation beyond this will cause the voice to sound "garbled" or inverted.

R.F. Insertion Technique

The receiver's detector will see a conventional AM signal (missing one unimportant sideband) if the "SSB carrier" is replaced at the i.f. with a b.f.o. or at the r.f. with a variable frequency oscillator. If replaced at the i.f., the carrier's relative position will change with b.f.o. and l.o. frequency changes. Small amounts of l.o. drift during a transmission can be compensated by b.f.o. adjustments. Continual adjustments or "riding" of the b.f.o. will not produce satisfactory results if the l.o. drifts appreciably. SSB demodulation is, of course, impossible if the receiver is not equipped with a b.f.o.

If the missing carrier is properly added to the incoming sideband signal at the receiver's antenna input, the all-important positioning relationship between the carrier and sideband will not be altered by receiver l.o. drifting. The entire receiver will see a conventional AM signal and will demodulate it accordingly. An SSB carrier generator, shown in Fig. 1, reproduces the "SSB carrier" in the radiotelephone portion of the 80-, 40-, and 20-meter amateur bands (3.8 to 4.0, 7.2 to 7.3, and 14.2 to 14.3 MHz). The generator is a low-level oscillator tunable over these bands.

The variable-frequency oscillator used as a carrier generator is of the Colpitts type and employs a single silicon transistor in a grounded-base configuration. Feedback is achieved by way of capacitors *C3* and *C4*. The main frequency-determining components are: inductors *L1*, *L2*, and *L3*; capacitor *C5*; and variable-capacitance diode, *D1*. Resistors *R9*, *R10*, and *R11* are used to set the tuning range in their respective bands.

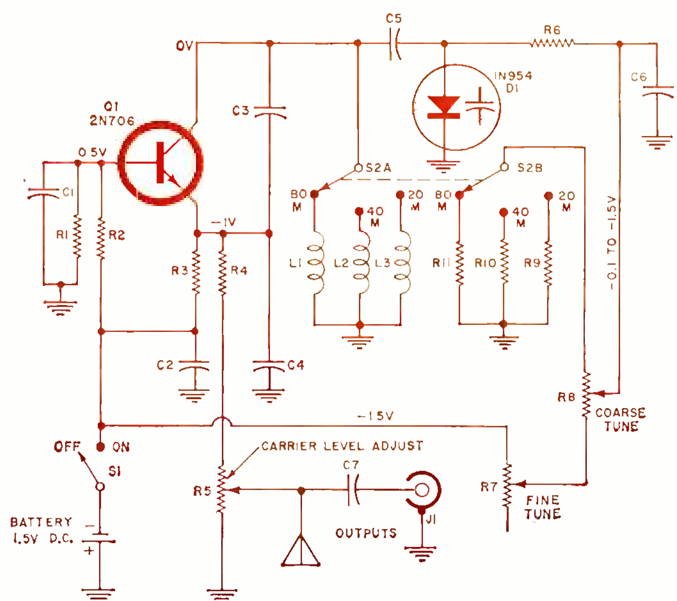
D1 is a diode whose capacitance changes as a function of the d.c. bias applied. This bias and the frequency of oscillation are varied by the potentiometer *R8* ("Coarse Tune") and *R7* ("Fine Tune"). Switch *S2* ("Band Select") selects the proper band and *R5* ("Carrier Level") varies the generator's output level.

The carrier generator can be connected directly to the receiver's antenna jacks in parallel with the antenna, or the carrier can be "transmitted" by way of a small antenna or loop of wire to the receiver.

Alignment is accomplished by adjusting inductors *L1*, *L2*, and *L3* in their appropriate bands. These adjustments are made such that the tuning range of *R7* and *R8* will provide complete coverage for each of the three bands.

Operation of the carrier generator is much the same as that of a conventional receiver b.f.o. With the carrier generator interconnected, tune the receiver until an SSB signal has been intercepted. Select the proper band and slowly advance the "Coarse Tune" control from its c.c.w. position until the injected carrier is within the receiver bandpass. Now adjust the "Carrier Level" until the effect of the injected carrier is just noticeable. Readjust the "Coarse" and "Fine Tuning" controls for the best sounding audio. ▲

Fig. 1. Diagram of three-band variable-frequency oscillator.



R1,R3,R11—510 ohm, 1/4 W res.
R2—1800 ohm, 1/4 W res.
R4,R6,R9—10,000 ohm, 1/4 W res.
R5—500 ohm pot
R7—250 ohm pot
R8—10,000 ohm pot
R10—3900 ohm, 1/4 W res.
C1,C2,C6—0.05 μF, 3 V capacitor
C3,C7—51 pF mica capacitor
C4—220 pF mica capacitor
C5—100 pF mica capacitor
D1—1N954 "Varicap"
L1—14-28 μH inductor (J.W. Miller 9053)
L2—3-7 μH inductor (J.W. Miller 9051)
L3—1.5-3 μH inductor (J.W. Miller 9050)
J1—Coax or phono jack
S1—S.p.s.t. switch
S2—D.p. 3-pos. switch
Battery—1.5 V flashlight cell
Q1—2N706 or 2N3564 transistor

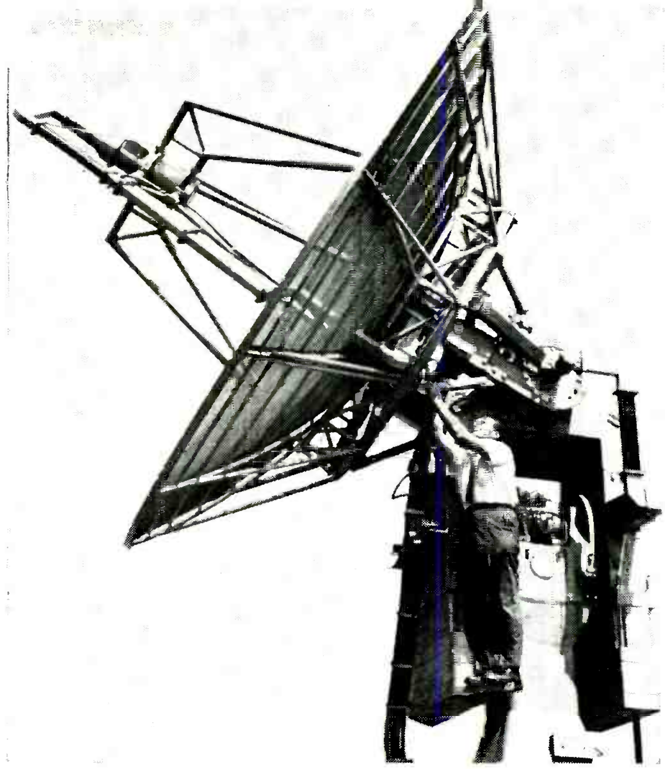
RECENT DEVELOPMENTS IN ELECTRONICS

Three-axis Laser Gyroscope. (Top left) The world's first operational three-axis laser gyro has been delivered to the Navy for tests of the system's ability to precisely sense a ship's roll, pitch, and yaw. These affect the accuracy of naval radar and gunfire. Because the laser gyro utilizes a wholly new principle—two intense beams of coherent light rotating in opposite directions—to sense rotational motion, there will be no friction-caused drift problems encountered in conventional gyros. The laser gyro, developed by Honeywell, has no moving parts and provides a digital output. Instead of using fragile glass tubes and adjustable focusing mirrors, as in laboratory lasers, this unit uses fused quartz blocks for ruggedness, long life, and ease of replacement. The triangular path through which the helium-neon gas beams pass is machined by a special precision technique. Motion in one axis changes the apparent distance each beam must travel, causing a difference in the frequency at which each beam oscillates. The frequency difference is detected by two photocells.

Laser Therapy. (Center) Using intense coherent infrared radiation produced by a laser, Dr. Robert Wilson of the University of Cincinnati Medical Center treats a patient's birthmark as part of a research project at the Center's laser laboratory. The laser emits a series of light pulses lasting from one to two milliseconds that are absorbed by the pigmented tissue only, limiting the area treated. A special attachment shaped like a bent arm is used for directing the red ray. Since conventional mirrors don't reflect the invisible ray, the arm uses a built-in gold mirror developed by Western Electric. The mirror reflects more than 90 percent of the laser's output energy. Doctors hope laser treatment will eventually provide an almost painless method for quickly removing tissue that is ailing, as in cancers and tumors, or that is unattractive.

Mobile TV Studio. (Left) Television station KUON, channel 12, the University of Nebraska's educational TV outlet, has taken delivery of a mobile television van at a price of $184,000. The station will use the mobile teleproduction studio for extensive on-location productions using professional crews. Programs produced by the station will be shown over the state-wide educational TV network, which now has stations in Lincoln, Omaha, and Lexington. The University's network will be expanded to seven stations to cover all of Nebraska and parts of Kansas, Iowa, South Dakota, Wyoming, Missouri, and Colorado. Initial assignment for the van is the production of 90 documentary shows; 30 for Project Head Start, 30 for a historical series on Nebraska, and 30 for exceptional children and rapid learners. The van contains three monochrome TV cameras, a video tape recorder, an audio recorder, in addition to a control console, associated camera and synchronizing equipment, monitors, and an internal communications system. Power is obtained from local power lines or from a trailer-mounted electric plant. The unit, supplied by Ampex, can beam a TV signal by microwave to stations in the network.

Moon-bounce Communications. (Right) This 16-foot diameter dish antenna, after installation aboard ship, will be used to transmit teletypewriter messages from ships at sea to the moon. The messages then bounce off the moon and are received by shore-based stations. The new system, delivered by Lockheed Electronics Co., gives the Navy reliable, long-range, ship-to-shore communications. By using the moon as a passive reflector, advantage is taken of microwave techniques to overcome conditions in the atmosphere and ionosphere which interfere with long-range communications at medium and high frequencies. A television system, with a zoom lens camera, provides a means of monitoring and verifying antenna position.



Portable Video Disc Recorder. (Center) A portable magnetic disc recorder is now widely used by U.S. and European television networks to insert instant video replays, including stop-action still pictures, into live sports telecasts. This recorder has now been adapted by its manufacturer, MVR Corp., for a broad range of scientific, medical, and industrial applications. The new device stores up to 20 seconds of signals from a live TV camera on the top surface of a 12-in aluminum disc coated with a nickel cobalt recording medium. The 20-sec recording can be immediately played back for the TV audience as a continuous sequence or as stop-action pictures. Cycling from record to playback requires 1/5 second.

Computer-interconnected Integrated Circuits. (Below left) A section of a 1¼-in diameter silicon wafer shown here illustrates an automated technique for interconnecting scores of tiny monolithic integrated circuits while bypassing faulty ones. After the circuits, each containing five transistors, have been formed on the wafer, an automatic device tests each of them and records the results on punched cards. This information is then fed to an IBM computer which calculates an interconnection pattern that avoids faulty circuits on the wafer and connects good circuits to perform the desired function. Actual connections can then be drawn under computer control.

Ultrasonic Thickness Indicator. (Below right) This portable ultrasonic thickness indicator provides an immediate numerical readout of metal thicknesses from 0.10 to 9.99 inches. Designed for both field maintenance and in-plant inspection, it is used to measure corrosion, erosion, and thickness of interior walls of process vessels, condensers, pipe, engine blocks and cylinder walls, and other metal structures. The instrument, made by Budd Instruments, uses ultrasonic pulses reflected from the material being checked to determine its thickness. These pulses determine the width of a gating signal, which in turn operates a precision oscillator for a period of time directly related to material thickness. Counter circuits then count these oscillations and display the count in terms of thickness readings, accurate to within ±0.02 inch.

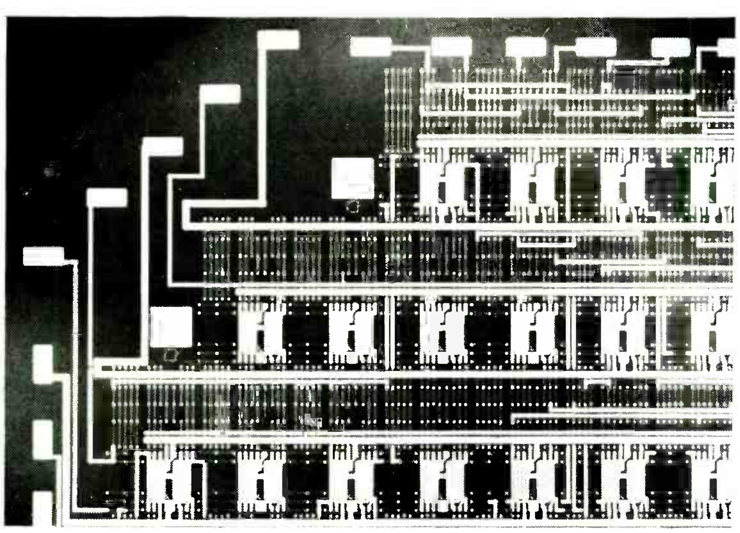


Fig. 1. The new G-E "Micro-Mustang" uses a single-IC amplifier.

FIRST Integrated-Circuit Phonograph

By A. F. PETRIE
Advance Development Engineering
General Electric Co.

Technical details on the first mass-production phono in which a single IC takes the place of all active components. Circuit includes 6 transistors, 6 resistors, and a diode in chip about 50 thousandths of an inch square, and produces 1-watt output.

THE first mass-production phonograph in which all of the transistors in the amplifier (along with several resistors and a diode) have been diffused into a single chip of silicon is the new *G-E* "Micro-Mustang". No, the phonograph isn't any smaller because integrated circuits have been used (see Fig. 1) because the records and changer still determine the size of the cabinet. Integrated circuitry was introduced in this set in order to pass the benefits of this new technology along as soon as it was feasible. These benefits include reliability of performance, competitive cost, and simplicity of assembly of the complete product by the manufacturer.

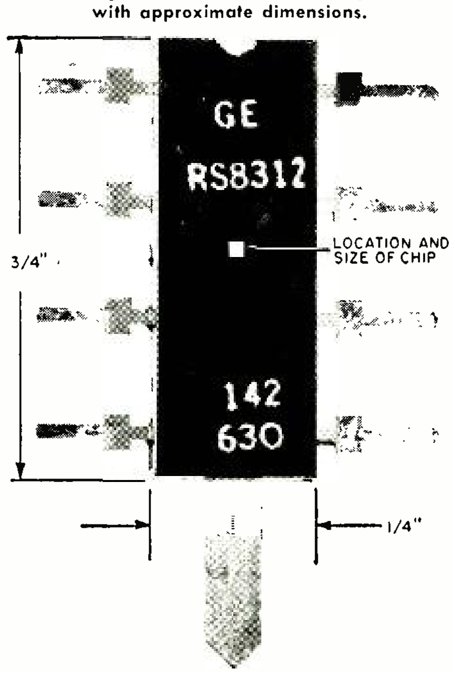
400 Watts/Square Inch

To remain competitive these days, even a small phonograph must have a power output of at least one watt. This unit delivers about 1½ watts music power or ¾ watt continuous power at no more than 5% distortion. Even with an efficient class-B circuit, this means that between one-half and one watt will have to be dissipated as heat in the amplifier, depending on tolerances, such as the saturation resistance of the output transistors. All of this power, which is normally divided between two output transistors and several resistors, must now be dissipated by a single chip of silicon approximately 50 thousandths of an inch square. This amounts to 400 watts per square inch.

When this program was started three years ago, no one had an economical solution to the problem of getting the heat out of the chip, so *G-E* developed a package and mounting that would do the job. The IC chip is mounted in a plastic encapsulated flat pack that looks like a rectangular bug with a big tongue sticking out one end (see Fig. 2).

The silicon chip is fastened to the tongue, which carries the heat out of the chip and into the printed-circuit board to which it is soldered. The legs of the "bug" make the several connections between the chip and external components such as controls, power supply, and electrolytic capacitors. The package is designed for 14 leads, but only 8 are used in this amplifier. The extra leads are removed, leaving a spacious 0.2 inch between the remaining leads.

Fig. 2. Photo of IC used along with approximate dimensions.



Positive Temperature Stability

This is probably the first amplifier to achieve true temperature stability. As temperature increases in the amplifier, the idle current in the output stages actually decreases, reducing heating. There is no such thing as "thermal runaway" with this amplifier. It can still be destroyed by such things as shorting the output, but there is no temperature at which the amplifier will run away with itself.

As an example, an amplifier from a "Micro-Mustang" performed well in an oven beyond 100° C (212° F) at a 0.4 watt output. (Maximum dissipation in a class-B amplifier occurs at around 40% of the maximum output.) The heatsink tongue was measured at 125° C and the junction temperature must have been well beyond the 150° C maximum rating. This is a bit extreme since the phonograph records would have melted at 65° C.

This unusual performance is due to three factors: (1) There is a d.c. negative-feedback path between the base of the lower output stage and the base of the input stage. Thus the base-emitter diode voltage (and hence the idle current) of the output stage is controlled by the base-emitter voltage of the input stage. Since the current density in the input stage is lower than that of the output stage, the input base-emitter voltage has a larger temperature coefficient which overcompensates for shifts in bias due to temperature. This reduces the idle current at high temperatures and increases idle current at low temperatures. (2) Both base-emit-

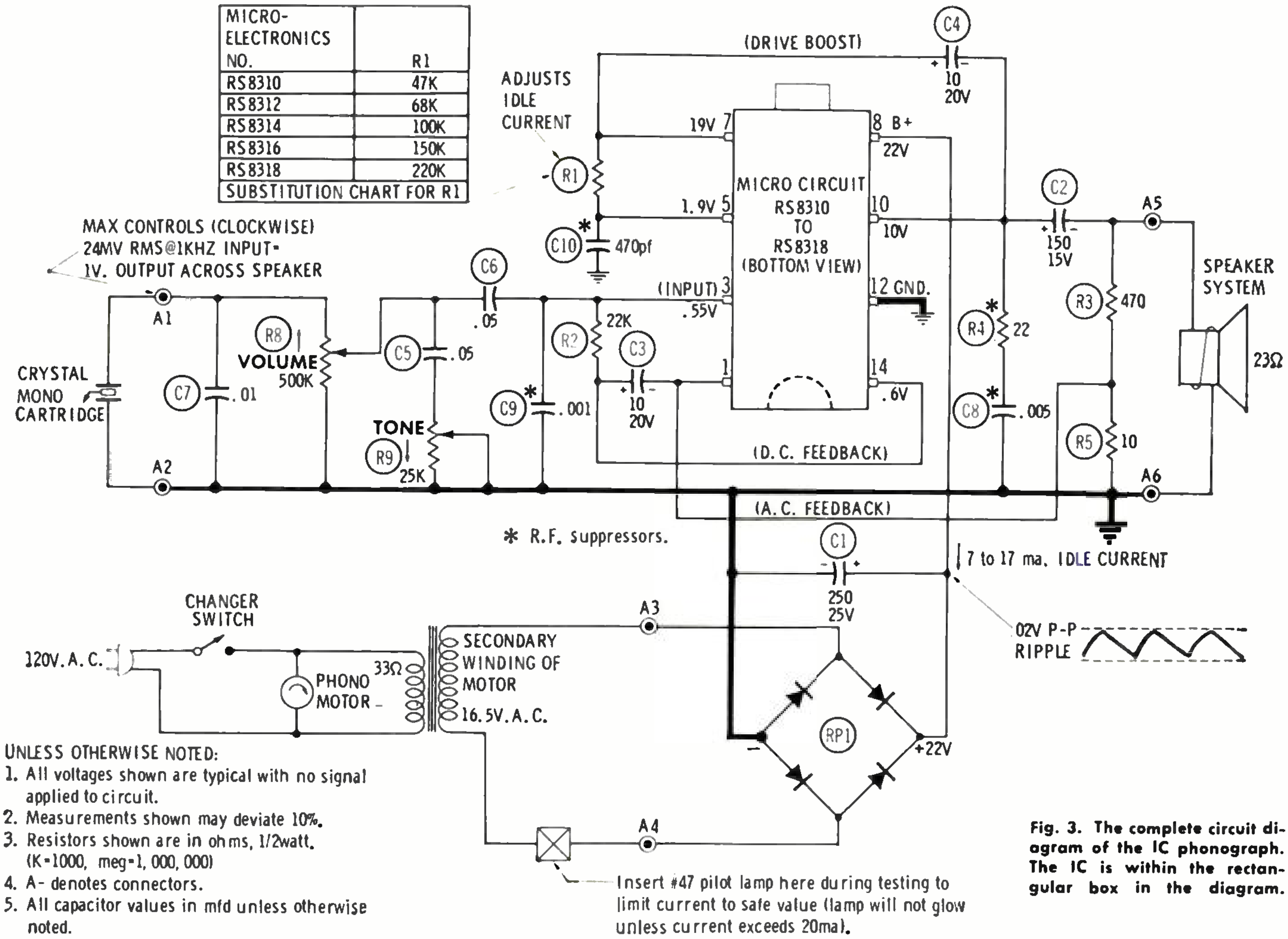


Fig. 3. The complete circuit diagram of the IC phonograph. The IC is within the rectangular box in the diagram.

ter junctions are at the same temperature since they are in the same silicon chip. (3) The junctions are matched since both are diffused in the same step. Thus, improved performance is obtained by making wise use of some inherent characteristics of integrated circuits.

Special Circuit Requirements

Not all of the inherent characteristics of integrated circuits are as easily turned to advantage. For one, it is no longer possible to sort transistors for gain and mix them in different stages to always come out with the same over-all gain. Since all of the transistors are diffused in the same step, all will be low gain or all high gain, resulting in a possible open-loop gain variation of 600 to 1.

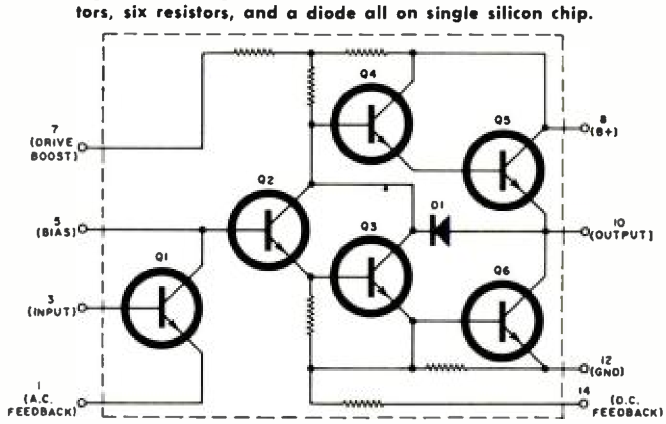
This is taken care of in several ways: (1) Two extra emitter-follower stages are added to insure sufficient gain when all transistors are low on gain. (2) A.c. negative feedback is applied from a voltage divider across the output to the emitter of the input stage to stabilize voltage gain. (3) The collector load resistor of the input transistor is adjusted to stabilize bias conditions. This controls the idle current in output stages through the d.c. feedback path mentioned previously.

Because the transistors in the circuit are small epitaxial units, their gain-bandwidth product extends into the v.h.f. region. The generous sprinkling of r.f. suppressors that are found in Fig. 3 are necessary to stabilize the amplifier and restrict its response to below 500 kHz.

The input circuit (Fig. 3) is a bit unusual. Since the amplifier has a low-voltage, low input impedance, the cartridge has been shunted with a 0.01-μF capacitor to reduce its voltage and impedance. The volume control is connected to give a loudness-control-type action, boosting the bass at low levels and cutting it at maximum volume.

Let us now look at the integrated circuit itself (Fig. 4). Q1 is a common-emitter amplifier with negative feedback applied to its emitter. Q2 is an emitter follower, supplying drive to Q3 a split-load phase inverter. Q4 and Q5 are emitter followers which drive the speaker during the positive half of the output signal. Q6 is a common-emitter stage which drives the speaker during the negative half of the output signal. Transistors Q5 and Q6 thus form a conventional series-connected single-ended push-pull output stage. Diode *D1* is a latching diode to ensure full drive during the negative half of the output signal. Outboard capacitor *C4* (Fig. 3) is a boot- *(Continued on page 70)*

Fig. 4. The integrated circuit itself consists of six transistors, six resistors, and a diode all on single silicon chip.



THE COVER STORY:

A Modern Color-TV Camera

The camera shown on the cover represents the latest in four-tube systems in which luminance is derived from a separate channel. Here is a complete description of one of these modern cameras, the transistorized RCA TK-42.

TRADITIONALLY, color-TV cameras for direct pickup of live subjects have been three-tube cameras in which the red, green, and blue video signals are generated simultaneously by individual pickup tubes that have been very accurately registered both optically and electrically.

The monochrome signal is produced by the addition of the three color signals; therefore, the resultant monochrome picture sharpness is determined by the accuracy of the registration of these three tubes over their entire pickup area. Slight misregistration shows up as "soft" or somewhat blurry-edged monochrome images, while violent color fringes can be displayed on a color set in the most aggravated form. Such misregistration can occur if one or more of the pickup tubes have slightly different optical or sweep linearities.

The importance of controlling any misregistration has led to many parallel efforts by TV-camera manufacturers both here and abroad. Some research was aimed at developing novel color-camera concepts, while other projects concentrated on the stabilization of the circuits and components of the three-tube pickup system.

The latest concept of color cameras involves the use of a separate, high-definition pickup tube to supply only the monochrome (luminance) portion of the signal, while the red, green, and blue components that make up the chroma information are produced by three independent tubes that are almost completely divorced from the luminance channel. This greatly reduces the visibility of misregistration and any resultant blurry pictures.

The separate luminance channel provides two advantages over the three-tube system. First, the output signal, when viewed on a monochrome receiver, is equivalent in resolution, gray scale, and over-all quality to that obtained from the finest black-and-white cameras. Second, the high-resolution luminance component enhances the resolution of the color picture.

Historically, the concept of a separate luminance channel is old. A patent filed by Dr. A. N. Goldsmith on October 12, 1944 makes him the Columbus of the new world of luminance channel cameras.

One of the latest four-tube, independent-luminance color-TV cameras, the *RCA* TK-42, is optically diagrammed both here and on the front cover. This new low-profile camera is transistorized, thus reducing both bulk and power requirements, and uses a 4½-inch image orthicon for the luminance channel and three one-inch vidicons for the chroma channels.

The light path shown, although correct optically, is slightly rearranged from the actual layout in order to "open up" the system for greater clarity. The photo at the lower right on the front cover shows the camera exterior.

Light from the scene being viewed enters the camera lens system, with its adjustable iris. This lens system is similar to that found in conventional film cameras. The light then passes through an orbiting wedge before reaching the beam splitter. The orbiting wedge is a round glass plate having non-parallel sides and which is slowly rotated by a low-speed motor. As the orbiting wedge is rotated, the image passing through it slowly rotates in a minute circle. This is done because if the highly sensitive image orthicon is left focused on a bright stationary pattern for some period of time, a "memory" occurs and remains on the orthicon target after the camera has been panned away or the scene changes. Rotating the image even slightly reduces this tendency to "sticktion," thus removing annoying after images. Some of the newly developed image orthicons do not require the wedge.

The beam splitter is an optical device that divides the light beam between the luminance and chroma channels, with 80% of the light passing to the chroma and 20% going to the luminance channel. The light from the beam splitter to the luminance channel is reflected off a front-surface 100% reflecting mirror and passes through a neutral-density filter. This filter is selected to compensate for variations in the sensitivity between different image orthicon pickups.

After passing through the neutral-density filter, the light falls on the target of a 4½-inch image orthicon where it generates the monochrome signal. Note that the image area of the orthicon is larger than that of the one-inch vidicons used in the chroma section.

The remaining 80% of the light from the beam splitter enters a folded optical path consisting of a trapezoidal prism and passes to the chroma section.

The light now strikes the first dichroic mirror. A dichroic mirror is essentially an interference filter with color-selective reflection and transmission characteristics. By appropriate adjustment of the layer thickness of the interference filter, a wide range of spectral responses may be achieved. The surfacing of the mirror used here is such that the blue component of the light is reflected while the red and green components are allowed to pass through. This is the optical equivalent of a bandpass filter.

The blue light is then taken off another front-surface 100% reflecting mirror and passed through a trimming filter to make sure that the color striking the blue vidicon conforms exactly with the FCC specifications for blue. Next, the light passes through a re-imaging lens where it is reduced in size for the vidicon and exactly focused on the target. The vidicon output is the blue chroma signal.

The red and green light components that passed through the first dichroic mirror (the light is yellow at this point) impinge on another dichroic mirror whose surface has been treated to pass only the green component and reflect the red. The green light then passes through its trimming filter and re-imaging lens to the green signal vidicon. The red component reflected from the dichroic mirror is bounced off a front-surface 100% reflecting mirror and passes through its trimming filter and re-imaging lens to the red signal vidicon.

The electronics of this system are similar to those of the three-tube variety, except that the monochrome signal is generated separately and is not created as a result of chroma addition.

Other TV camera manufacturers are also building cameras using this independent luminance channel approach. ▲

COLOR-TV SIGNAL GENERATORS

By LESLIE SOLOMON/Associate Editor

Many manufacturers were queried as to why they chose certain parameters for their color-bar generators. Although there was no definite agreement, some interesting observations came to light.

WHEN we looked over the specifications of the many color signal generators on the market (shown in the accompanying table), we noted that there didn't seem to be much agreement on the number of horizontal and vertical lines made available. We also observed that dot size and line thickness varied among manufacturers, and we wondered why almost all companies used the gated rainbow approach for color generation rather than the NTSC method.

This prompted us to query some manufacturers as to why they picked the characteristics they did and what technical reasoning lay behind their choices.

Following are the answers we received to this inquiry.

What is the optimum number of lines or dots required, and why?

Allied Radio. The number of lines is not critical. However, too few lines could cause a line to miss the area of greatest misconvergence at the edge of the visible raster, and too many lines are confusing. Based on present CRT sizes, 10 to 16 vertical or horizontal lines should be used.

Amphenol (Cadre). The optimum number of lines is 20 vertical and 15 horizontal, less those in the blanking interval. This yields an aspect ratio of 4:3 which is the standard used in the TV industry. With this aspect ratio, the operator, when making proportioning adjustments, merely regulates height, width, and linearity controls for perfect squares over the entire screen. Also, the 20 by 15 line complement provides more vertical lines, thus affording the operator a greater selection of lines for convergence over the number of lines normally used. The number of dots for a 20 by 15 line complement would be 300, less those lost during the blanking interval.

Eico. Long experience has shown that 10 vertical and about 13 horizontal are the optimum number of lines for easy convergence. A larger number of lines can cause optical confusion, while fewer can cause missed raster areas for poor over-all screen convergence. Once the number of lines required has been determined, the number of dots is automatically the product of the number of vertical and horizontal lines.

Heath. Ten vertical and 14 horizontal visible lines are the optimum number for adequate convergence. Any more than this brings the dots or lines too close and causes confusion. The fact that this number of lines is readily available from a stable sync divider chain makes for economical design.

Lectrotech. The sole requirement is that there be sufficient information over the total CRT screen area to properly converge it. Experience has shown that 12 vertical and 15 horizontal lines are adequate. However, with the advent of the rectangular CRT, there is some question as to whether there is enough information in the corners of the tube to do a proper job. While the above number of lines is adequate, we suspect that color generators of the future will at least increase the number of vertical lines to provide slightly more corner information.

Precise. For convergence, the dots must not be spaced so close that the technician can accidentally misconverge the dots of one color onto the adjacent dots of other colors. Minimum dot spacing must be greater than the maximum displacement range of the receiver static convergence magnets. The minimum number of lines or dots for dynamic convergence should be sufficient to provide the necessary information in all areas of the CRT screen. Five or six lines horizontally and vertically are sufficient.

A crosshatch pattern dividing the screen area into squares is optimum for linearity checking as the eye can determine squareness much more readily than degrees of rectangularity. The optimum number of lines for this pattern is a 12 by 16 array that would provide linearity information at a glance without a cluttered screen.

RCA. In our opinion, there is no optimum number of dots or lines.

Seco. Ten horizontal and 10 vertical lines will produce the desired aspect ratio. This is required for proper linearity adjustment.

Sencore. The optimum number of lines in a generator is 14 horizontal and 10 vertical. If there are any less, convergence becomes harder. If the number increases, it becomes confusing. The same holds true for dots.

What is the optimum size of the dots and thickness of the lines?

Allied Radio. Thickness is not critical. The important thing is a well-defined edge for the dot or line. This requires a single scanning line, since sync jitter of adjacent scan lines in wide horizontal lines will spoil edge definition.

Amphenol (Cadre). Optimum size of dots and lines is approximately one scanning line in width. The important criterion is that the pulses creating the lines or dots have controlled rise and fall times. These times should be such as to produce good, steep pulses but should not be fast enough to "ring" or create overshoot in the video amplifiers. Pulses having one scanning line dimensions produce the best lines and dots.

Eico. There is no optimum line width or dot size as long as the leading and trailing edges are sharp. Because some

MODEL	VIDEO: COLOR	CROSS-HATCH	VERT. LINES	HORIZ. LINES	DOTS	ADJ. SIZE	CHROMA GAIN	OTHER	AUDIO (4.5 MHz)	OUTPUT: R.F. CHAN.	VIDEO	PHYSICAL DATA: H (in)	W (in)	D (in)	WGT (lbs)	POWER	GUN KILLERS	PRICE ($)
	ALLIED RADIO CORP., 100 N. Western Ave., Chicago, Illinois 60680																	
KG-685	gated rainbow	yes	yes 9	yes 14	yes	no	yes	gray scale, clear raster	yes	3, 4, 5	yes	4 5/8	12	9 5/8	14	line	yes	89.95
	AMPHENOL DIST. DIV., Amphenol Corp., 2875 S. 25th Ave., Broadview, Ill.																	
860	side-by-side red, blue, cyan	yes	yes 20	yes 15	yes	no	yes	single horiz. and vert. lines, centered crosslines, centered dot	no	3, 4	no	5	9	4	3 1/2	line or battery	yes	A.C. 189.95 Bat. 169.95
	B & K DIV. of Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, Ill.																	
1245	gated rain.	yes	yes 10	yes 15	yes	no	yes	none	no	3, 4, 5	no	2 7/8	8 7/8	8 1/2	3	line	yes	134.95
	EICO ELECTRONIC INSTRUMENT CO., INC., 131-01 39th Ave., Flushing, N.Y.																	
380	NTSC	yes	yes 10	yes 13	yes	yes	no	chroma white, clear raster	no	3	yes	8 1/2	5 3/4	6 3/8	4	line	no	159.95
	HEATH COMPANY, Benton Harbor, Michigan 49022																	
IG-62	gated rain.	yes	yes 12	yes 15	yes	no	no	shading bars	yes	2-6	yes	8 1/2	13	7	10	line	no	64.95
	HICKOK ELECTRICAL INSTRUMENTS CO., 10514 Dupont Ave., Cleveland, O.																	
656XC	NTSC	yes	yes 20	yes 15	yes	no	yes	none	yes	2-6	yes	7 1/2	16 3/4	18 3/8	34	line	no	549.50
660	ungated rain.	yes	yes 20	yes 15	yes	no	yes	none	no	2-6	yes	5	10 1/2	10 1/2	15	line	no	245.00
661	NTSC	yes	yes 20	yes 15	yes	no	no	none	no	3, 4	yes	11 1/16	15	8 1/8	18 1/2	line	no	349.50
662	fixed[a]	yes	yes 18	yes 10	yes	no	no	none	no	all[b]	no	8 1/2	11	5	6	line	yes	159.95
GC-660	gated rain.	yes	yes 18	yes 18	yes	no	yes	none	yes	3, 4, 5	yes	10 3/8	10 3/4	5	6 1/4	line	yes	——
	LECTROTECH INC., 1221 West Devon Ave., Chicago, Illinois 60626																	
V6	gated rain.	yes	yes 12	yes 13	yes	yes	yes	none	no	3, 4, 5	no	4 1/2	7 5/8	10 3/8	7 1/2	line	yes	99.50
V7	gated rain.	yes	yes 12	yes 13	yes	yes	yes	CRT display.	no	no	yes	7 1/2	8 1/4	12 7/8	13	line	yes	189.50
	MERCURY ELECTRONICS CORP., 315 Roslyn Road, Mineola, N.Y. 11501																	
1900	gated rain.	yes	yes 10	yes 14	yes	yes	yes	none	no	3, 4, 5	no	6 1/4	10	4 1/2	4 1/4	line	yes	89.50
	PRECISE ELECTRONICS Div. of Designatronics Inc., 76 E. Second, Mineola, N.Y.																	
660	gated rain.	yes	yes 10	yes 14	yes	no	yes	clear raster, shading bars	yes	3, 4, 5	no	8 1/2	9 1/2	10	5	line	yes	124.95
	RCA, 415 South Fifth St., Harrison, N.J.																	
WR-64B	gated rain.	yes	no	no	yes	no	yes	none	yes	3, 4	no	10	13 1/2	8	13 1/2	line	yes	189.50
	SECO ELECTRONICS CORP., 1201 S. Clover Dr., Minneapolis, Minn. 55420																	
900	gated rain.	yes	yes 9	yes 10	yes	yes	no	clear raster	no	2, 3, 4	no	3 1/2	10 1/2	8 1/2	6	line	yes	129.95
980	gated rain.	yes	yes 9	yes 6	yes	yes	yes	none	no	2, 3, 4	no	6 3/4	11 1/8	6 1/8	10	line	no	99.50
990	gated rain.	yes	yes 9	yes 6	yes	yes	yes	unkeyed rain., clear raster	no	2, 3, 4	no	6 3/4	13 1/8	6 1/8	10	line	yes	129.50
	SENCORE, 426 South Westgate Drive, Addison, Illinois 60101																	
CG-10[c]	gated rain.	yes	yes 10	yes 14	yes	yes	yes	none	no	2-6	no	3	10 1/2	8 1/2	5 1/2	battery	yes	89.95
CA-122	gated rain.	yes	yes 10	yes 14	yes	no	yes	shading bars	yes also 900 Hz	2-6 20-50 MHz i.f. output	yes	10	14	8	15	line	yes	187.50
CG-126	gated rain.	yes	yes 10	yes 14	yes	yes	yes	none	no	3, 4, 5	no	9	11	6	10	line	yes	109.95
CG-135	gated rain.	yes	yes 10	yes 14	yes	yes	yes	none	yes	3, 4, 5	yes	9	10	3 1/2	8	line	yes	149.95

[a] Synced from TV set, color is fixed at yellowish-green, 1/2 vertical field; [b] TV signal is used as carrier; [c] Model CG-138 same as CG-10 except a.c.-operated and 4.5-MHz sound carrier.

technicians prefer a large-size dot or a thick line, while others prefer a small, fine dot or a very thin line for more precise convergence, we provide a front-panel line/dot size control that can produce lines and dots from one scanning line to several scanning lines in thickness.

Heath. The size of the dot is not nearly as important as the sharpness of the leading and trailing edges. There is far less eye fatigue in a dot that might be ½-inch square. If the edges are sharp, it is easier to obtain good convergence with this size dot. We would not accept a dot smaller than two scanning lines square.

Lectrotech. Correct convergence can only be performed with a line/dot as thin as possible. The thinnest horizontal line that can be created is one scanning line wide. The vertical thickness must then be matched to this to produce a small dot. If the horizontal line is more than one scanning line wide, additional information will be present on the screen which can only produce visual confusion. Thicker lines and very bright lines can cause defocusing of the CRT, and the sharp edge with which to evaluate misconvergence will no longer be visible. This is particularly true of some of the later model color sets, whose high-voltage regulation is at best marginal.

Precise. We selected a line thickness of two scanning lines as the optimum choice between line thinness for dynamic convergence and dot size large enough for easy visibility during static convergence. Dots smaller than this are difficult to use for static convergence because of the limitations of shadow-mask color CRT's. When a fine dot structure is used, it becomes apparent that the displayed red, blue, and green dots are of different dimensions. This is understandable when one considers the differing brightness of red, blue, and green required to produce white, the various phosphor efficiencies, and the electron-beam intensities needed to produce these colors. Spot size is directly related to electron-beam intensity. It comes as no surprise that the green dot, with about twice the brightness, is larger than the red dot. With a very small generated dot, it is almost impossible to center the red dot over the green dot during static convergence. Another difficulty is the less-than-perfect static convergence system currently being used in color sets. Very small dots, when converged, become ellipses with the major axis along the axis of action of the particular color convergence magnet. The visible result is a lopsided, six-pointed, multi-colored star rather than a square white dot. Larger dots minimize this difficulty because these aberrations are fixed in size and become proportionately smaller as dot size is increased. Large dots are comfortable to use, but the corresponding crosshatch lines would be too thick. The optimum is a compromise between the two divergent requirements.

RCA. There is no "best" dot size or line width for convergence adjustments. Veteran technicians have found that very small dots or thin lines are difficult to use under average lighting conditions. If receiver brightness is turned up to overcome this handicap, blooming will result. Proper convergence cannot be achieved under this abnormal condition. The dot and line size should be small enough to permit exact, speedy adjustment yet should be large enough to be useful under average lighting conditions.

Seco. Single scanning line thick horizontal lines and very fine vertical lines show up misconvergence error clearly.

Sencore. The thickness of the lines and the size of the dots should be about the same. The lines should be about two scanning lines thick and the dots about the same thickness, in both directions. If the lines are any narrower, convergence is not improved and it becomes difficult to see the lines.

←Table 1. Characteristics of the most popular types of color-bar generators. Note that there are no standard number of horizontal or vertical lines, which along with other points are discussed by representative generator manufacturers.

Color-TV broadcasting uses discrete brightness levels for each color. Does it make any difference that in a gated rainbow generator each color is generated at the black level? Also, in these generators, there is a slight shift in phase (therefore color) across each color bar. Is this harmful, or is it unimportant?

Allied Radio. Not all keyed rainbow generators operate at the black level; some are brightness-keyed. While black-level generation lends itself to easy oscilloscope display interpretation, brightness-keyed bars come closer to NTSC standards. With narrow color bars, distortion of the pedestals by the receiver circuitry makes the edge-to-edge phase error negligible. Because of the newer rare-earth phosphors, CRT's exhibit less color shift with changing excitation current; therefore, errors in the displayed color hue at different brightness levels are less.

Amphenol (Cadre). Color bars generated at the black level will have no effect on color circuit alignment. For viewing purposes, the color bars will appear better with a luminance component, but this is not necessary for alignment. It is true that in a keyed rainbow generator, the phase (color) is continuously changing across each bar and that this prevents extremely accurate alignment. However, if the TV manufacturer's alignment procedure is followed closely and his waveforms duplicated, reasonably good alignment accuracy can be attained.

Eico. While it is true that gated rainbow generators produce a non-standard color signal with the color shifting across the width of each color bar and that these color bars have no standard luminance components, these generators are fine as long as they are used only for relatively broad alignment in the customer's home. However, when high-quality alignment is desired and when an accurate source of $R-Y$, $B-Y$, I, and Q signals are required for proper chroma alignment, then an NTSC generator must be used. We decided to make available a low-priced NTSC generator because we feel that best color alignment can only be made with a signal that is identical to that being transmitted by the color-TV broadcasting station. No experienced technicians would think of aligning an FM-stereo unit without a source of FCC-type stereo signals and expect to get the best results; therefore, why shouldn't he have access to an NTSC generator to get the best results from an expensive color-TV set?

Heath. A keyed rainbow generator is entirely adequate for service-type color instruments. The fact that the phase angle of the signal changes across each color bar is of little consequence, nor is it important that the color bar is generated at the black level. These are not inefficiencies in the generator, as adequate alignment procedures using this type of signal have been written and produce excellent color rendition.

Lectrotech. The fact that a color bar is generated at the black level is not very important, since additional brightness can be introduced with the set's brightness control. The keyed rainbow pattern is satisfactory, even though the phase angle of the signal changes across a color bar. A vector display indicator can be used to eliminate the error caused by this change.

Precise. A keyed rainbow generator produces more usable information with simple circuitry than any other color signal generator. The phase shift across the bar appears to be of minor significance and only in the visual display. It is of no significance when an oscilloscope is used to check receiver phasing. Some designers claim that color bars should not be on pedestals, apparently because the pedestal adds a luminance component to the signal. This is of no importance in the receiver chroma circuits because the luminance information is removed from the sig-

(*Continued on page* 67)

Chroma Circuits in Color TV: Sylvania

By WALTER H. BUCHSBAUM

A high-level color demodulator, a combined high-voltage regulator and automatic picture width control, and a transistor noise gate are features of this new 19-inch rectangular-tube color-TV set.

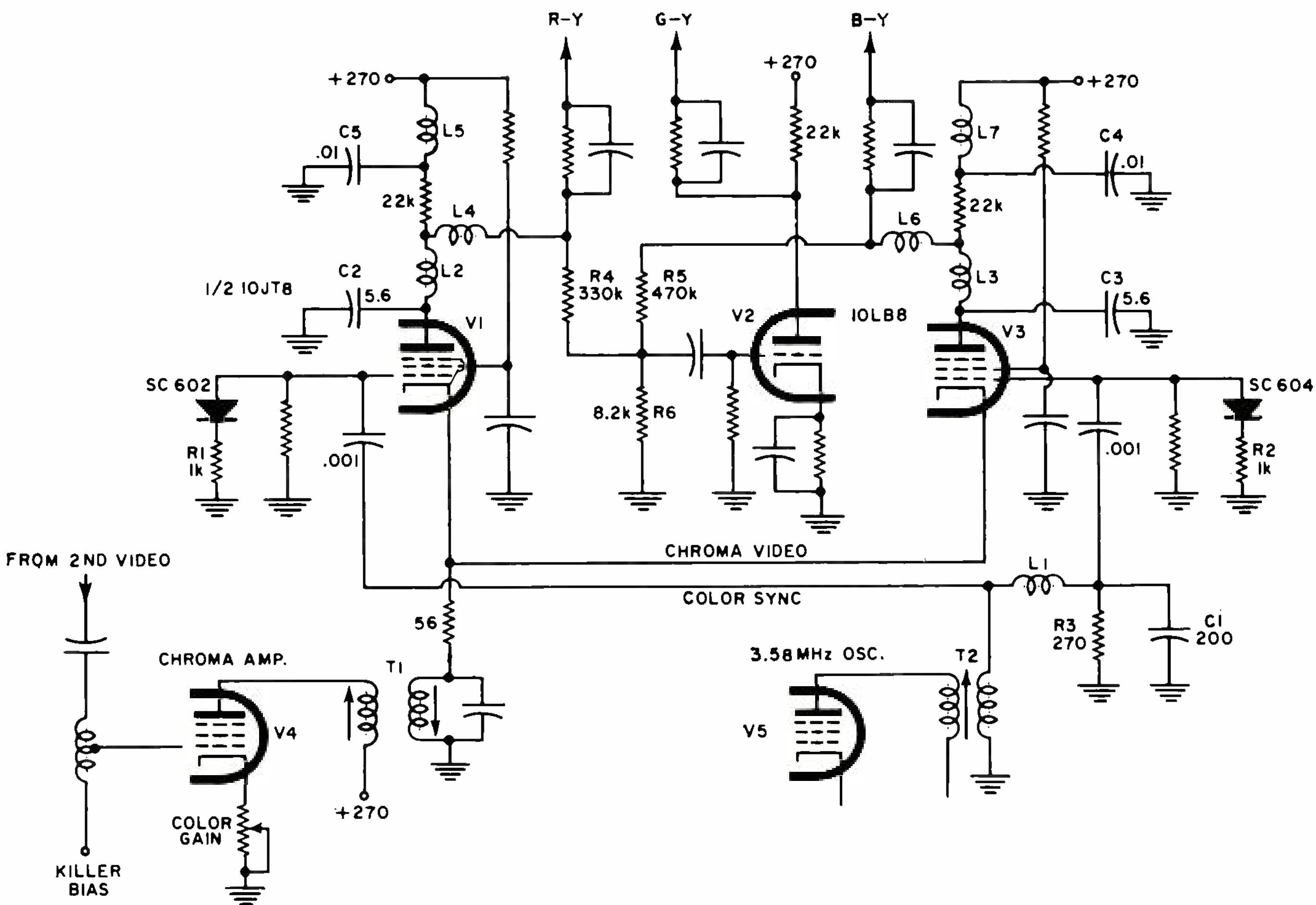
THE *Sylvania* Model DO3-2 color-TV receiver is the first recent color set that is operated from the power line without a power transformer. To provide the necessary "B+" voltage, the Model DO3-2 uses a conventional voltage doubler as well as an additional rectifier for the −140 volt supply. For the +450 volts required by the picture-tube screen grids, the conventional boost voltage from the horizontal flyback circuit is boosted again by means of an additional diode. All tube filaments are in series, with the picture-tube obtaining its voltage from a small transformer.

Degaussing coils are connected across the thermistor which is in series with the a.c. power line. The three-gun shadow-mask color picture tube (RE19FMP22) has a rectangular envelope, 90° deflection angle, and rare-earth phosphors. This picture tube requires 22 kV on the ultor and approximately 5 kV on the focusing element. The ultor voltage is obtained through a 3A3 rectifier in the flyback circuit, while the focus voltage is obtained from a silicon rectifier connected to the plate of the horizontal output tube.

Since the receiver consists of only 16 tubes and 17 diodes, dual-purpose tubes and circuit simplifications are employed wherever possible. The i.f. section, for example, uses only two tubes. A quadrature detector and single audio output stage are preceded by a single tetrode amplifier. The triode portion of the sound amplifier acts as a keyed a.g.c. tube. This means that the printed-circuit board containing the i.f. and the audio section has only five vacuum tubes. The horizontal output tube, high-voltage rectifier, and damper are mounted in the high-voltage compartment, while the remaining eight tubes are all contained on the second printed-circuit board.

Most of the circuits in the *Sylvania* Model DO3-2 will be familiar to the reader either from previously described color-TV receivers or from widely used black-and-white sets. The convergence section, for example, is almost iden-

Fig. 1. In the high-level color demodulator, the color subcarrier is injected at the cathode and the sync at the grids.



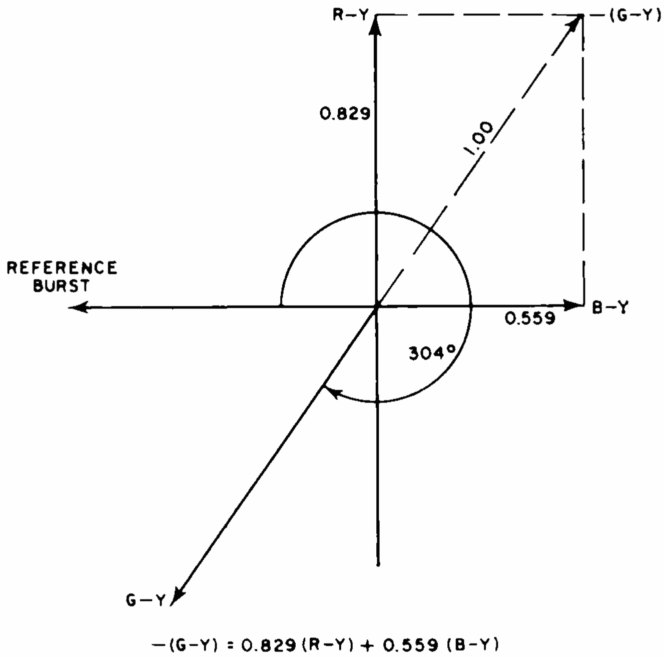


Fig. 2. Phase diagram for the generation of the G-Y signal.

tical to that found in the new *RCA* color receiver models.

The color synchronizing section is essentially the same as that used in some *Sylvania* and *RCA* receivers. A dual-diode phase detector, a reactance control tube, and a crystal-controlled oscillator perform the function of comparing the locally generated color sync signal with the incoming color sync burst. However, considerable circuit innovation is found in the color demodulator and matrixing section of this color receiver.

Color Demodulator

The receiver uses a high-level pentode color demodulator, the circuitry of which, in simplified form, is shown in Fig. 1. Two pentode sections (*V*1 and *V*3) are used to directly demodulate the red and blue color-difference signals. Although the amplitude of the input video signal is relatively low, the gain available in each pentode provides output signals that are sufficiently large to directly drive the control grids of the picture tube.

The 3.58-MHz color subcarrier signal is amplified in chroma amplifier *V*4; then it is coupled through *T*1 to the common cathodes of the two demodulators. The color gain control is a potentiometer in the cathode of the chroma amplifier. Transformer *T*1 acts as a step-down transformer, since the input impedance to the demodulator cathodes is considerably lower than the output impedance of the chroma amplifier. Chroma amplifier *V*4 has its control grid d.c.-connected to the color-killer bias circuit, an arrangement which is common in most color receivers.

With the chroma video signal present at the cathode of the demodulator, the color sync signal is applied at the control grid. Note that in the circuit of Fig. 1, each of the two control grids is returned to ground through a diode and resistors *R*1 and *R*2. This circuit clips the positive sync pulses and sets up a d.c. bias level for each demodulator. The color sync signal itself comes from the oscillator through transformer *T*2 and has its 90° phase shift provided by the combined action of *L*1, *C*1, and *R*3. At the plate of each of the demodulators, the respective color difference signal (*R—Y* or *B—Y*) appears. Network *L*2 and *C*2, as well as *L*3 and *C*3, are filters which remove the 3.58-MHz subcarrier component from the video signal. The remaining video peaking coils (*L*4, *L*5, *L*6, and *L*7) are used to provide the required video bandwidth. Capacitors *C*4 and *C*5 improve the low-frequency response of the two demodulators.

To obtain the green color-differ- (*Continued on page* 80)

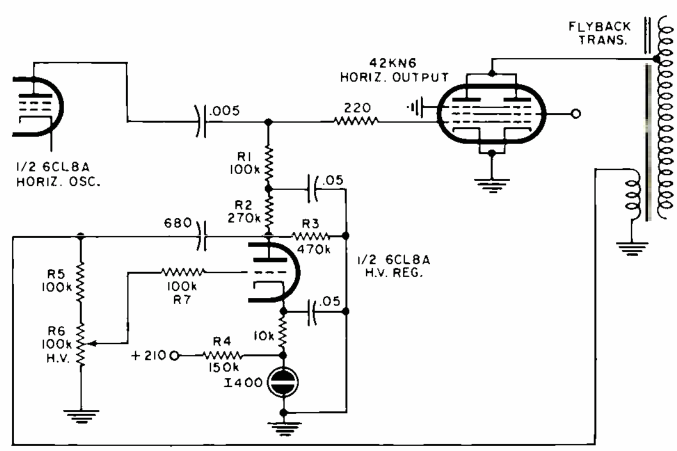


Fig. 3. The high-voltage regulator also controls picture width.

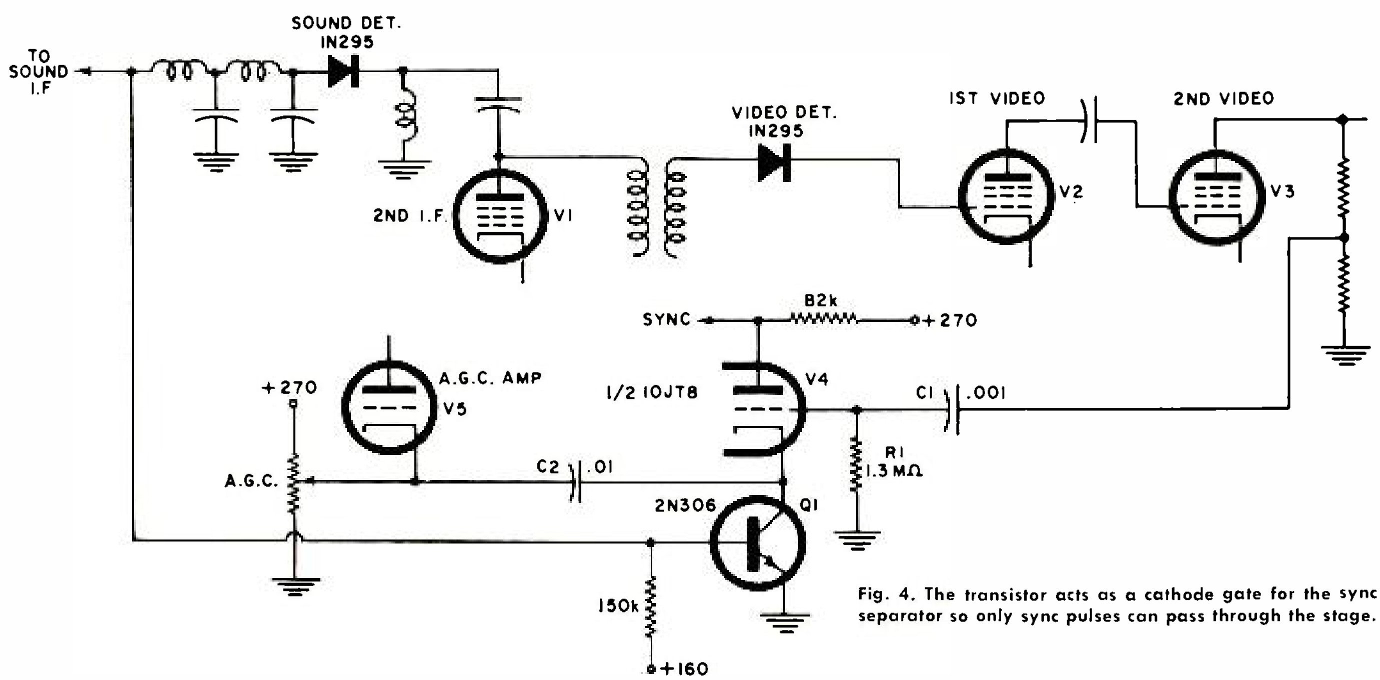


Fig. 4. The transistor acts as a cathode gate for the sync separator so only sync pulses can pass through the stage.

Cryogenic Liquid Level Controls

By WALTER W. SCHOPP
University of California, Lawrence Radiation Lab.

Electronic controls are taking the place of mechanical devices to regulate the coldest liquids known to man.

ALMOST everyone is familiar with some sort of liquid level control. The device that controls the valve in the automatic washing machine and keeps the hot water from spilling over the floor is a liquid level control. So is the float valve in the bathroom water closet. When the liquid being controlled is water at room temperature, a float valve is usually sufficient. When the temperature of the liquid is below —321° Fahrenheit, using the float-valve approach leads to problems. Moisture from the surrounding air freezes on moving parts, eventually encasing the mechanism in ice. Condensation moisture trapped in a small crevice and frozen and thawed many times can exert great pressure on anything periodically immersed in this liquid. These were some of the problems that had to be surmounted by electronic cryogenic liquid level controls.

The control circuits to be described were developed for use at —321° F with liquid nitrogen, which is one of the most commonly encountered cryogenic fluids. Control circuits for other cryogenic fluids operating at different temperatures would be similar, although some changes in circuit components might be necessary. An understanding of the pros and cons of these basic control circuits can aid any technician whose work involves industrial electronic controls.

The uses of liquid nitrogen vary from quick-freezing of fruits and vegetables to heat-treating razor blades. Liquid nitrogen is also useful in biology as a blood preservative and in medicine for treatment of skin disease. It is often imperative that reservoirs of this super-cool fluid be maintained at a constant level. The liquid level control must sense a drop in the surface level of the liquid in the reservoir and replace the liquid that has evaporated. Sophisticated models add a timer to fill the reservoir for a predetermined period, raising the liquid level above the sensing device and thus cutting down the number of times that the control unit cycles. The transfer pipes have to be cooled less frequently, conserving liquid consumption somewhat. Other models use an upper and lower sensing device and maintain the level of the liquid between these two points. Variations in models and modes of operation are as numerous as the types and sizes of the reservoirs that are available.

Early Control Methods

Illustrated in Fig. 1 is one of the early methods of liquid nitrogen level control. Consisting of a metal bulb and capillary tubing, this control is classed as electro-mechanical. The bulb, capillary tubing, and diaphragm housing contain a refrigeration gas. As the liquid in the reservoir drops, exposing the bulb, the gas inside warms and expands. This expansion exerts pressure through the capillary tube on the diaphragm, pushing the sensitive switch closed. Closing the switch activates a solenoid valve in the transfer line, allowing the cryogenic fluid to enter the reservoir from the supply. As the liquid again covers the bulb, the gas in the bulb condenses, relieving the pressure on the diaphragm. This opens the switch and closes the valve from the liquid supply.

Operation was simple and effective for many years until deeper and deeper reservoirs began to be used. This revealed a certain problem: the undisturbed layer of nitrogen gas just above the liquid surface was found to be only a few degrees warmer than the liquid itself. So cold was this layer of gas that unless a sizable amount of heat from the room crept down the capillary tubing and helped warm the

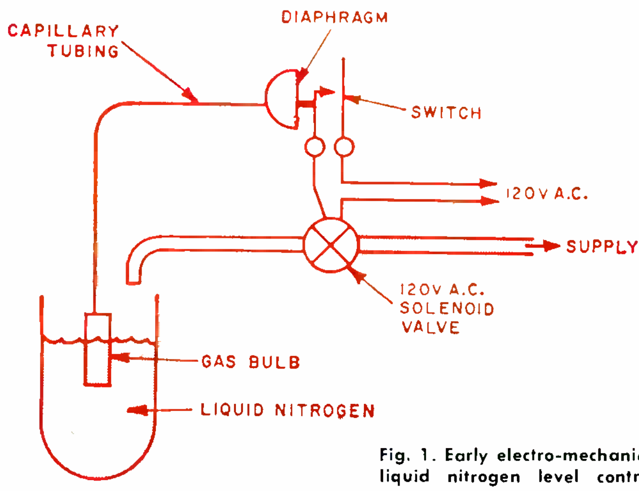


Fig. 1. Early electro-mechanical liquid nitrogen level control.

Fig. 2. Balanced bridge sensor uses composition resistor.

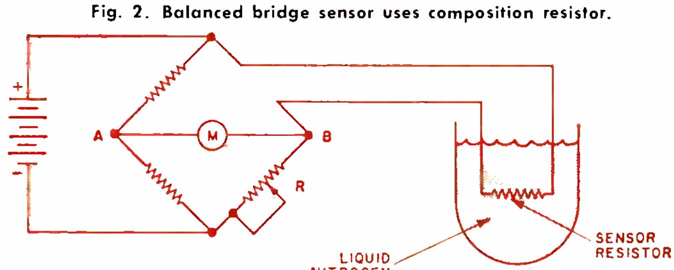
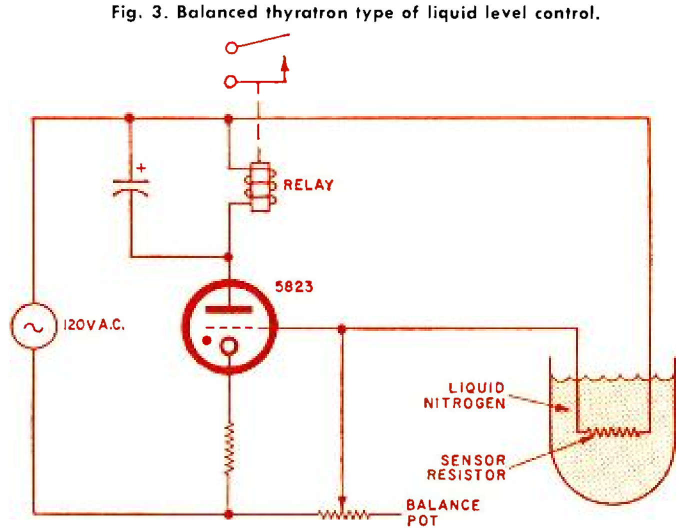


Fig. 3. Balanced thyratron type of liquid level control.



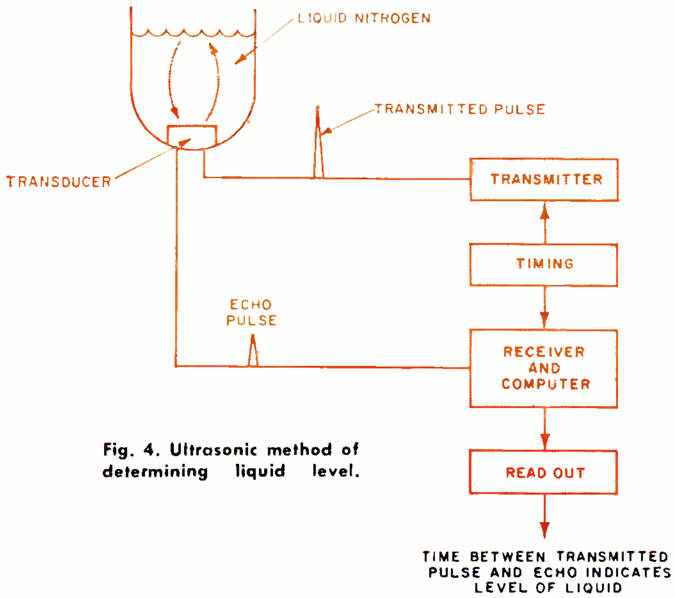


Fig. 4. Ultrasonic method of determining liquid level.

bulb, the control would not turn on until the reservoir was completely dry. One solution was to use an electric heater surrounding the sensor bulb, since the ability of liquid to carry away heat is much greater than that of gas. However, the use of a heater around an already bulky gas sensor bulb was not a desirable solution.

Balanced Bridge Circuit

At this point, electronics made its debut in this field. Why not use a balanced bridge circuit with one leg of the bridge submerged in liquid nitrogen as the sensor (Fig. 2)?

It is well known that carbon-composition resistors exhibit large increases in resistance when exposed to these low temperatures. If a low-wattage resistor were used as a sensor and operated close to its maximum heat dissipation limits, it would have its own built-in heater. Placed in the bridge circuit and immersed in liquid nitrogen, its resistance would increase to a higher than normal value. The circuit could then be balanced under these conditions by variable resistor *R* until no voltage appears across balance points *A* and *B*. As the liquid level drops and exposes the sensor, the internal heat quickly returns the resistance to its nominal value. This unbalances the bridge circuit and indicates on the meter that the liquid level has dropped below the sensor.

The balanced bridge circuit was further improved by the modification shown in Fig. 3. Here the balanced thyratron circuit directly operates a load relay when the balance between the balance potentiometer and the warming sensor resistor is upset.

The bridge circuit was a simple approach to a complicated problem. It overcame the cold sensor difficulty and distinguished positively between liquid and gas in the deepest reservoirs. However, all was not yet well as a new problem was introduced.

Small changes in applied voltage do not upset a normal bridge circuit in balance. All the voltages across all the legs increase or decrease uniformly and the net result across the balance point is zero. In the cryogenic version of this balanced bridge, however, a slight rise in applied voltage results in more internal heat being applied to the sensor resistor, driving the resistance down in this leg while not adversely changing the resistance of the other legs of the circuit. This unbalances the circuit and usually results in a large container of liquid nitrogen being dumped on the floor while the reservoir goes dry.

Still another problem was discovered with the circuit. If the sensor resistor was out of the liquid for a prolonged time, the value of the resistor would change slightly due to overheating; thus, when the liquid level was restored and the sensor was again cooled, the circuit would not return to balance. A constant voltage source and close scrutiny would cure most of the ills of this circuit.

Ultrasonic & Transformer Controls

Ultrasonic gaging devices have been applied successfully to the level control of cryogenic liquids (Fig. 4). Application is similar to sonar principles. The surface level is determined on a readout device by the time differential between the transmitted pulse and the received echo. However, complex circuitry makes the cost very high. As the transducer is an integral part of the reservoir, versatility is not an attribute, although the system is quite reliable.

Another innovation is the variable-transformer level control. The sensor element consists of a bellows that houses a variable transformer. As the bellows expands and contracts from the liquid temperature, the inductance change due to the core movement is read with the circuit shown in Fig. 5.

The circuit in Fig. 6 illustrates how the transformer sensor can be incorporated into a transmitting level indicator. Changing frequency directly with the bellows temperature, this circuit can transmit level indications to a remote location. This control suffers the same ills as the gas-bulb sensor inasmuch as no external heat is provided.

Optical Techniques

The optical liquid level detector shown in Fig. 7 also deserves consideration. This novel approach uses light pipes

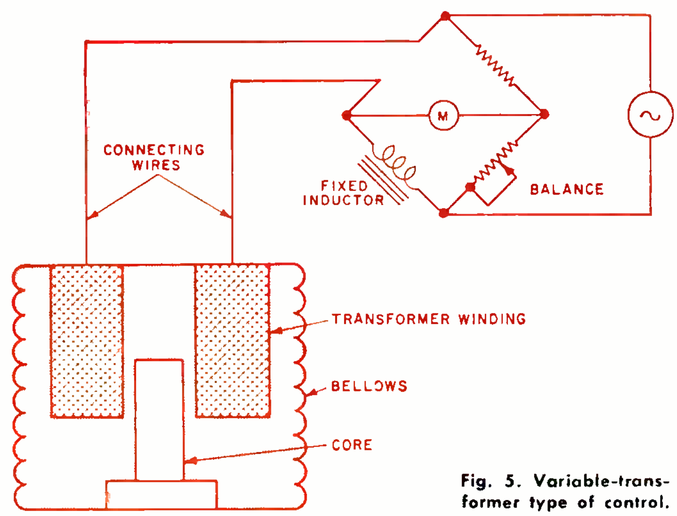
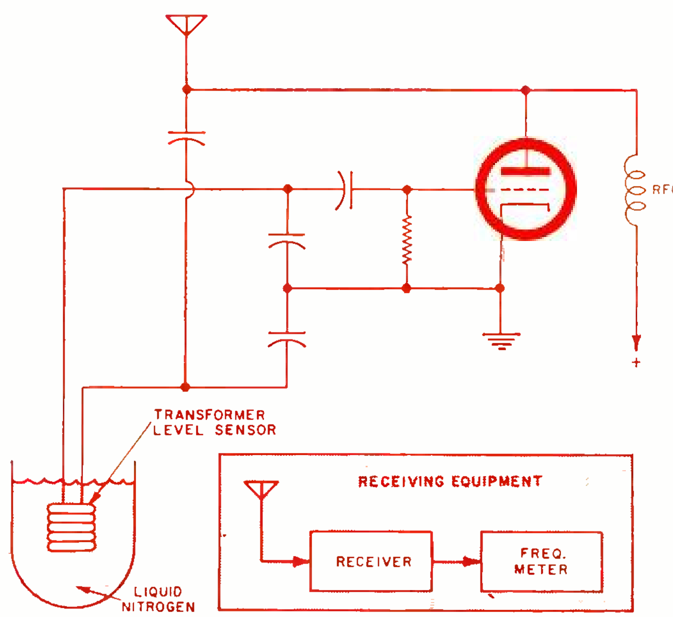


Fig. 5. Variable-transformer type of control.

Fig. 6. Frequency of the transmitter is determined by level.



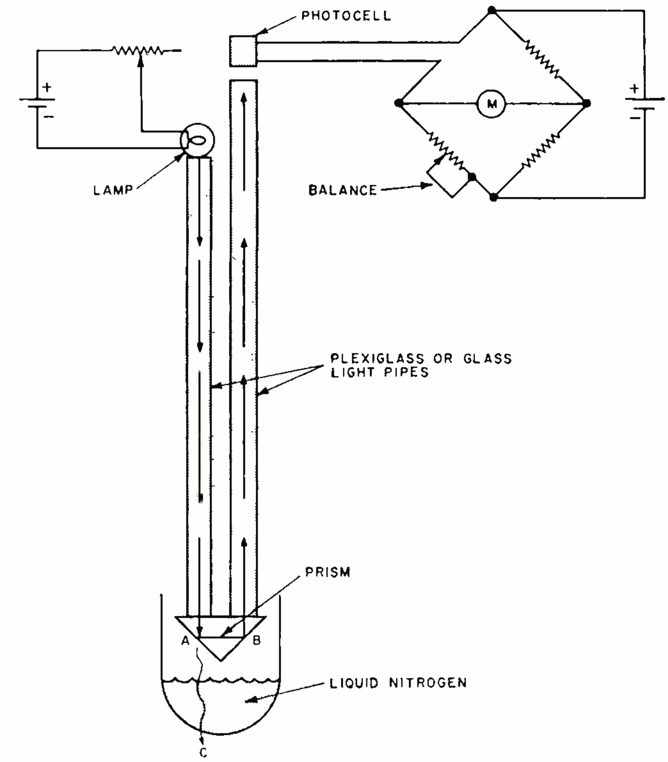


Fig. 7. An optical level control used for liquid nitrogen.

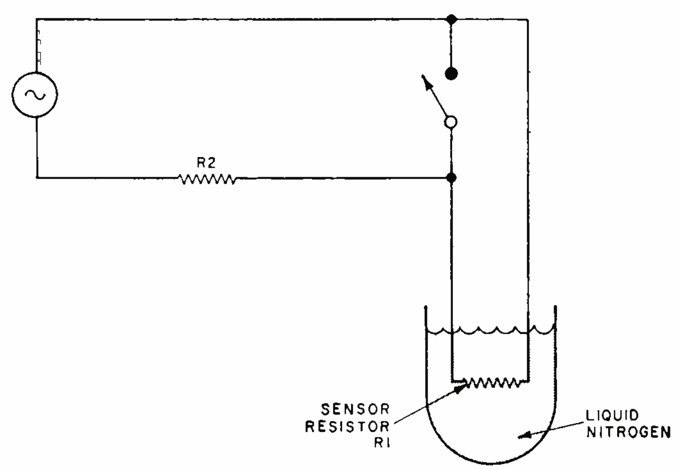
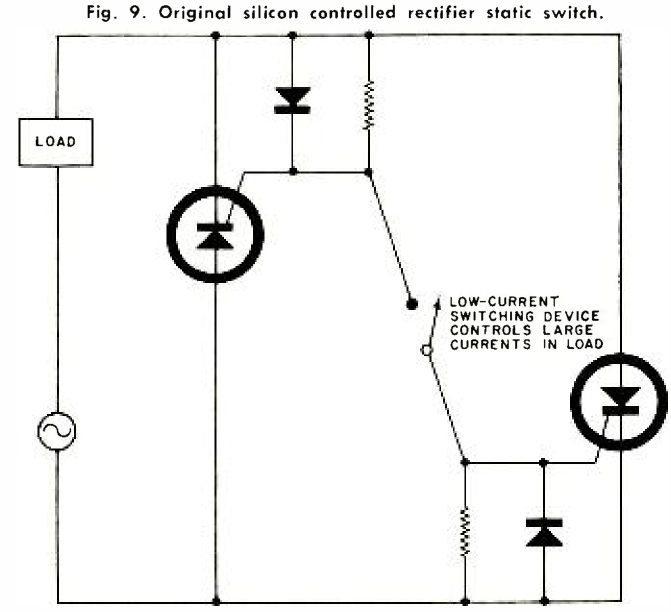


Fig. 8. The simplified electronic control circuit employed.

Fig. 9. Original silicon controlled rectifier static switch.



and a photocell along with a light source and associated circuitry. The sensing device in this system is a small glass prism. When this prism is dry or out of the liquid, light from the lamp travels down one light pipe, reflects off the two 90° prism surfaces *A* and *B*, and moves back up the other light pipe to the photocell. When the sensor prism is wet, the new light path is into the liquid towards point *C*, since the two wet prism surfaces lose their ability to reflect due to the similarity in the refractive indices of the glass and liquid nitrogen. The resulting resistance change of the photocell caused by the light variations is read on the balanced bridge.

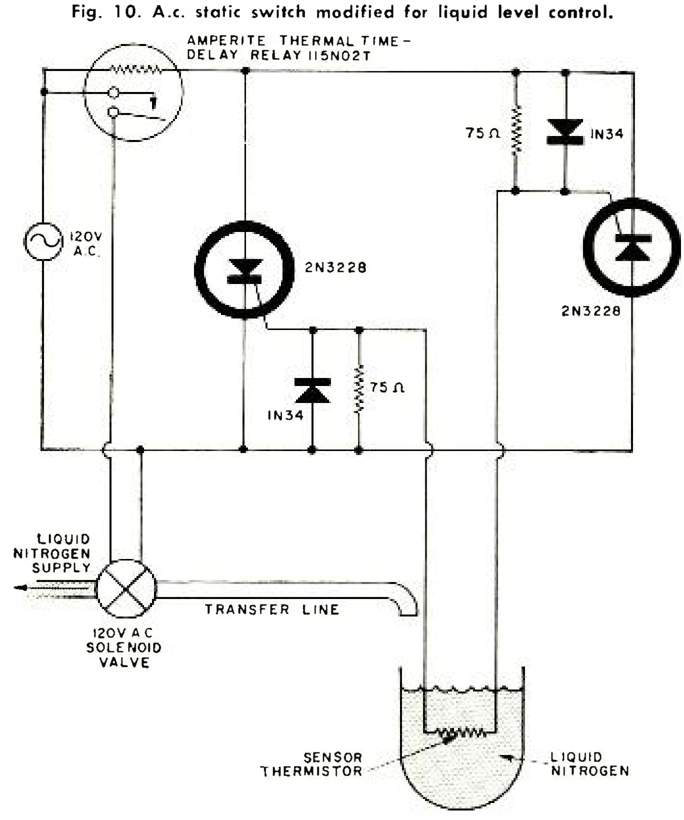
A problem with this type of sensor is that it becomes erratic due to splashing and vapor created during the liquid transfer cycle. This deposits enough liquid on the optical surfaces to falsely indicate that the sensor is immersed in liquid, which prematurely stops the liquid transfer and causes short cycling.

A definite need existed for a control that possessed the reliability of the gas-bulb sensor in a shallow reservoir and the selectivity of the internally heated sensor, without the voltage sensitivity of the cryogenic version of the bridge circuit or the troublesome resistance drift. Economy was also desired, which ruled out ultrasonic devices. What was really needed was a liquid level control that removed the heat from the sensor while it was out of the liquid but would stand by to apply it quickly as the sensor was immersed in liquid and the heat was required.

Electronic Methods

Shown in Fig. 8 is a simplified circuit illustrating a new concept of electronic liquid nitrogen level control. The basic circuit consists of a load resistance (*R2*), a switch, and a resistor representing the sensor (*R1*); also shown is a voltage source. If the load has a high positive temperature coefficient, when the switch is open, most of the voltage appears across the comparatively high resistance of sensor resistor *R1*. As the switch is closed, the full voltage now appears across the load resistance, while the heat-creating current is bypassed by the switch. This was the exact operation desired and the silicon con- (*Continued on page* 74)

Fig. 10. A.c. static switch modified for liquid level control.



ELECTRONIC METAL LOCATORS

Basic Types and Design Factors

Here is a rundown on what's available for the non-military user. Comparative characteristics and performance of the beat-frequency, induction-balance, and transmitter-receiver types.

By DONALD E. LANCASTER

THE advancing electronic art has made possible a new family of underground metal locators. These lightweight, sensitive instruments are designed as non-industrial "sport" types, aimed mainly at the mineral prospector, the beachcomber, and the treasure hunter. Today the outdoor adventurer has a choice of fifty different instruments available from a dozen firms, varying in price from a few dollars up to specialized thousand-dollar underwater models, with many versions doubling as effective pipe and buried wire locators. Industrial models operate on the same basic principles.

Although there are several basic detector types, they all share several common design principles. Obvious goals of a locator are a high sensitivity to very small objects, deep penetration, and the sharp discrimination of the object outline. No basic detector type can possibly meet all three goals, since each must emphasize one particular factor.

Basic Operating Principles

All electronic locators have a transmitter used to illuminate a desired area and a second circuit to interpret any *changes* in that illumination caused by the presence of metal. Loop antennas are often used to couple the signals to and from the earth due to their small size and exactly predictable field patterns.

There are several effects a metal target will have if brought near a loop antenna. First, the inductance of the loop will change. If the metal is iron, the inductance will *increase*, just as an iron core increases the inductance of an air-core coil. If the metal is non-magnetic, it will *decrease* the inductance, just as a brass core is often used to decrease the inductance of an r.f. tuning coil. Secondly, the metal will *distort* the normally predictable field pattern of the antenna. This distortion may then be sensed by electronic means.

Finally, the metal will receive the transmitted signal and rebroadcast or reflect it from its own location, just as a radar illuminates a target which in turn rebroadcasts or reflects energy to a receiver.

Beat-frequency metal locator is shown here.

The mathematics behind loop-antenna operation reveals two energy terms, an inductive coupling term and a resistive coupling term. Both terms are of equal importance one-sixth of a wavelength away from the loop, but for closer distances, the inductive term is much stronger. This is the case with practically all electronic locators, and the design of a locator may then use such inductive concepts as mutual inductance and loosely coupled transformers for mathematical analysis.

The basic laws behind inductive coupling dramatically illustrate why metal location over any appreciable distance is a major design problem, and painfully show why the performance of simple experimental locator circuits is often highly disappointing. It turns out that the received signal produced by an inductively coupled target will normally be proportional to the *cube* of the target diameter and inversely proportional to the *sixth* power of the target depth, neglecting the effects of terrestrial attenuation. A one-inch diameter target will produce only 1/64th the signal of a similar four-inch-diameter target at the same depth; a target four feet deep will only produce 1/4096th the response of an identical one-foot-deep target.

It is possible to obtain deep penetration by careful control of the loop-antenna field patterns, but a drastic reduction in small-object detectability must inevitably accompany such a design.

Operating Frequencies

The round-trip inductive coupling between a target and an antenna in air increases as the *square* of the operating frequency, while the terrestrial absorption becomes worse as the *square root* of frequency. Changing from an operating frequency of 10 kHz to one of 1 MHz will increase the received signal by a factor of 10,000, but the terrestrial absorption will simultaneously become ten times worse. The highest possible operating frequency that will still allow penetration to the desired depth without excessive attenuation should always be used.

Terrestrial attenuation is highly dependent upon the resistivity of the earth

	Beat-Frequency	Induction-Balance	Transmitter-Receiver	Underwater
AZLE DISTRIBUTING CO., 141 Lynn Drive, Azle, Texas	X			
DETECTRON CO., Box 234, San Gabriel, Calif.	X	X		
D-TEX ELECTRONICS, Box 246, Garland, Texas	X			
FISCHER RESEARCH LABS., 1961 University Ave., Palo Alto, Calif.	X	X	X	
GARDINER ELECTRONICS, 4729 N. 7th Ave., Phoenix, Ariz.	X		X	X
GEOFINDER CORPORATION, Box 37, Lakewood, Calif.	X		X	
GOLDAK CO., 1542 Glen Oaks Blvd., Glendale, Calif.	X	X	X	X
IGWT ASSOCIATES, Williamsburg, N. M.		X		
METROTECH, INC., 670 National Ave., Mountain View, Calif.	X		X	
RACOM EQUIPMENT CO., Box 13469, Orlando, Fla.	X			
RAYSCOPE CO., Box 1715, North Hollywood, Calif.	X	X	X	
RELCO INDUSTRIES, Box 10563, Houston 18, Texas	X			
SHARPE INSTRUMENTS INC., 967 Maryvale Drive, Buffalo, N. Y.			X	
STATES ELECTRONICS CORP., 96 Gold St., New York, N. Y.				X
UNDERGROUND EXPLORATIONS, Box 793, Menlo Park, Calif.	X	X	X	
WHITES ELECTRONICS, 1011 Pleasant Valley, Sweethome, Oreg.	X	X		

Table 1. Manufacturers of metal locators for sport use, with types available from each firm indicated.

and its moisture content, but as a worst-case rule-of-thumb for normal soils, rock, and sands, attenuation values are around 0.1 decibel per foot at 10 kHz, 1.0 decibel per foot at 1 MHz, and 10 decibels per foot at 100 MHz. These are one-way values. An eight-foot-deep target will have 16 decibels of terrestrial attenuation added to its normal sixth-order drop-off with depth at 1 MHz. Some soils will make the attenuation somewhat less than expected at high frequencies due to a high dielectric constant which acts as a "bypass capacitor" to allow the high-frequency energy to traverse a lossy medium more freely.

Ordinary river water actually has less attenuation than most soils, and the problem in fresh-water locator operation is primarily one of waterproofing and sealing the circuitry. Such is not the case with sea water, salt lakes, and brackish swamps, for salt water is both highly conductive and moderately corrosive, requiring specialized detector designs that ordinarily make use of very low operating frequencies.

Most commercial non-aquatic instruments operate in the 50-kHz to 2-MHz region, with newer designs favoring the higher frequencies, particularly where high resolution to small objects is an important consideration.

Beat-Frequency Locator

This is the oldest type and often the simplest to manufacture. The beat-frequency metal locator is characterized by low cost, good sensitivity to relatively small objects, and very limited depth penetration. It is favored by beachcombers and coin collectors but is of little or no practical value in the location of pipes, mineral veins, or other deeply buried objects.

The change in loop inductance in the presence of a buried target is the basic principle of operation. Two similar r.f. oscillators are used, one an adjustable reference oscillator and a second that uses a search loop as part of its frequency-determining tank. The outputs of the two oscillators are mixed together and the difference frequency is amplified and fed to a speaker, headphones, or a meter. The block diagram of the basic beat-frequency detector system is illustrated in Fig. 1.

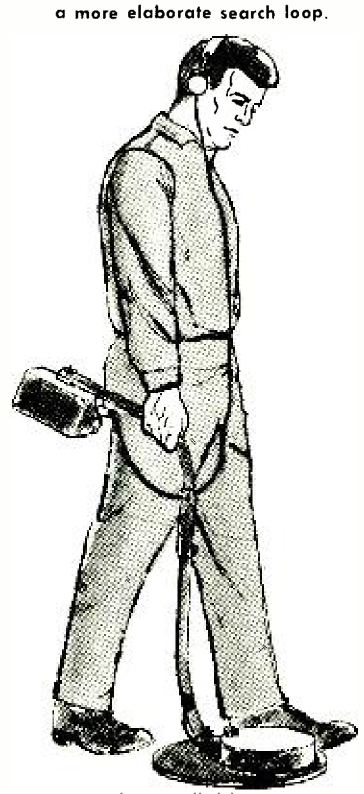
In operation, the reference oscillator is adjusted to a few hertz lower in frequency than the loop oscillator, producing a deep growl in the speaker. If the search loop nears a magnetic conductor, the loop's inductance goes up which slightly lowers the frequency of the loop oscillator. This in turn lowers the *difference* between the two oscillators, and the audio tone drops in pitch accordingly. A non-magnetic conductor does just the opposite—it lowers the loop inductance, raises the loop oscillator frequency, and raises the pitch of the difference note. The beat-frequency locator can then discriminate between magnetic and non-magnetic conductors by the decrease or increase in pitch of the audio note produced as a target is detected.

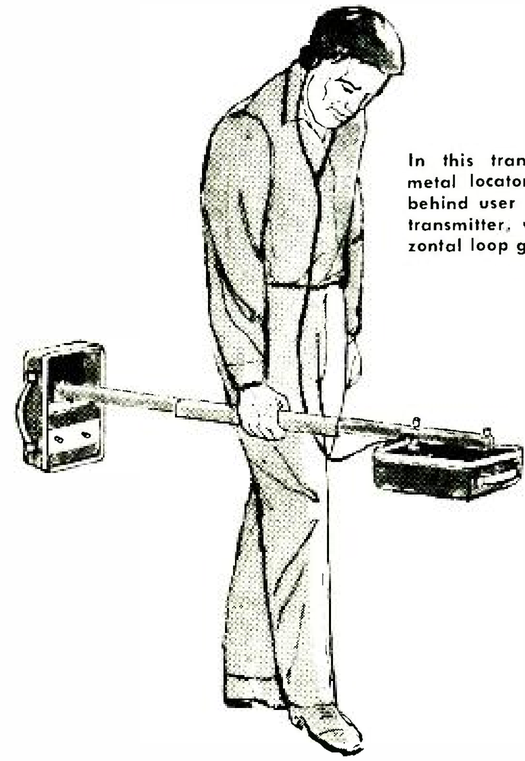
The size of the search loop will determine the depth penetration and the small-object resolution. The larger the loop, the deeper the penetration, and the larger an object has to be to produce detection. As an example, a target 1/10th the diameter of the search loop at very shallow depths will produce a mutual inductance of roughly 1/1000th the self-inductance of the loop, since the mutual inductance between loop and target varies as the cube of the target diameter. An inductance change of 1 part in 1000 will produce a frequency change of 1 part in 2000. In the case of a 100-kHz locator, this corresponds to a 50-Hz shift in audio output. If the search loop were ten inches in diameter, this would correspond to a one-inch diameter target.

Although simple in principle, there are many headaches involved in the design of a quality beat-frequency locator. The oscillators must be very stable, drifting no more than a few hertz per minute; otherwise the instrument must be continuously adjusted. The oscillators cannot be crystal-stabilized, for the tiny inductance changes produced in the search loop would be unable to pull a high-"Q" crystal oscillator even a few hertz.

A second problem is pulling and phase-locking. Two r.f. oscillators at nearly the same frequency will attempt

Induction-balance locator uses a more elaborate search loop.





In this transmitter-receiver metal locator, vertical loop behind user is connected to transmitter, while the horizontal loop goes to receiver.

to synchronize each other. This readily occurs if any energy from one oscillator is allowed to reach the other, either by direct radiation or through common supply impedances. Since both oscillators must meet at the mixer, the mixer stage represents a critical design area. High-impedance, non-pulling inputs are required at this point, along with careful shielding and supply decoupling.

One interesting way to avoid the phase-locking problem entirely is to use a conventional AM radio as a mixer and detector, using the reference frequency of a local AM station as a transfer oscillator. Some commercial models carry this to an extreme; they are simply oscillator attachments that clip onto a transistor radio. Although attractive in principle, many compromises are often involved, not the least of which is finding a strong AM station in many areas where such a locator would be used.

Another major problem is that of stray capacitance to ground. Any change in capacitance seen by the loop assembly will also change the loop oscillator's frequency. This could be caused by varying instrument height, the motion of the operator, or foliage effects. One method of minimizing capacitance effects is to use single-turn loops, which result in a very high C to L ratio and a large amount of fixed capacitance shunting the loop. A second method is to use an electrostatic Faraday shield which prevents any external stray capacitance from having any effect upon the loop resonance. A slot must be placed in the shield in order to pre-

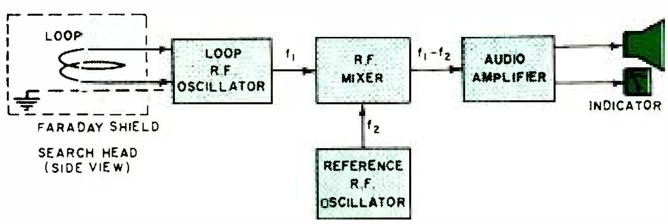


Fig. 1. Block diagram of the beat-frequency metal locator.

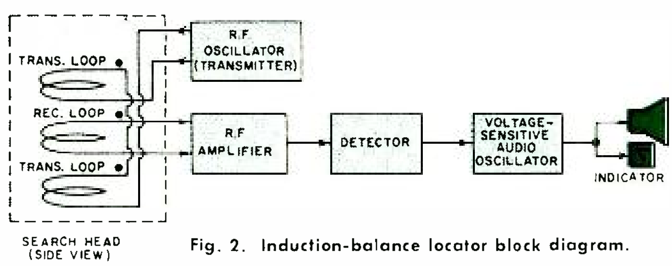


Fig. 2. Induction-balance locator block diagram.

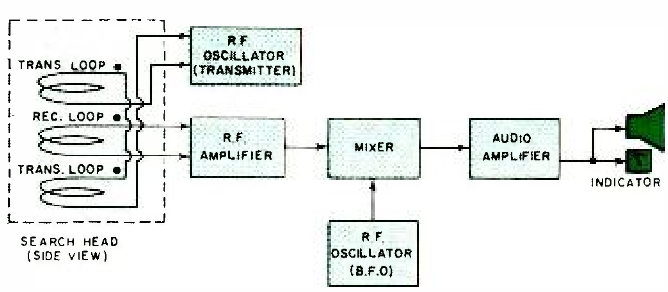
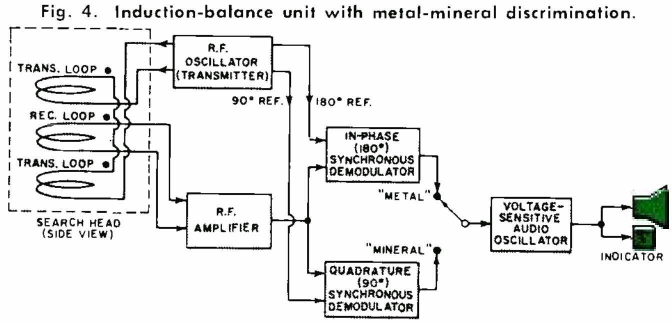


Fig. 3. Alternate audio scheme for the induction-balance locator.

Fig. 4. Induction-balance unit with metal-mineral discrimination.



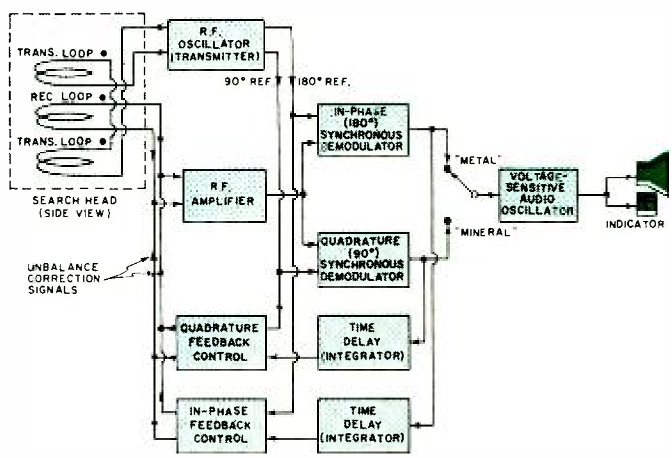


Fig. 5. Automatic drift correction in induction-balance unit.

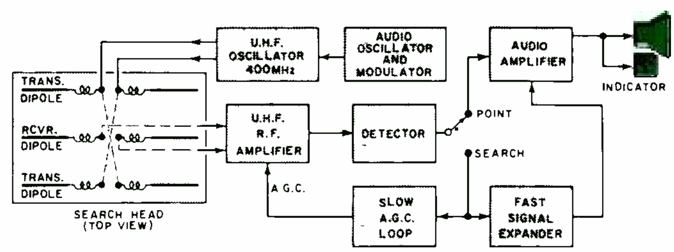


Fig. 6. U.H.F. induction-balance locator operates on metals or non-metals. Search mode eliminates spurious terrain response.

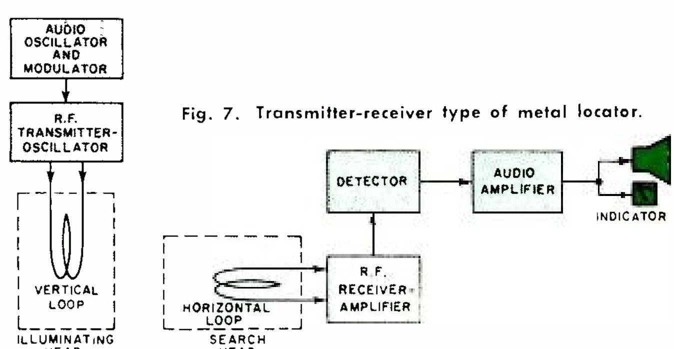


Fig. 7. Transmitter-receiver type of metal locator.

vent the shield from acting as a shorted turn and severely lowering the "Q" of the search-loop assembly that is employed.

Induction-Balance Locator

This is a more sophisticated instrument of better sensitivity and resolution. Depth penetration is better, yet still somewhat limited, and an excellent sensitivity to tiny metallic objects can often be obtained. Fig. 2 shows a typical block diagram. Three loop antennas are used, stacked vertically within the same search-head assembly. The top and bottom loops are connected to an r.f. oscillator; the middle one is connected to a sensitive r.f. amplifier. The two transmitting loops are fed out-of-phase. Under no-target conditions, their induced voltages very nearly cancel each other in the receiving loop, resulting in very little net induced receiver voltage. The presence of a target below the bottom loop will upset the balanced induced voltages and produce a signal in the receiving loop. This unbalance signal is then amplified and appears as an output.

The design problems here are entirely different from those of the beat-frequency locator. Mechanical stability of the search head is very important, for the loops must be perfectly planar. Temperature and stress can produce breathing of the loops, which can upset the induction balance. No metallic fasteners should be used on the search head, and a minimum of metallic parts of any kind in the vicinity of the search head is highly desirable. A stable transmitter frequency, unaffected by search-head stray capacitance, is mandatory. In the more sophisticated designs, all circuitry must also be phase-stable and drift-free, particularly with respect to temperature or battery voltage.

Since modulating the r.f. source presents balancing problems, c.w. oscillators are normally used whose detected-target output voltage will be d.c. This output may be used to deflect a meter or power an integrated sonic module. Another alternative is to form an audio beat note with a second oscillator and mixer tuned to 1 kHz or so away from the main transmitter. The beat note will have its amplitude proportional to target unbalance and can be amplified to power a loudspeaker or a pair of headphones. Such an alternate system is shown in Fig. 3.

Target Discrimination

Some fancy techniques allow the induction-balance locator to discriminate between conductive metallic targets and magnetic minerals such as black sand or soils with a high iron-ore content. This allows the locator to see through the remanent magnetism of the soil, greatly enhancing the sensitivity to marginal targets.

These techniques are accomplished by using the *phase* information in the received signal. The receiver and transmitter are inductively loose-coupled, so there will be a 90° phase difference between the receiver *voltage* and the transmitter *current*. A conductive target will be inductively coupled *twice*, once from transmitter to target and once from target to receiver, so the receiver unbalance voltage due to a target will be phase-shifted twice 90°, or 180°.

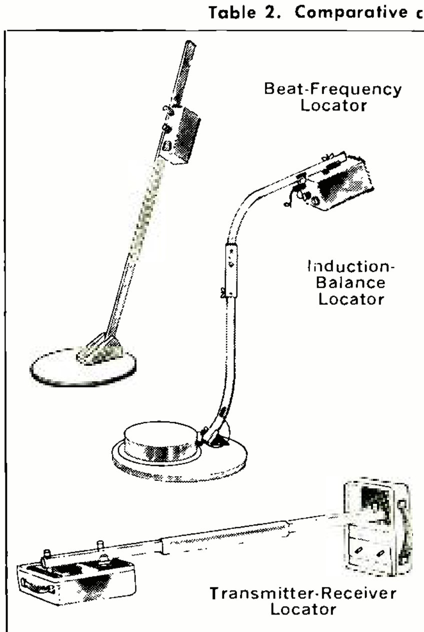
Magnetic sands and remanent magnetism in soils will simply increase and distort the inductive coupling without introducing a resistive (180°) component. Thus, there will be a 90° phase difference at the receiver between conductive targets on the one hand and magnetic soils on the other hand.

To discriminate between the two, two demodulators (detectors) are used, both of which are *synchronized* to the transmitted signal. An "in-phase" (180°) demodulator will detect *only* the return from conductive targets, while a "quadrature" (90°) demodulator will detect only magnetic minerals. A "Metal-Mineral" selector switch is used to route the desired output to the indicators. Fig. 4 shows a block diagram of this type of locator.

Automatic Drift Correction

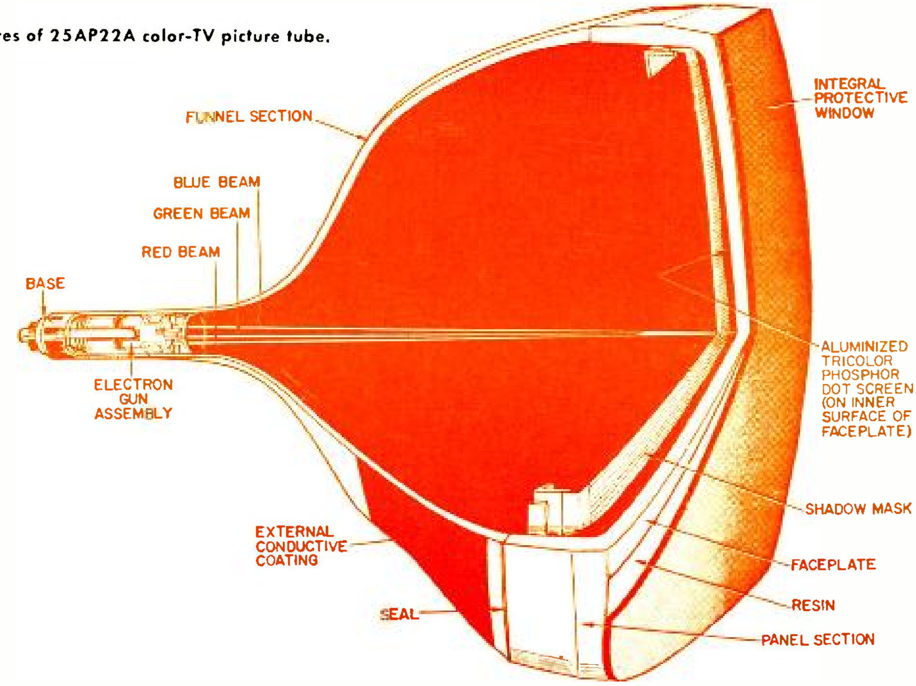
The induction-balance locator can also be made to automatically correct its own unbalance due to loop breathing, ground effects, and varying instrument height. Feedback techniques are used. The output of each phase detector is used to control the introduction of just enough in-phase and quadrature transmitter power of proper polarity to exactly buck out the unbalance signal at the input to the r.f. amplifier. Enough time delay (integration time) is introduced into the feedback path to allow the detection of targets. Otherwise, the target signals would be bucked out with the unbalance and no output would ever reach the indicators. Two to five seconds of delay allows the correction circuitry to keep up with gradual changes in soil conductivity and instrument height yet lets the sudden appearance of a target produce a strong output. One of many possible systems is outlined in Fig. 5. (*Continued on page* 62)

Table 2. Comparative characteristics of the basic types of metal locators discussed in accompanying article.



	BEAT-FREQUENCY LOCATOR	INDUCTION-BALANCE LOCATOR	TRANSMITTER-RECEIVER LOCATOR
1. DEPTH PENETRATION	POOR	BETTER	EXCELLENT
Maximum depth at which a small object produces a strong return	1 foot	2 feet	8 feet
2. RESOLUTION	GOOD	EXCELLENT	POOR
Smallest object detectable at four inches depth	Ring or large coin	Metal nugget or small coin	3" sphere
3. WEIGHT	LIGHTEST	HEAVY	HEAVIEST
Typical weight of commercial models	1-5 pounds	3-15 pounds	9-25 pounds
4. COST	LEAST	MODERATE*/HIGHEST**	HIGH
Typical economy commercial unit	$30	$100* $150**	$125
Typical quality commercial unit	$80	$200* $350**	$225
5. UNIQUE FEATURES	Discriminates between magnetic and non-magnetic conductors	Can discriminate between conductive targets and magnetic soils and ores**	Can triangulate for depth indication
6. COMMON APPLICATIONS	Beachcombing. Locating lost jewelry	Exploring Coin finding	Pipe tracing Prospecting

*Non-synchronous
**Synchronous
Individual instruments will vary widely from performance suggested in this table.



Construction features of 25AP22A color-TV picture tube.

The Modern Shadow-Mask Color-TV Tube

By R.K. GESSFORD / Manager, Technical Liaison, Electron Tube Div., Sylvania

Many articles have been written about the improvements in color-TV circuitry. However, unconsidered by many are the great parallel strides that have been made to produce a better type of shadow-mask CRT to go with the new circuits.

ALTHOUGH the performance of shadow-mask color picture tubes has been greatly improved in the past fifteen years, the real significant improvements have occurred within the past six or seven years. The most important of these will be described in some detail in the following article.

A lot of space would be required to set down the tremendous strides represented by design improvements over this period. These innovations include contributions from all phases of industry, such as chemical, glass, graphic arts, metal fabrication, and many others, as well as from the electron-tube design engineers of the electron-tube industry itself. The industries mentioned have made great progress in the development of new materials and in the techniques of processing and applying them.

Now we come to what might be called the modern shadow-mask color television tube—the wider angle, smaller (shorter) neck diameter, rectangular screen, rare-earth phosphor tube.

Probably the best-known visible innovation in this area was the changeover from the relatively low brightness sulphide phosphors to the higher brightness rare-earth types. However, this change represents only one milestone in the design of the modern color CRT. Obviously, the vast bulk of these changes occurred within the glass bulb where they are out of sight but, without them, color receivers would suffer.

The first move in this direction was from 70° to 90° deflection and to a 23-inch diagonal, rectangular, small-neck bulb. The increase in deflection angle from 70° to 90° and change from round to rectangular shape, though simple in monochrome, was a major step in color tube progress because of the completely new problems associated with color tube manufacture as well as color tube use. Much had to be learned about how to optically print the dot screen with a light source and lens that came close to duplicating the trajectory of the electron beam after it had been acted upon by the neck (sweep) components. This development was brought about by using, through special handling and reworking, the bulb originally designed for the 23-inch monochrome picture tube. This was done because there was no specific color bulb of the 90° rectangular variety available. A lot of hard work and sound engineering evaluation went into the development of 90° deflection, smaller-neck tubes, which incidentally included work on a 21-inch, 90° round tube too.

The rectangular bulb seemed a natural step in the progression of bulb sizes and shapes, and so the 21-inch, round 90° tube was put aside and a 25-inch, 90° rectangular tube with a smaller neck diameter (1 7/16 inches instead of 2 inches) was developed by the glass industry specifically for use by tube manufacturers. It might be asked why the first rectangular tube turned out to be a 25-inch device. This was deliberate, for in order to have the same vertical height in the picture as the 21-inch, 70° or 90° round tube had, and with the proper aspect ratio, a rectangular tube with a 25-inch diagonal measurement was required.

In the normal scheme of things it seemed that there was also a place for a somewhat smaller color tube, one that might be put into smaller cabinets and operated at some reduced anode voltage, yet still perform well. The end result of deliberation along this line between the tube producers and the glass supplier brought forth the 19-inch, 90° rectangular tube, the second rectangular 90° bulb in the shadow-mask color tube design family.

The next step down in color tube size appeared to be a 15-inch, 90° rectangular tube. At this point, however, consideration was also given to what other benefits might be offered to the receiver manufacturer through design

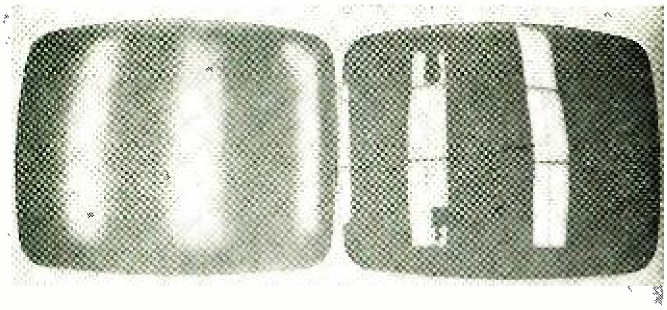


Fig. 1. Example of how etched surface (left) reduces amount of glare reflected off the front surface of a picture tube.

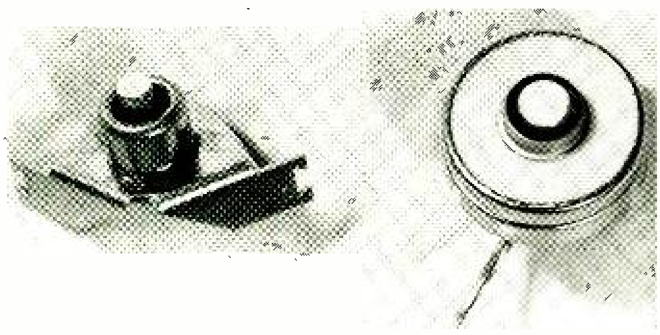


Fig. 2. (Right) Cathode of a 70°, 21-inch color tube. (Left) The improved design as used in the latest 90° rectangulars.

changes. It turned out that the use of low-voltage focus electron-gun structures instead of the high-voltage equipotential-lens type appeared to provide the greatest advantage to the receiver manufacturer, for it simplified the circuitry by eliminating the need for a variable high-voltage source on the order of 4 to 5 kV and substituting a need for only a −75 to 400 volt source. This new focus characteristic for the color tube had been used in monochrome tubes for some time, but putting it into a triple-gun color tube presented different problems, as will be discussed later in the article.

Continuing the progression of tube sizes, but going outside the family of 25-, 19-, and 15-inch rectangular designs, the 11-inch, 70° rectangular tube appeared. This tube departed from conventional design and sacrificed some performance to obtain certain economies and portability. The departures consisted of a coarser dot screen and a different phosphor dot arrangement with larger dots. The circuits associated with the external neck components, and their adjustments, were simplified. Having three guns in line rather than the familiar triangular configuration, plus a low-inductance single-layer toroidal yoke, provided chassis economies.

Next came indications that the industry was interested in a 21- or 22-inch, 90° size. In line with this, bulbs have been developed and samples have been released which otherwise follow the present design family of 25-, 19-, and 15-inch, 90° types. How soon production quantities will be forthcoming is still dependent upon the tube manufacturers' ability to produce the needed quantities of the earlier sizes and types.

So much for a thumbnail sketch of the recent moves in the color tube size story. Now let us go back and examine the behind-the-scenes side of the modern shadow-mask color tube and the changes that have taken place in its design to make it an efficient reproducer of color pictures.

Face Plates

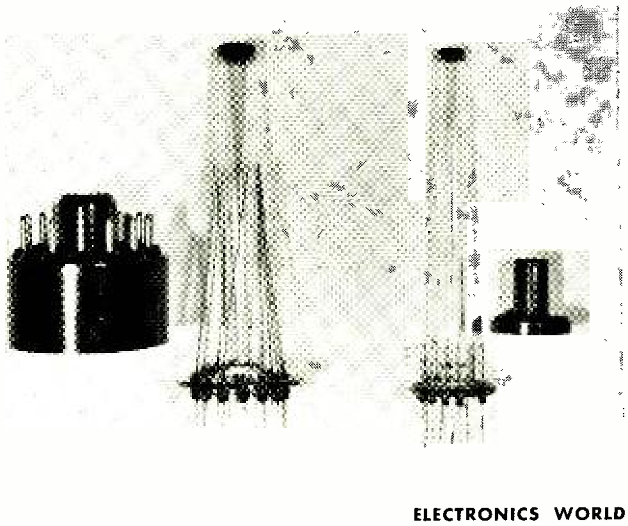
For example, a few years ago when color television started to take hold, color tubes could be obtained without a bonded-on cover plate, with a bonded-on cover plate having a polished surface, or with a bonded-on cover plate whose surface was treated to reduce specular reflection. These different types of finishing touches to the color tube generally had different type numbers to identify them: for the unbonded type, 21FBP22; for the bonded-cover type with polished surface, 21FKP22; and for the bonded-cover type with treated surface, 21FJ22. This latter type was also frequently identified by placing the prefix AR before the type number to indicate that there was an anti-reflection finish in the form of a special surface treatment (chemical etch) on the bonded-on cover plate (for example, type AR21FJP22). The innovation of the bonded-on cover plate, with or without the anti-reflection finish, first came about on monochrome tubes in 1959. Besides reducing the hazard of implosion, it also reduced the number of reflective surfaces as well as the light loss due to the additional surfaces. (See Fig. 1.) The bonded-cover technique also eliminated the dirt trap between the tube and safety plate and eliminated the necessity for cleaning those surfaces. In addition, it provided a means of attaching a usable anti-reflection surface assembly close to the screened surface of the tube to minimize loss of resolution.

More recently, the cover plates, whose glass-transmission factor was originally standardized in monochrome at 55%, are being made in 70% as well. The original figure of 55% was decided upon by the industry as the best compromise between loss of light and improvement in contrast under the normal range of ambient or surrounding-light viewing conditions. The shift to 70% by some receiver manufacturers did not seriously change the contrast, and the increase in transmission allowed more light from the picture to pass through which, of course, increased the highlight brightness level.

Electron Guns

The move from 70° to 90° deflection, brought out in the 25-inch color bulb, called for a considerable change in gun design and assembly. The smaller gun assembly and neck diameter allowed a smaller diameter yoke for increased deflection power efficiency and also reduced beam separation in the deflection yoke so that the problems of convergence caused by the increased deflection angle were minimized. Further, a gun design improvement in the structure of the triple-gun package was a cup-shaped, one-piece or deep-drawn cage for the radial pole pieces to increase the accuracy of the assembly and provide the uniformity requirements demanded by the wider angle of the 90° rectangular types. Another principal advantage was better electrostatic shielding from charges on the neck in the clear areas opposite the electron guns. These areas tend to collect

Fig. 3. (Left) Flexible lead stem, cemented-on base, as used in 21-inch round, 2-inch neck, 70° tubes. (Right) The rigid lead stem for the 1 7/16-inch neck, 90° rectangular tubes.



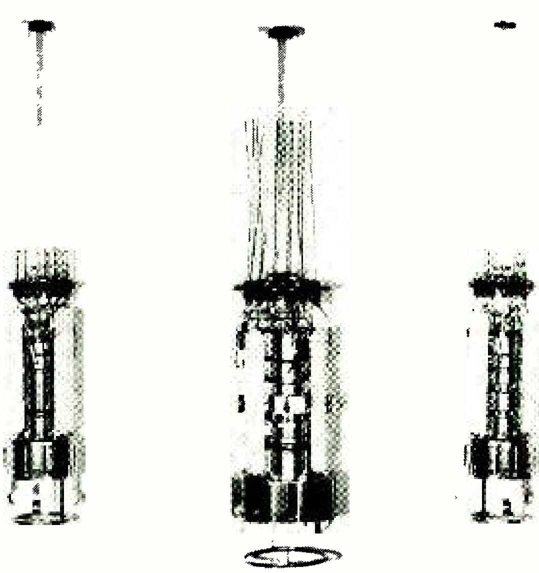
stray electrons and charge up in a non-uniform manner, thus producing a distorted field in regions where the electron beam can be affected. The other elements of the guns were reduced in diameter to allow the triple-gun package to fit into the smaller neck. The problems of voltage breakdown due to the closer spacing of the elements of the electron optic system, as well as the compression of the triple-gun package became more critical and added to the operations required to control this area. Greater care in alignment of parts due to the increase in lens aberrations that goes with the use of smaller diameter gun parts and the use of tighter tolerance parts and jigs were a must.

Along with all the foregoing changes, completely new and more effective cathode and heater designs were developed for the 90° gun. (See Fig. 2.) The cathode structure was made more efficient by improved mounting and shielding. Microphonics were reduced and the thermal efficiency of the cathode was improved by about 40%. The improved mounting of the cathode reduced microphonics (visual) by cutting down unwanted movement of the cathode. Early structures used cathodes crimped in ceramics and the crimp was not always tight. In addition, this assembly did not always remain immovable in the control grid so that, with vibration present, the spacing between the cathode and the control grid aperture could change. This would show up as a change in modulation or light output on the screen. The reduction in power input, besides lowering circuit requirements, had an added advantage in that it decreased the heat transferred to both the stem and the gun parts and diminished the movement of gun parts, which in turn reduced convergence drift.

All of these areas were dealt with and the design changes and development problems overcome by closer attention to processing and assembly of parts and high-voltage treatment of the finished tube to provide a product that would be equivalent to the 70° round tube—one that would give equal performance and operate under the same conditions of high voltage and current.

The foregoing only touches on the highlights of the changes and improvements brought about by the move to a 90° rectangular tube. All of the attendant tube structure changes, such as a new rigid-lead wafer stem instead of the flexible-lead type and a push-on base instead of the cemented-on soldered-lead type (see Fig. 3) helped to reduce the length of the tube, increased reliability of the 90° tube, and provided receiver manufacturers with a product performance equivalent to the earlier round 70° color tube.

Fig. 4. (Left) Low-focus gun for 15-inch tubes. (Center) Typical flex lead stem. (Right) Gun used in 90° high-focus tubes.



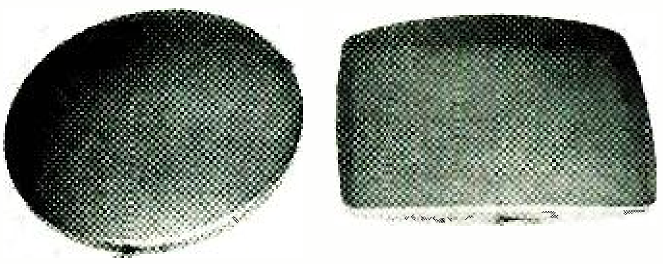
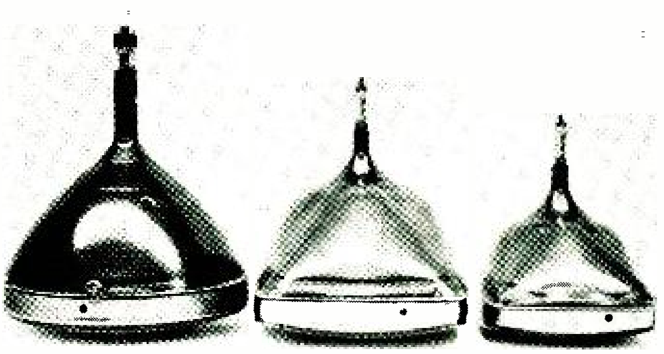


Fig. 5. The rectangular shadow mask is more difficult to fabricate than a round one because it is unsymmetrical in shape.



Proportionate size reduction in the progression from a 21-inch round (left), 25-inch rectangular (center), and 19-inch rectangular (right) shadow-mask color-TV tube. Besides squaring off the picture, the new tubes permit use of smaller cabinets.

In the previous discussion of tube sizes, it was noted that with the advent of the 15-inch, 90° tube there was a change from the high-voltage electron-tube focus gun of the equipotential-lens variety to the low-voltage electrostatic focus (Einzel) type lens such as shown in Fig 4. This gives the circuit designer an advantage, for it eliminates the need for a separate high-voltage supply required by the high-voltage electron optical focusing system. The Einzel, or saddle-lens system, is basically a less effective focusing system for it does not produce as good an electron beam bundle and therefore makes a larger spot. There is a partially compensating factor due to the shorter tube wherein the "throw" (optics to screen) distance is reduced. This compensation is present in any shorter tube so that even the 25- or 19-inch unit gains something from this factor. However, this does not reduce the need for close attention to the other factors of gun design which play a part in focus quality, namely, good gun parts, close tolerances on both parts and jig mandrels (fit), and good alignment.

Along with the benefits of this system appears a problem that should be mentioned as it affects the ratings of a low-focus voltage tube, at least for the present. This is the complication of how to jig and assemble a triple gun of the low-focus variety with additional and difficult-to-align elements. Needless to say, the design and condition of the jigs, the fit and quality of the parts, as well as their alignment makes it even more imperative that every attention be paid to the control of this critical gun assembly operation to get an acceptable unit. With the move to low-focus voltage comes an increase in the possibility of high-voltage breakdown between the low-voltage and high-voltage elements of the gun. For the present at least, the rating (final anode maximum voltage) has been reduced to keep the potential difference between final anode and focus anode approximately the same as in the high-focus voltage gun design. Unfortunately, this (*Continued on page 73*)

Author is shown here working on the aircraft transmitter-receiver unit which employs frequency synthesizer described.

Crystal-Saving Frequency Synthesizer

By F. PATTERSON SMITH

Project Engineer, R & D
National Aeronautical Corp.

A novel method of generating many crystal-controlled frequencies which reduces cost of multiple-channel communications equipment. The synthesizer's design, possible FM receiver and CB transceiver applications, and typical circuit in aircraft equipment are covered.

CRYSTAL-controlled equipment offers the user detented tuning and drift-free operation. Additionally, it lends itself to remote operation with suitable diode switching. These features are desirable for many applications. However, the high cost of a large number of crystals has limited usage primarily to military and industrial markets. Usually multi-crystal circuits appear only in consumer equipment when necessary to meet FCC requirements.

The system to be described significantly reduces the cost of crystal-controlled equipment and makes possible new applications previously considered economically unfeasible. In addition to the FM broadcast receiver, Citizens Band, and aviation examples to be described, other applications might include v.h.f. and u.h.f. TV receivers. This system appears desirable for any application requiring the user selection of any one of a number of channels in the same portion of the frequency spectrum.

How It Works

A single bank of crystals is employed with two oscillators independently connected to any crystal. One oscillator is controlled by the crystal's fundamental vibration mode, while the other is controlled by a desired overtone mode of the crystal. If, with proper precautions, both oscillators are connected to the same crystal, this crystal will vibrate simultaneously and independently in both modes; and the frequency of one oscillator is essentially independent of the connection of the other. (Patent No. 310,378)

This system may be used to generate many crystal-controlled signals as shown in Fig. 1. It is assumed that three crystals are available with third overtone frequencies of 30.0, 30.3, and 30.6 MHz. These same crystals will also oscillate in their fundamental mode at about 10.0, 10.1, and 10.2 MHz.

If we are only interested in the sum of these frequencies, one possible synthesis, it may be seen that nine new frequencies may be obtained when $f1$ and $f3$ are mixed and filtered. The fundamental $f1$ or low-frequency oscillator (l.f.o.) is in 0.1-MHz steps. The overtone or high-frequency oscillator (h.f.o.) is in 0.3-MHz steps. The synthesizer's output ($f1 + f3$) is nine crystal-controlled frequencies in equal steps, employing only a three-crystal bank.

It may be seen that there are many variations available including subtraction of the individual frequencies gener-

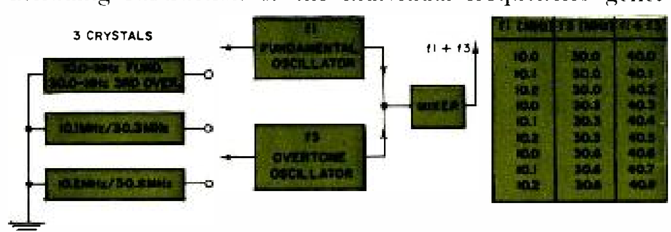
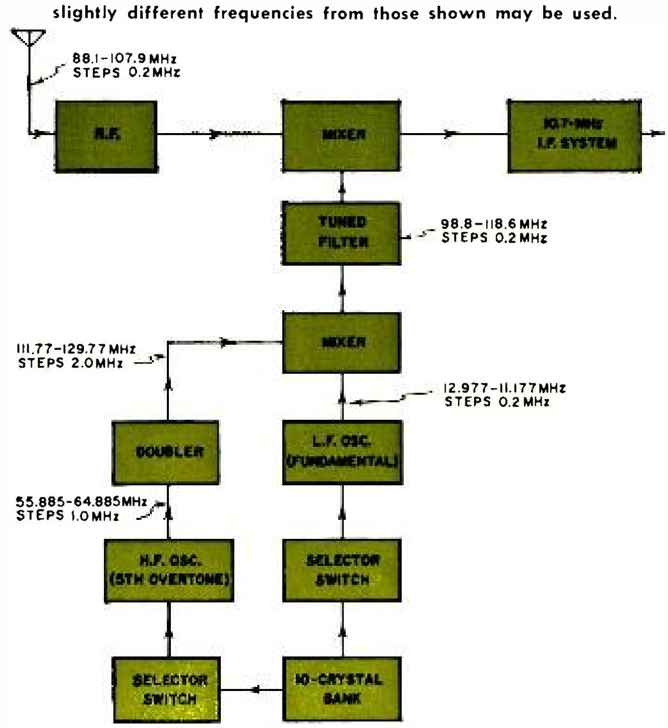


Fig. 1. The basic synthesizer along with its output frequencies.

Fig. 2. A 10-crystal synthesizer for FM receiver use. In practice, overtones may not be precisely related harmonically so slightly different frequencies from those shown may be used.



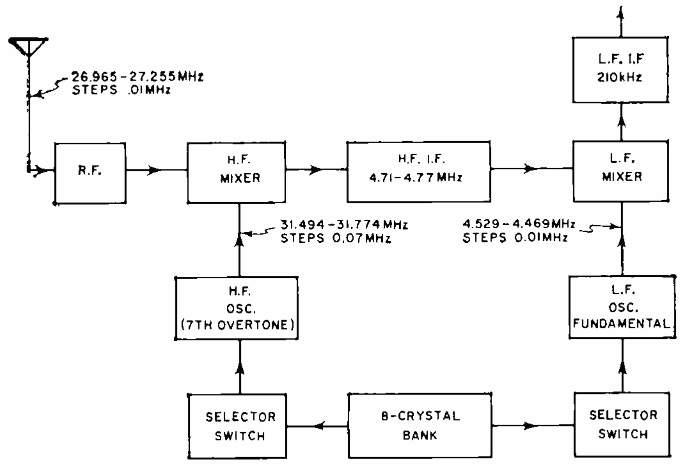
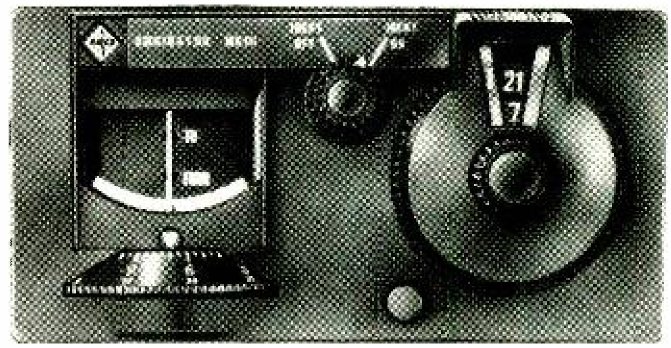


Fig. 3. An 8-crystal synthesizer designed for a CB transceiver.



Front-panel view of the v.h.f. radio navigation and communications equipment which provides for direct manual selection of 100 navigation reception channels and 90 communications channels, all crystal-controlled. Direct-reading dial at the right is set to frequency of 121.7 MHz. Thumb-wheel dial at left along with indicator are employed for aircraft navigation.

CB Channel No.	R.F. Frequency (MHz)	L.F.O. (MHz)	Xmtr. H.F.O. (MHz) (7th Overtone)	Receiver H.F.O. (MHz) (7th Overtone)
1	26.965	4.529	31.494	31.284
2	26.975	4.519		
3	26.985	4.509		
4	27.005	4.489		
5	27.015	4.479		
6	27.025	4.469		
7	27.035	4.529	31.564	31.354
8	27.055	4.509		
9	27.065	4.499		
10	27.075	4.489		
11	27.085	4.479		
12	27.105	4.529	31.634	31.424
13	27.115	4.519		
14	27.125	4.509		
15	27.135	4.499		
16	27.155	4.479		
17	27.165	4.469		
18	27.175	4.529	31.704	31.494
19	27.185	4.519		
20	27.205	4.499		
21	27.215	4.489		
22	27.225	4.479		
23	27.255	4.519	31.774	31.564

Table 1. Frequencies employed in the 8-crystal circuit of Fig. 3.

ated, use of an overtone mode for the l.f.o., frequency multiplication or division before combining, and even three or more mode crystal oscillation. This technique of frequency synthesis permits operation of the systems to be described.

Past Usage of Synthesizers

Usage of crystal control in the aviation market parallels other fields. Early equipment utilized one crystal for each transmitter channel, plus a variable-tuned receiver. With the increase in communications requirements, more channels were added. The next generation of equipment used two crystal banks—one bank in 1.0-MHz steps, the other in 0.1-MHz steps. When properly mixed, these became the synthesized signal used in the transmitter.

Later equipment used these same crystal banks, plus a few more crystals, to generate the local-oscillator signals for the accompanying receiver. The system outlined in this article simply makes possible the use of a single crystal bank to generate these same 1.0-MHz and 0.1-MHz steps.

It is recognized that single-crystal synthesizers are available and offer significant advantages especially where extreme stability and small frequency increments are required. However, the complexity of obtaining sufficiently pure signals reliably has prevented their use in the general aviation market to date.

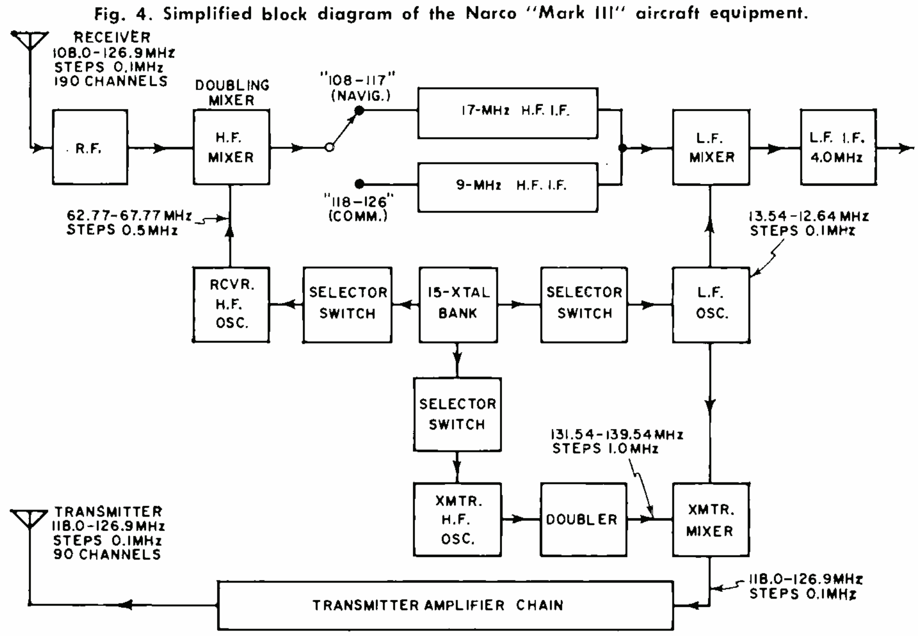
Some previously proposed systems have utilized the crystal bank twice, but all appear to use essentially the same frequency for each connected oscillator. With such a system, it has not been economically feasible to separate the frequencies, and excessive spurious components result. With the large frequency separation existing between the fundamental and the overtone modes, however, simple filtering can readily isolate the desired component.

FM Broadcast Receiver Applications

It appears that this synthesis approach could be applied to the design of a crystal-controlled receiver for the FM broadcast band. The direct approach of synthesizing the same local oscillator signal presently used could be employed as indicated in Fig. 2. Careful shielding of the synthesizer is required, since the h.f.o. can be close to the receiver's image response and harmonics of the l.f.o. may cause difficulty. Ten crystals are required to select any of the 100 channels.

An FM receiver employing only eight crystals and a 5-MHz i.f. system may also be designed. Other frequency choices are possible. If only 98 channels are required, a seven-crystal synthesizer may be used. The lower (5.0-MHz) i.f. system requires good r.f. image rejection and the channel-selection switching becomes more complex. In this case, the local-oscillator injection is above the signal in

Fig. 4. Simplified block diagram of the Narco "Mark III" aircraft equipment.



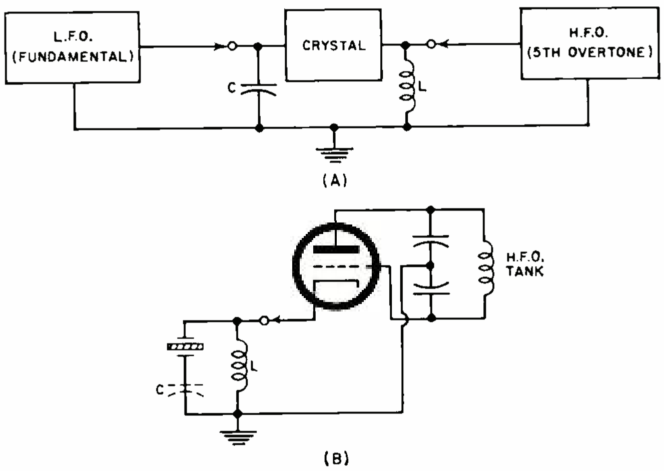


Fig. 5. (A) Simultaneous crystal operation using series circuit. (B) A high-frequency oscillator employing a series circuit.

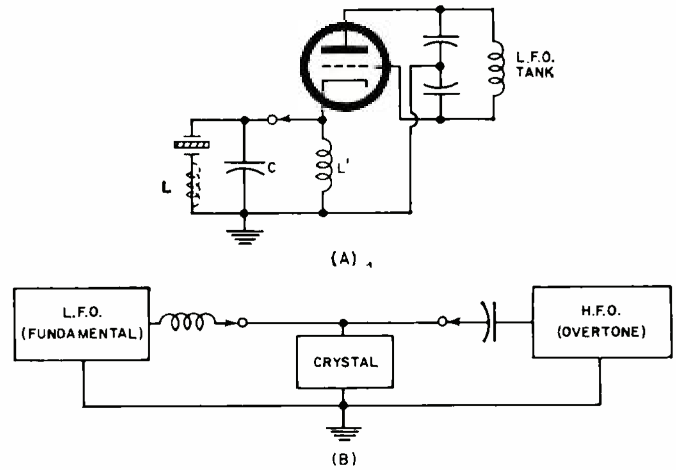


Fig. 6. (A) Low-frequency oscillator series circuit. (B) Simultaneous crystal operation by means of shunt circuit is also used.

the lower half of the band and below the signal in the upper. A double-conversion receiver approach may be employed in order to reduce the shielding requirements.

Citizens Band Applications

A 23-channel Citizens Band transmitter synthesizer may be designed using six crystals and this same basic technique.

The design of an all-channel crystal-controlled, double-conversion transceiver for Citizens Band is more complex and many different frequency systems are possible. One version is shown in block form in Fig. 3 with frequencies tabulated in Table 1. Eight crystals are employed in this system. Only seven crystals would be required if channel 23 is omitted. The output low-frequency i.f. is 210 kHz placing severe selectivity requirements on the high-frequency i.f. section that would be employed.

Table 2. Frequencies used in the 15-crystal circuit shown in Fig. 4.

HIGH-FREQUENCY OSCILLATORS				
TRANSMITTER		R.F. CHANNEL (MHz)	RECEIVER	
H.F.O. (MHz) (5th Overtone)	H.F.O. (MHz) (Doubled)		H.F.O. (MHz) (5th Overtone)	H.F.O. (MHz) Doubled
		108	62.771	125.542
		109	63.271	126.542
		110	63.771	127.542
		111	64.271	128.542
		112	64.771	129.542
		113	65.271	130.542
		114	65.771	131.542
		115	66.271	132.542
		116	66.771	133.542
		117	67.271	134.542
65.771	131.542	118	63.771	127.542
66.271	132.542	119	64.271	128.542
66.771	133.542	120	64.771	129.542
67.271	134.542	121	65.271	130.542
67.771	135.542	122	65.771	131.542
68.271	136.542	123	66.271	132.542
68.771	137.542	124	66.771	133.542
69.271	138.542	125	67.271	134.542
69.771	139.542	126	67.771	135.542

LOW-FREQUENCY OSCILLATORS			
R.F. Channel (MHz)	L.F.O. (MHz) Fundamental	"108-117 MHz" H.F. i.f. (MHz)	"118-126 MHz" H.F. i.f. (MHz)
.0	13.542	17.542	9.542
.1	13.442	17.442	9.442
.2	13.342	17.342	9.342
.3	13.242	17.242	9.242
.4	13.142	17.142	9.142
.5	13.042	17.042	9.042
.6	12.942	16.942	8.942
.7	12.842	16.842	8.842
.8	12.742	16.742	8.742
.9	12.642	16.642	8.642

Aviation Equipment Example

The frequency synthesis used in the new *Narco* "Mark III" communication/navigation package for aircraft employs this single crystal bank principle. A block diagram of this unit is shown in Fig. 4, with frequencies tabulated in Table 2.

Note that 190 receiver channels are provided, while the transmitter covers only the upper 90 channels. To reduce the number of crystals required by the receiver, a switched high-frequency i.f. is employed. This h.f. i.f., which passes signals ± 500 kHz from center frequency, is tuned to 17 MHz when the receiver frequency selection is 108-117 MHz, and tuned to 9 MHz when reception is required between 118 and 126 MHz. All the required channels are selectable. Fifteen crystals are required for this 190-channel receiver and 90-channel transmitter. Previous designs required 29 crystals for the same receiver/transmitter frequency coverage.

Circuit Operation

Operation of the system is reasonably straightforward when the high-frequency oscillator and low-frequency oscillator are connected to different crystals. To provide the necessary function of common crystal operation requires simple *LC* networks in the crystal circuits.

Several techniques may be employed to connect the oscillators to the crystal bank. One possible version places the crystal in series between the two oscillators as shown in Fig. 5A.

Assuming for the moment that only the h.f.o. is connected to a given crystal, the circuit will be as shown in Fig. 5B. This is a capacitively tapped oscillator with the crystal inserted in series with the low-impedance cathode lead. The inductance *L* functions to neutralize crystal, stray, and tube (cathode to ground) capacitances, insuring frequency control on the desired overtone.

Assuming that only the l.f.o. is connected to a given crystal, the circuit will be as shown in Fig. 6A. This circuit is similar to the h.f.o. and also operates the crystal in series with the cathode. The inductance *L'* neutralizes the sum of capacitor *C*, crystal, stray, and tube capacitances. For wide-band

(*Continued on page 69*)

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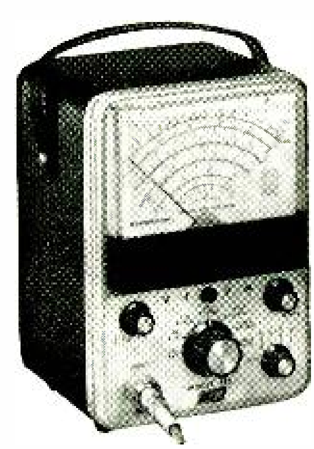

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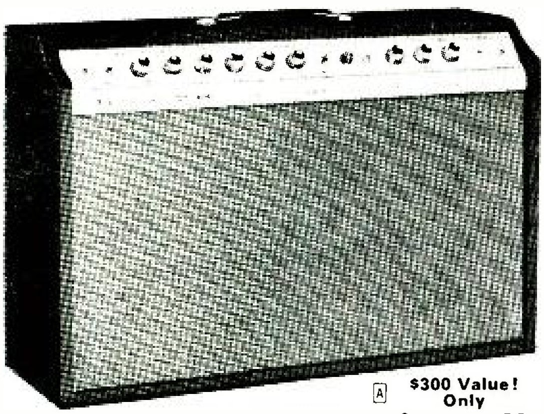

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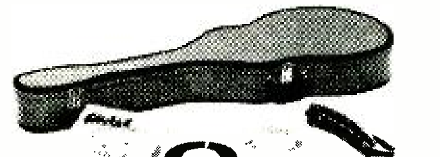

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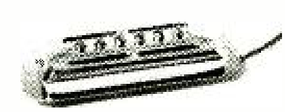

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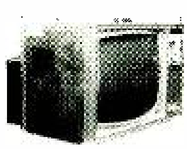

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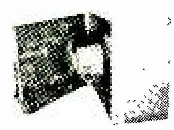

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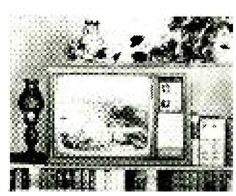

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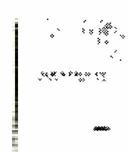

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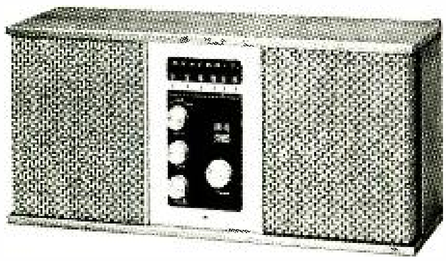

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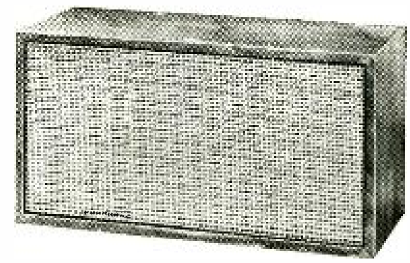

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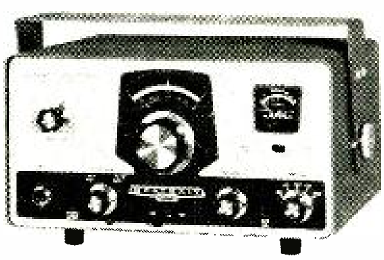

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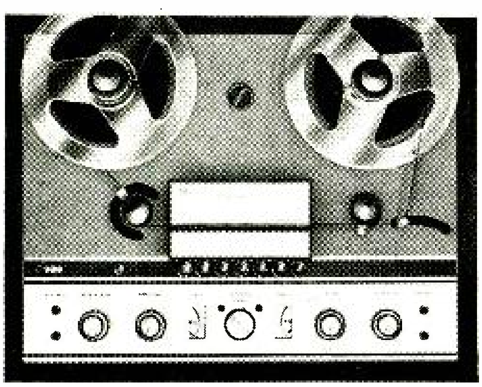

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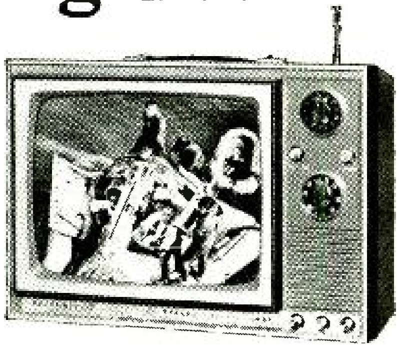

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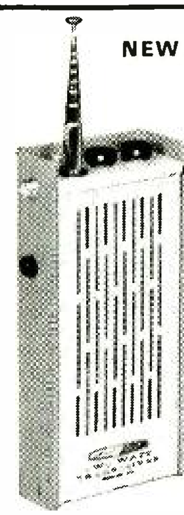

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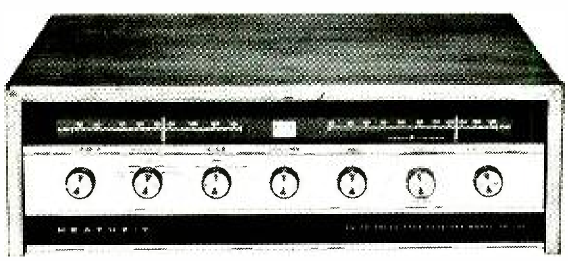

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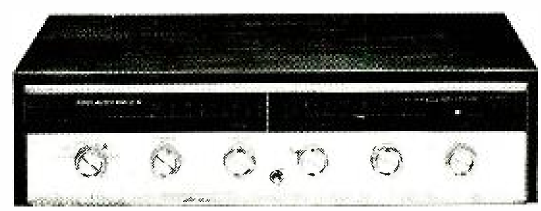

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JOHN FRYE

Technician honesty is not the simple black-or-white affair many newspaper and magazine writers would have us believe.

Integrity in the Service Shop

FEATHERY flakes from the first real snow of winter were sliding down the window of Mac's Service Shop as the owner returned from lunch. "Looks like we're in for it," Barney, his assistant, offered as he helped Mac brush the snowflakes from his shoulders. "Hey, you look kind of funny. Anything happen at lunch?"

"Yes, something *did* happen that upset me. I saw an honest man in action. Remember Mark Twain's saying, 'Always do right. This will gratify some people and astonish the rest'? Well, he wasn't kidding."

"Tell me about it."

"Bert Gardner and I were having lunch together, and an insurance adjuster stopped by to talk to Bert about the loss of his TV tower and antennas in that windstorm the first of the week The first thing Bert did was to sound off in no uncertain terms about his renewed policy that had just gone into effect ten days before the storm. The new policy included a $50 deductible feature against windstorm and hail losses; yet the premium on the home-owner's policy had been jacked up 10%.

"Once that was off his mind, Bert gave the adjuster an estimate I'd prepared on the cost of replacing the tower, antennas, rotator, lead-ins, etc. However, he made it clear that he did not intend to replace the installation. He was going onto the cable instead. The adjuster said this made no difference. Bert had suffered a loss and could do what he pleased with the money he received to cover that loss. The adjuster took my figures, knocked off the $50 I mentioned, subtracted another percentage for depreciation for the time the antenna tower had been standing, and then told Bert how much cash he could receive

"Bert thought about this for a few seconds, and then he shook his head. 'That's too much,' he said."

"'What did you say?' the insurance adjuster stammered in disbelief.

"'I said you were offering too much. Your figures are based on the cost of replacing the installation, which I'm not going to do. At the time I put up that tower, everything, including labor, was considerably cheaper; so I do not have that much in it Knock 20% off that figure you quoted, and that will be about right. I don't have any more coming.'"

"What did the adjuster say to that?"

"Not much. He was so amazed he couldn't talk. But that is the way it ended. After the adjuster had left, I pointed out to Bert that he seemed to feel the insurance company had taken advantage of him with their new policy; yet he passed up a golden opportunity to 'get even.'"

"'I know,' he said, 'but my feeling that I've been had doesn't give me a license to cheat—not even the party who took me. Wrongs always carry the same negative signs; so you can't cancel one with another. I can do little about the dishonesty of others, but I always remember what Carlyle wrote: *Make youself an honest man, and then you may be sure there is one less rascal in the world*. That's the simple creed I try to live by. I don't always make it, but I try.'

"That darned quotation has been haunting me ever since Bert uttered it," Mac confessed. "I've been thinking about it particularly in the light of recent bad publicity that radio and TV technicians received in a Midwest city as the result of another of those exposés where TV sets are deliberately 'gimmicked' and then taken to various shops for repair. As always happens, in this instance some shops installed parts not actually needed; others overcharged badly; only a few located the trouble and made a reasonable charge for the repair."

"Surely you don't condone that sort of thing."

"Of course not. But I can't help wondering how many of the technicians who didn't find the gimmicked trouble promptly were actually guilty of deliberate dishonesty Let me give you an example or so from other fields to show what I mean. Last fall I had a stubborn kidney infection. My doctor prescribed five different kinds of expensive antibiotics with no favorable results. In fact, I had a violent reaction to one and became much sicker than I was in the beginning. Finally, after I had wasted some sixty dollars on these, the doctor ran a culture test and found out just what antibiotic would kill the bugs causing the trouble. When I took this, the infection disappeared. But I didn't accuse my doctor of being dishonest or inept. I didn't demand he refund money wasted on drugs I didn't need. I didn't yell for the passage of a law to prevent this sort of thing. I realized the doctor had prescribed for me in good faith according to his knowledge and experience. Repairing any complicated thing, whether it be a broken-down body or a broken-down TV set, is not a simple cut-and-dried affair The most experienced person is bound to be misled by confusing symptoms and to make a wrong guess now and then.

"Another instance you know about is that of my brother's car motor that was misfiring. Remember how reputable and experienced mechanics installed new plugs, new distributor points, and a new capacitor before they finally located the defective resistor-type plug wire causing the trouble? They didn't take off the new parts they had installed that were not actually needed, and my brother did not expect them to. While the new parts did not cure his specific complaint, he paid for them because he had received virtually a 'tune-up' job on his car. And he knew any one of those parts *could* have logically been expected to cause his motor to miss. He didn't accuse the mechanics of trying to cheat him. He didn't complain to the Better Business Bureau.

"By the same token, I'll wager at least some of those technicians who put parts into the TV set not actually needed were simply displaying poor judgment, inexperience, or slovenly troubleshooting techniques. They were not deliberately trying to cheat the customer out of his money.

"But that brings me to another more serious type of dishonesty that besets some technicians. This is failure to do the best job of repairing a set they know how to do. It's the sort of thing that makes a technician simply stick

another horizontal output tube into a set after a couple of other new tubes have failed in that socket in as many months. He may try to tell himself it is just coincidence, but he knows in his heart he should find out WHY those tubes were failing. The same guy will call an intermittent radio 'repaired' simply because it hasn't cut out in a half-hour bench test—even though he never found any reason for the intermittent action. That radio will be back, and he knows it.

"Here the technician is trying to deceive himself. He is being false to his training, his experience, and his conscience. This is a vicious, corroding type of dishonesty that will do much more than earn him a bad reputation in the community. It will certainly destroy him as a technician if he persists in it."

"I believe I get you," Barney said slowly. "I've been thinking, and it seems to me that all the really good technicians I know—the ones who do their flat-out best on every job they tackle—are also honest with their customers. They do not work cheaply, and some people may think their charges high; but they give good honest work for those charges. Yep, I believe you've got something."

"It's not my idea and it's not new," Mac quickly disclaimed. "Remember the words of wise old Polonius? 'This above all: to thine own self be true, and it must follow, as the night the day, thou canst not then be false to any man.' "

"Hey, you never cease to amaze me!" Barney exclaimed. "I thought you never read anything but technical books and magazines, and here you are spouting Shakespeare!"

"I even read *Batman* comics," Mac retorted gruffly; "but let's get back to what we were saying. No one will ever convince me that the radio and TV service business has more than a normal complement of crooks. If a person is determined to make his living by cheating, there are lots easier ways of doing it than by repairing radio and TV sets. At the same time, I certainly will not deny that we have some dishonest people in our ranks. So has the medical profession, the legal profession, the law enforcement profession, and any other group you care to name. There was a Judas Iscariot among the twelve disciples.

"But I'm tired of these repeated attempts to 'prove' that most radio and TV technicians are dishonest by methods that smack of entrapment. I wonder how doctors would shape up if similar methods were used to test their honesty and proficiency. Suppose we sent a patient with beri-beri the rounds of the doctors. How many would diagnose it correctly immediately and initiate the proper treatment?

"Doctors insist they treat the whole body rather than just a single symptom. Isn't the technician who checks over the entire set after he locates and repairs an obvious defect doing exactly the same thing? If preventive medicine is good, why is preventive maintenance suspect in the TV shop? I've said it before and I'll say it again: I never saw a radio or TV set whose performance I couldn't improve at least a little if I set my mind to it. Am I to be condemned as dishonest because I try to make that radio or television set perform better than it did when it was brand new?

"In its final analysis, honesty is an individual matter. You can't legislate it. You can't license it into existence. Actually, we can do little to influence the honesty of others. But we can always, as Carlyle reminded us, reduce the rascal population by one. That's what we try to do in this shop. But our being 'honest' goes far beyond refraining from bilking a customer. After all, he is pretty much at our mercy. He doesn't know if he is getting his money's worth or not. But *we* know, and it is our aim to see that he receives the very best service we can provide. I don't need to tell you that it's a lot harder for a conscientious technician to please himself than it is to please an unknowledgeable customer, but that is our aim: to turn out a good honest servicing job by *our* standards."

"And I have the bruised ego to prove it," Barney said with one of his most disarming grins. ▲

DRY-TRANSFER LABELING

By A. A. MANGIERI

Dry-transfer labeling of completed equipment is often difficult because knobs, shafts, meters, and terminals, prevent proper placement of the transfer sheet. Any attempt to transfer individual titles cut from the sheet will usually end in failure because the sheet itself, with its tacky back, is relied upon to maintain position of the title while the transfer is made.

One solution is to remove the backing sheet. Then, with the tacky side of the title sheet upwards, cut the title from the sheet, using a razor blade. Place the title, tacky side down, on the backing sheet. Place a strip of Scotch tape over the title. Peel the tape, with adhered title, from the backing strip. Position the tape and title on the panel and burnish well. Peel the tape slowly from one end. If a portion of the title has not been transferred, lay the lifted portion of the tape down and rub again. Alignment will be perfect.

Multiple word titles are easily handled on one strip of Scotch tape. However, avoid placing the tape over previously transferred titles. ▲

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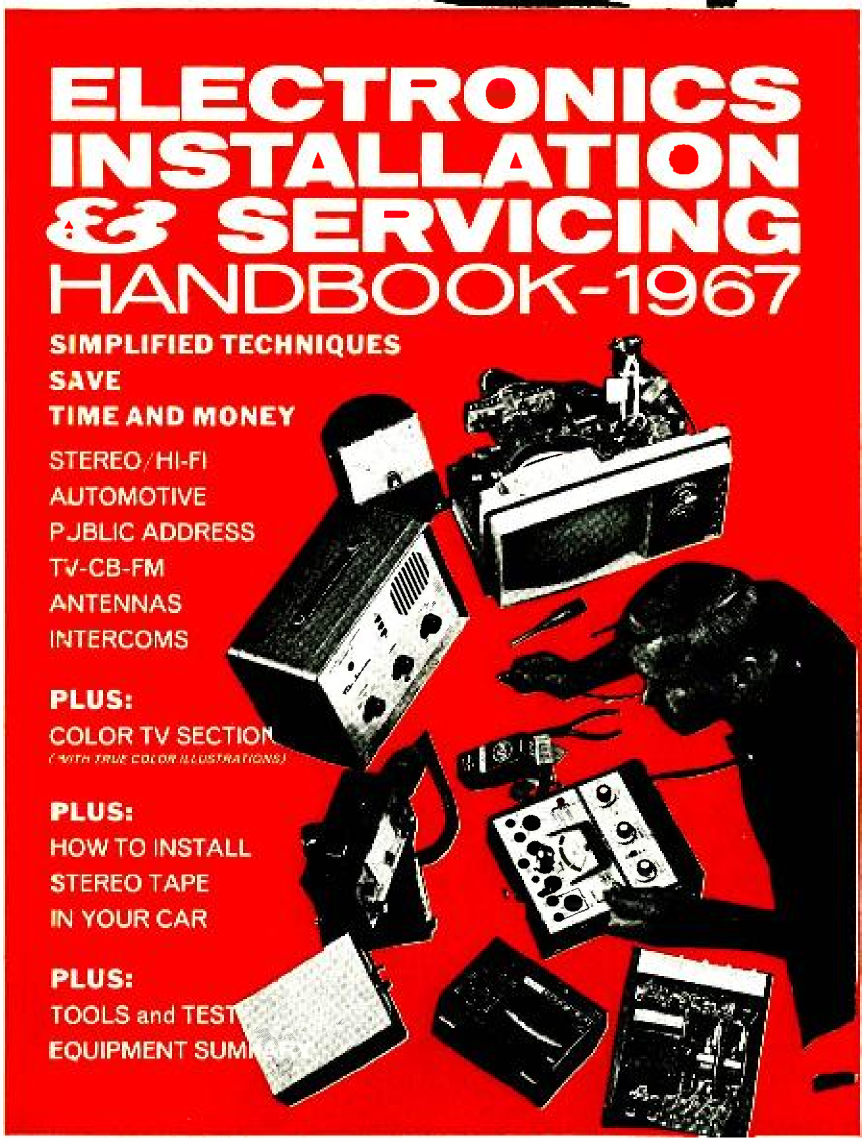

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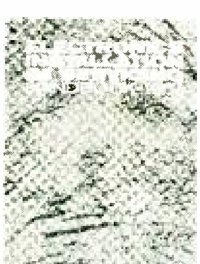

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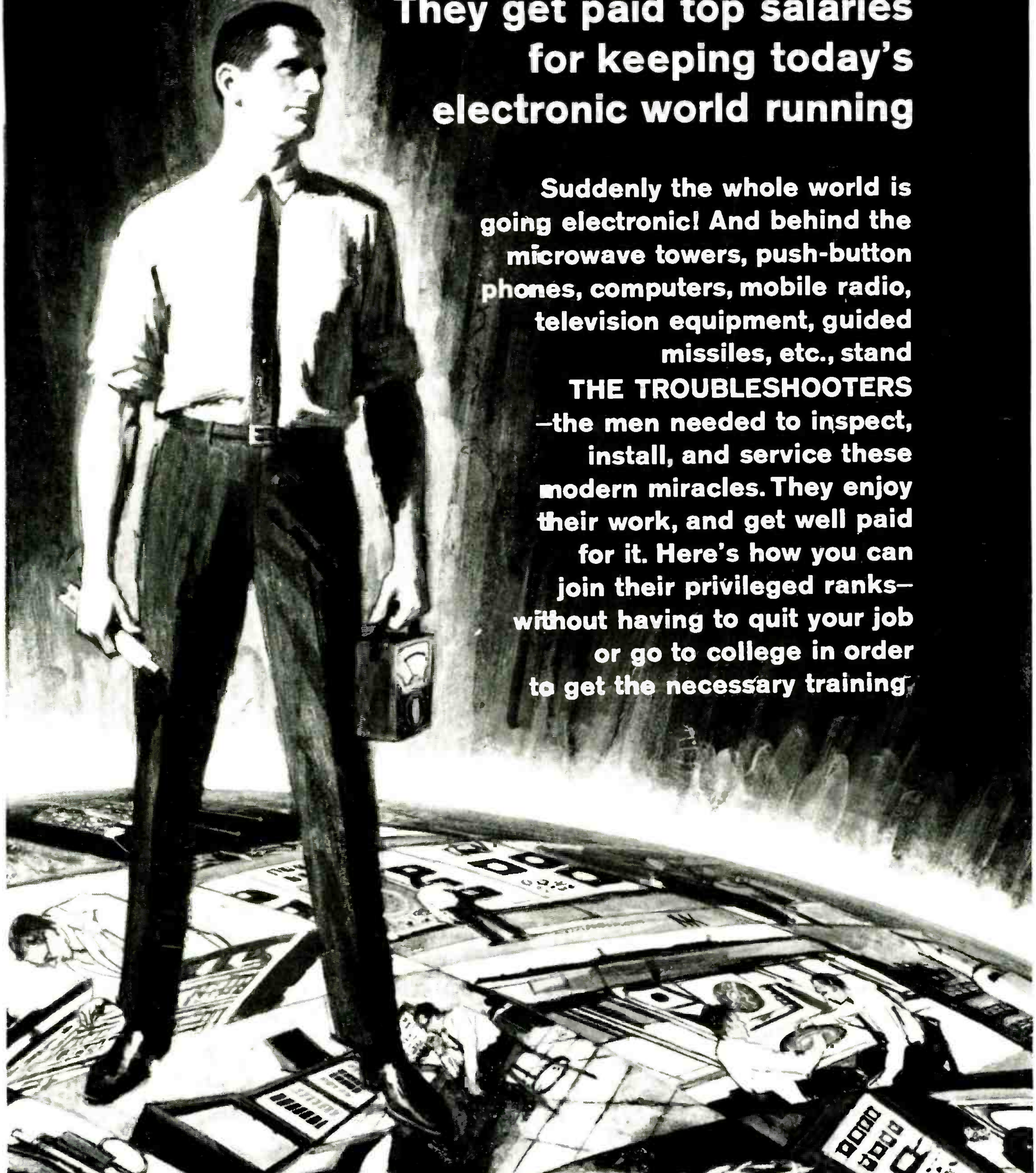

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS —the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks— without having to quit your job or go to college in order to get the necessary training.

JUST THINK HOW MUCH in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by repairing a computer.

Today, whole industries depend on electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay—and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college diploma, but you don't. What you need is know-how—the kind a good TV serviceman has—only lots more.

Think With Your Head, Not Your Hands

The serviceman, you see, "thinks with his hands." He learns his trade by taking apart and putting together, and often can only fix things he's already familiar with.

But as one of The Troubleshooters, you may be called upon to service complicated equipment that you've never seen before or *can't* take apart. This means you have to be able to take things apart "in your head." You have to know enough electronics to understand the engineering specs, read the wiring diagrams, and calculate how a circuit should test at any given point.

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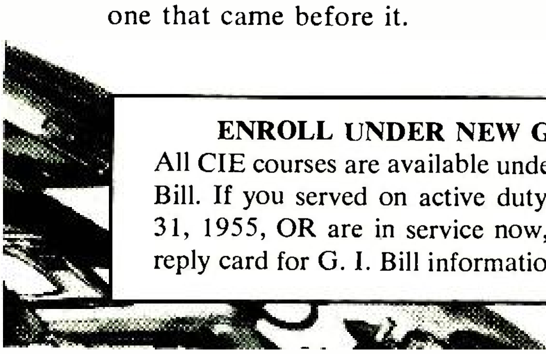

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Electronic Metal Locators

(Continued from page 42)

U.H.F. Type

This metal locator has several unique operating features. Fig. 6 shows the block diagram. The u.h.f. locator is capable of detecting either metallic or non-metallic objects and is able to discriminate between these objects and the normal clutter of rock discontinuities. Operation is somewhat similar to the induction-balance locator, except that the operating frequency is 400 MHz and the loops are replaced by a search array consisting of inductively loaded dipole antennas. Two transmitting dipoles are used with a receiver dipole between them. A figure-eight pattern is produced in the absence of any target, resulting in balanced voltages that nearly cancel in the receiver dipole. The presence of any object of uniformly different conductivity and dielectric constant from the surrounding medium upsets the balance and produces an output signal.

There are two modes of operation, the "Search" mode and the "Point" mode. In the "Search" mode, all of the spurious return is averaged out by a long time constant a.g.c. loop, while any sudden changes in the field patterns are greatly amplified by an expander circuit, indicating the edge of a target directly below the search array. In the "Point" mode, the receiver output is amplitude-sensitive and the instrument may be used to outline the buried object. The u.h.f. locator is principally used by the military for the detection of metallic and non-metallic mines.

Transmitter-Receiver Instrument

Of the popular locator types, the transmitter-receiver instrument is capable of the deepest penetration and is principally used for large-object detection, such as locating buried pipes and tracing mineral veins. Many instruments of this type can also give a relative indication of the depth of target burial by a triangulation method. Utility companies as well as amateurs make extensive use of this particular type of instrument.

If two loop antennas are placed at right angles to each other so that one loop is positioned directly along the null axis of the other, no signal coupling between the two will exist. In practice, one loop is excited with an r.f. oscillator-transmitter. This is usually the vertical rear loop. The other loop forms the front end of a highly sensitive r.f. receiver-amplifier followed by a detector and indicator, as shown in the block diagram of Fig. 7.

In the absence of targets, the received signal is zero because of zero mutual inductance between receiver and transmitter; any energy inductively coupled *via* a target produces a receiver signal in proportion to the size and location of the target.

Maximum signal return occurs when the target is almost centered under the receiver loop. For the first few feet of target depth, the distance from *transmitter* to *target* changes very little. In addition, more energy is actually delivered to a deeper target than to a very shallow one, due to the field patterns of the transmitting loop. For these two reasons, the transmitter-receiver locator retains a very good penetration capability to depths comparable to the instrument length. Only for depths substantially greater than the transmitter and receiver separation does the signal return begin to fall off as the sixth power of depth.

The price paid for the good penetration is inability to resolve small objects. When a target is in the position of optimum detectability, it is at least four feet away from the transmitter and thus must be physically large to intercept enough transmitter energy to produce a useful receiver voltage. The majority of transmitter-receiver locators are incapable of detecting an object less than three inches in diameter, even if the target is on the surface.

Synchronous demodulation may be employed on the transmitter-receiver locator, but only if totally balanced circuitry is used. Otherwise, the interconnection between receiver and transmitter will itself radiate and distort the normal field patterns.

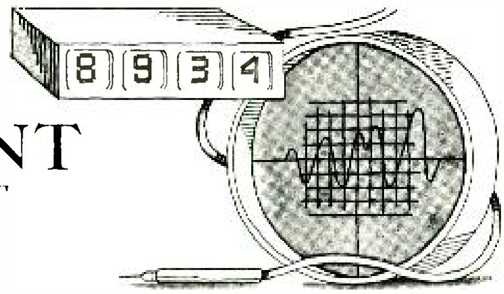
Design problems include mechanical stability and the minimum use of metal parts in assembly, for either of these factors can eliminate the sharp null obtained at 90° positioning and greatly reduce apparent sensitivity.

Commercial Instruments

Table 1 lists major manufacturers of electronic metal locators intended for sport applications. Table 2 gives the relative performance capabilities of the three sport types in terms of relative cost, penetration, resolution, weight, and applications. Individual commercial instruments will vary widely from the values shown, depending upon soil conditions, operator experience, the quality of the instrument, and other factors.

In addition to the sport types covered here, there are a number of industrial-type metal locators that are used by the utility companies and others. In general, the operation and characteristics of these metal locators are very similar to the sport types covered, although the industrial types may be more expensive and constructed to withstand more physical abuse than a unit that is only used occasionally would encounter. ▲

TEST EQUIPMENT
PRODUCT REPORT



RCA WR-50B R.F. Signal Generator

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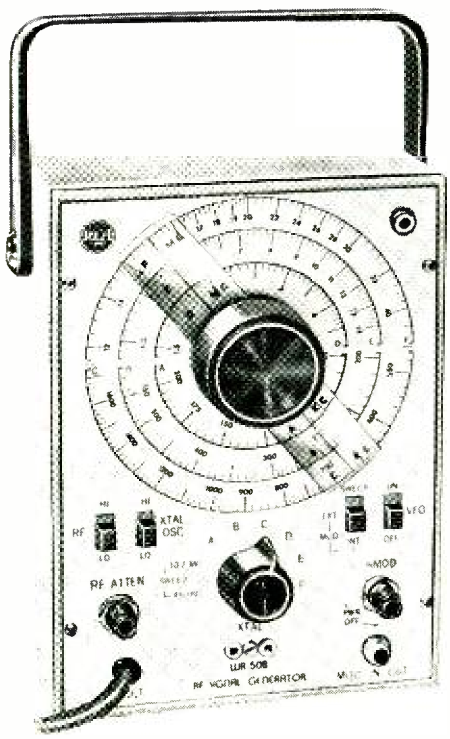


SERVICE-type signal generators have come and gone over the years with few significant changes in their capabilities or performance. But the inclusion of FM-sweep output at 455 kHz and 10.7 MHz in *RCA's* new WR-50B r.f. signal generator is a major step forward in general servicing convenience.

Except for this feature, the WR-50B is similar to the WR-50A reviewed in these pages in March, 1964. It is a compact AM generator having fundamental r.f. output from 85 kHz to 40 MHz; an internal 400-Hz oscillator modulates the r.f. signal, including the auxiliary crystal-controlled output, or provides separate audio output.

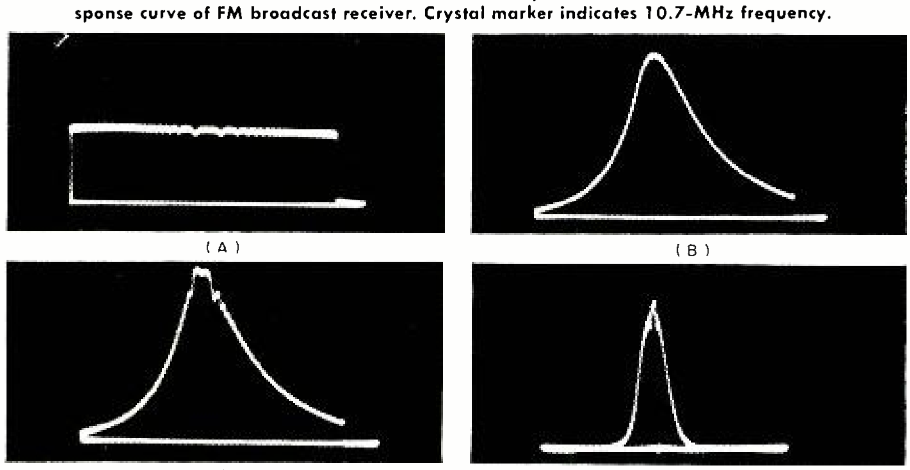
The two sweep-output frequencies have preset positions on the main bandswitch. Sweep width is approximately 10% of the center output frequency; a 60-Hz sinusoidal sweep rate is used.

Sweep alignment has been employed for years in servicing FM receivers. Until now, however, the service fraternity has had to use peak-alignment methods for AM broadcast receivers.

The waveforms show the sweep response curve obtained by feeding the 455-kHz FM signal into the mixer stage of an AM receiver and taking it from the second detector.

Sweep alignment of AM receivers has a number of advantages: it gives an instantaneous picture of over-all amplifier alignment; it requires only one signal-injection point and one take-off point; and it reveals oscillation in amplifier stages. Relative signal amplitude can also be checked with the WR-50B because it has built-in blanking, which supplies a reference base line on the oscilloscope.

(A) The 455-kHz sweep output from the WR-50B. Plug-in crystal produces marker in center of the trace. (B) Over-all i.f. response curve showing bandpass of broadcast AM receiver. (C) Same curve with 455-kHz crystal marker. (D) Over-all i.f. response curve of FM broadcast receiver. Crystal marker indicates 10.7-MHz frequency.



(A) (B) (C) (D)

With FM receivers, the 10.7-MHz output from the WR-50B will produce an "S" curve at the output of the FM detector or a peaked bandpass curve at the detector input. If needed, 455-kHz or 10.7-MHz markers can be added to the response curves simply by plugging a crystal into a front-panel socket.

In the sweep functions, the oscillator stage is frequency-modulated by a varactor diode which is connected into the oscillator tuned circuits. A small 60-Hz signal is fed to this diode from the heater winding of the power supply. Because the capacitance of the diode varies in accordance with the voltage across the diode, it varies the frequency of oscillator output at a 60-Hz rate.

Optional user prices of the WR-50B are $65 for the prewired version and $45 in kit form. ▲

Hewlett-Packard Model 400GL A.C. Electronic Voltmeter

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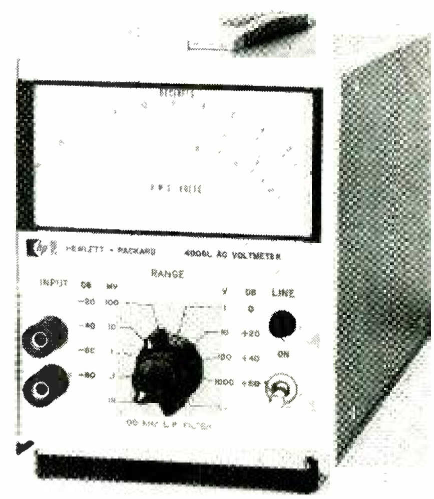
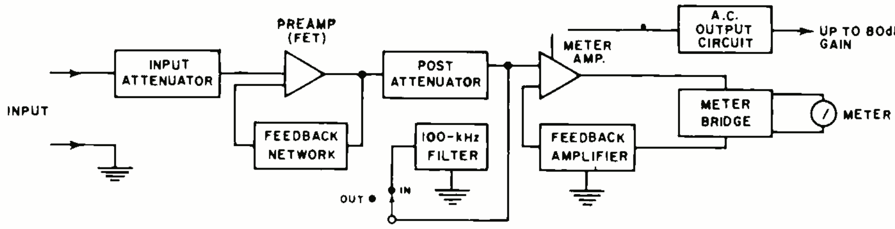


THE most recent addition to the *Hewlett-Packard* 400 Series a.c. voltmeters is the all-solid-state Model 400-GL with a linear dB scale on each range. It has a 100-μV full-scale range and 10-megohm input impedance. Frequency coverage is from 20 Hz to 4 MHz, and accuracy over most of this range is within 0.2 dB. Voltage gains up to 160 dB may be measured readily over five frequency decades. A built-in 100-kHz low-pass filter, controlled from the front panel, will eliminate the error-producing effects of high-frequency voltages when low-frequency measurements are being made.

The new Model 400GL is especially useful when signals which vary widely are being measured; with 20-dB range on each scale, signals varying in voltage over a 10 to 1 magnitude may be continuously followed without changing the setting of the instrument. The unusual gain of the built-in amplifier



and the high sensitivity of the meter make the instrument suitable for use as a calibrated high-gain preamplifier for oscilloscopes, bridge detectors, and other devices. As a preamp, the unit has only 3 μV of noise referred to the input for 100-kHz bandwidth, enabling it to be used for measurements of acoustical noise in radio receivers and p.a. systems. In acoustical measurements, sensitivity is so high that a calibrated microphone may be connected directly to the input terminals.

Referring to the block diagram, the meter uses a high-impedance input attenuator (0 or 60 dB) followed by a field-effect-transistor preamp. This preamp has a basic sensitivity of 1 millivolt with a 3-dB bandwidth at 10 MHz. To achieve linearity, the meter bridge is inserted in the feedback path.

The meter bridge is driven from a current source to further insure tracking and stability of the meter reading under wide temperature extremes. By the use of bootstrapping, a current source approaching 1 megohm is achieved. The meter bridge is driven from this current source to eliminate reading errors due to diode non-linearities in the meter bridge.

The instrument is normally operated from the a.c. power line, although external battery operation is possible *via* terminals provided on the rear panel. The Model 400GL is priced at $290. ▲

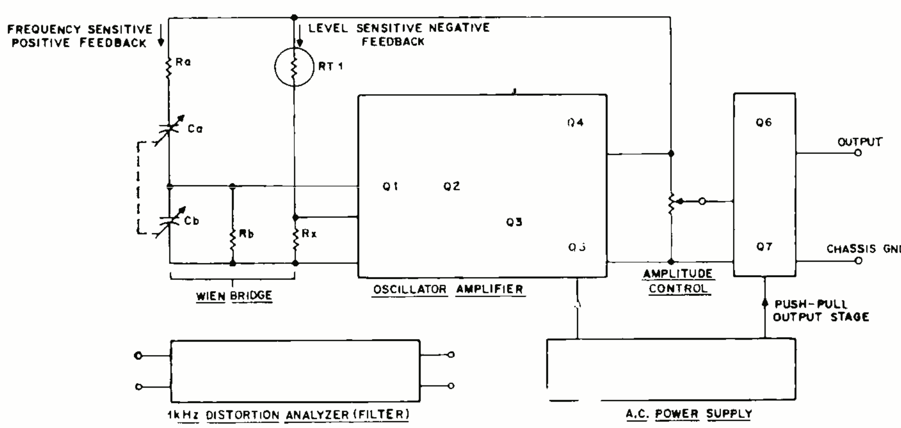
Motorola Model S1067A Audio Oscillator

For copy of manufacturer's brochure, circle No. 29 on Reader Service Card.

A NEW audio oscillator, featuring all-solid-state components including a field-effect transistor, has been introduced by *Motorola* as Model S1067A. The oscillator is designed for general laboratory use in checking audio amplifiers, filters, or speakers. It is particularly useful for two-way radio technicians in maintaining reed-controlled, tone-coded radio equipment. A built-in 1-kHz distortion analyzer or band-elimination filter is very desirable for making EIA SINAD sensitivity measurements of two-way radio mobile and base-station FM receivers.

The oscillator employs a capacitance-tuned Wien-bridge network to obtain a sinusoidal signal over a 20-Hz to 200-kHz frequency range in four overlapping bands. The network consists of capacitors C_a and C_b and resistors R_a and R_b in the positive-feedback path, and thermistor *RT*1 and resistor R_x in the negative-feedback path. (See diagram.) Oscillations are maintained through the positive-feedback network which is frequency-selective and which has a maximum output voltage with zero phase shift at the oscillator frequency.

Frequency variation of 10:1 is accomplished by a two-section, ganged variable capacitor. A set of equal-value precision film resistors is used for each frequency range. Vacuum-sealed, negative-temperature-coefficient thermistor *RT*1 keeps the oscillator output



constant at all frequencies covered during operation.

Transistor Q1 is a common-source n-channel junction FET operating as an amplifier, followed by Q2, a direct-coupled emitter follower. Transistor Q3 is an emitter-follower amplifier which drives a push-pull emitter-follower pair (Q4 and Q5). A similar output stage, Q6 and Q7, is used to isolate the oscillator amplifier from the load.

The distortion analyzer circuit uses a bridge-T filter that rejects a 1-kHz tone by more than 50 dB but passes all other frequency components. These can be measured with an audio voltmeter which indicates harmonic distortion.

The oscillator is operated either from the a.c. power line or from a single, inexpensive 22½-volt internal dry battery. Battery life is over 100 hours for a 600-ohm or higher load. The unit is supplied with a detachable front cover and a shielded a.c. power cable that has a miniature short-circuit-proof power transformer molded right into the a.c. plug. Price of the instrument is $185. ▲

IMPROVED BLOWN-FUSE INDICATOR

By RONALD L. IVES

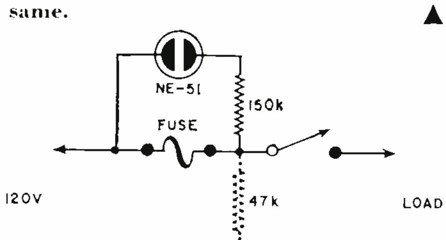
A NEON lamp and series resistor are usually shunted across the fuse protecting a piece of equipment to provide immediate indication when the fuse blows. When the fuse is intact, it shorts out the lamp-resistor combination and the lamp is unlit.

When, as is often the case, the equipment is plugged in but not turned on, a blown fuse is not detected until the power switch is turned on. This usually leads to a missed operation which may disrupt an expensive and complicated test.

To indicate a blown fuse immediately when the equipment is plugged in but not turned on, a small resistive load is connected from the load side of the fuse to the cold side of the line as shown in the diagram.

As before, the neon lamp will not light as long as the fuse is intact. If, however, the fuse is opened the neon lamp will light whether the equipment is turned on or not.

The added resistor, about 47,000 ohms (value not critical), should have a minimum rating of ½ watt. A 1-watt resistor is preferred as it has a much larger radiating surface and hence will run cooler, all other factors being the same. ▲



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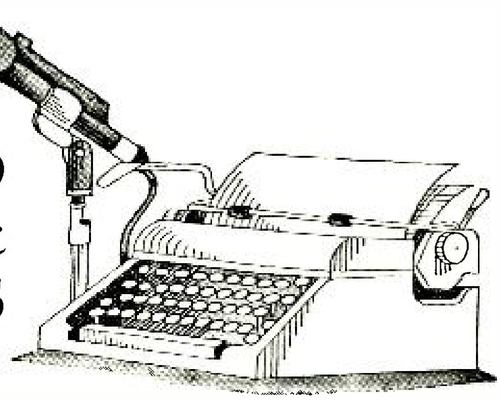
RADIO & TV NEWS



OVER 90% of the nation's CATV systems receive at least one distant signal, imported from beyond the transmitting station's predicted grade-B contour, the National Community TV Association recently disclosed. The number receiving only local signals (grade B or better) is quite small—under 8%. About one-quarter of the systems receive only distant signals, while 67% get a mixture of both.

The data indicates that of the 1668 operating systems:

14 systems (.9%) serving 8493 homes receive only the stations located in the same community as the system. This does not include New York which, when operational, will also distribute only local signals.

23 systems (1%) serving 21,675 homes receive only signals from stations within whose predicted grade-A contour the systems are located.

41 systems (2%) serving 28,281 homes receive only signals of predicted grade-B intensity.

74 systems (4%) serving 123,188 homes receive a combination of predicted grade-A and grade-B signals.

405 systems (25%) serving 539.203 homes receive no signals of grade-A or grade-B intensity, although 81 of these systems are within the grade-A or grade-B contour of one or more stations.

1111 systems (67%) serving 1,789,-147 homes receive an assortment of signals including at least one station of less than grade-B predicted intensity and at least one station of predicted grade-B or greater intensity.

These figures do not include the master antenna systems commonly used in apartment houses or hotels.

Phosphor Laser

Laser material is usually thought of as being some exotic combination of chemicals found only in a research laboratory. Recently, however, scientists at the Electronic Research Center of *RCA* have discovered that zinc oxide, a material used as the phosphor in certain types of CRT's, can be made into an ultraviolet laser.

A tiny platelet of zinc oxide, resembling a soap flake, is mounted on a metal support housed in a vacuum chamber. It is activated by an electron beam which is fired at it at a rate of 2000 pulses per second. At first, the phosphor glows green, but when the power of the electron beam reaches a certain critical density, the light coming from the phosphor suddenly becomes coherent, shifts predominantly into the ultraviolet region, and emerges as a narrow beam of laser light shooting out at right angles to the bombarding electron beam.

The mechanism by which the beam initiates laser action involves a transfer of energy in which each incoming electron excites as many as 1000 electrons in the phosphor to a higher energy level. They remain in this state until one of them falls back spontaneously to its original level, throwing off its excess energy as a tiny burst of ultraviolet light. This in turn triggers all the other excited electrons to follow suit with the result that a pulse of intense coherent ultraviolet laser light is generated.

Electronic Eavesdropping

As in all other phases of electronics, the new generation of electronic eavesdroppers is far more sophisticated than the oldtimers.

The latest type to hit the market is one that can be attached to the telephone line. When the remote listener wants to hear what's going on, he dials that telephone number, and immediately after the final digit is dialed and before the phone gets a chance to ring (a couple of seconds elapses after the relays work and before the phone rings), he causes an audio tone to travel down the line to activate a frequency-sensitive relay within the listening system. This relay prevents the phone from ringing and simultaneously opens up a remote microphone. If anyone dials the phone during the listening-in operation, he will get a busy signal. When the remote listener hangs up his phone, the system goes back to normal. Conventional operation of the phone is not affected by this device.

In this age of virtually universal dialing, there are almost no limits to distance between the two units. ▲

Color-TV Signal Generators

(*Continued from page 33*)

nal. At the picture tube, the pedestal may dilute color saturation, but this is of little importance. If full saturation is necessary, it may be obtained by turning down the receiver contrast. This will effectively minimize pedestal.

RCA. The axes of the color-bar pulses should lie on the zero axis and not on elevated brightness pedestals. Elevated pulses necessitate use of an oscilloscope for accurate setting of receiver phasing. A generator having zero-axis color-bar pulses does not require an oscilloscope. The change in bar color is not significant, and because of the range of adjustment of the receiver tint control, this slight variation across the width of the color bar has no detrimental effect on receiver setup.

Seco. These factors are a necessary evil, but their effect is minimal.

Sencore. The phase angle of the color bar is continuously shifting, but for the human eye it is very difficult, if not impossible, to see any color variation within a bar. This really should be of no importance as the bar pattern is used mainly to see if the chroma circuits are working. When the color circuits are set up using a bar pattern, it is no different than if an NTSC-type generator were used. The waveform is easy to interpret on a scope.

Why hasn't the NTSC type of color signal generator become more popular?

Allied Radio. Complexity, cost, and difficult pattern interpretation. Also, a 10-bar gated rainbow generator is very useful for narrow-band color receivers using $R-Y$ and $B-Y$ demodulation.

Amphenol (Cadre). Because it is generally much more expensive, the added accuracy and convenience of an NTSC generator is not that important in color alignment.

Eico. See our answer to the previous question.

Heath. The NTSC generator has not become popular because of its inherent high cost and the fact that most color-TV set alignment procedures have been written around the gated rainbow generator.

Lectrotech. For the service technician with great expertise, the NTSC generator would be optimum, since it provides all the color and luminance information required by the chroma section. NTSC generators, however, need calibration checks. The keyed rainbow signal, on the other hand, is inherently accurate and provides color information only every thirty degrees including the all-important $R-Y$ and $B-Y$ axes. Economics also enter in since the NTSC signal is far more costly to generate than the keyed rainbow.

Precise. A true NTSC signal requires more elaborate circuitry than the keyed rainbow signal. Receiver manufacturers provide service data in terms of keyed rainbow generators, which will insure their continued popularity. Technicians find little, if any, receiver service information based on NTSC generators and must rely on their unaided competence in the use of these generators.

RCA. NTSC generators are too heavy and too expensive. Fully saturated NTSC colors are not needed to achieve perfect adjustment any more than an FCC-type broadcast signal is needed for tuner or i.f. alignment. The gated rainbow signal is used by virtually all TV manufacturers in establishing service procedures for their sets.

Seco. The cost of an NTSC generator is too high.

Sencore. The NTSC generator has never become popular and will probably fade away except at broadcast studios. The cost, size, and complexity of this type of generator led to its downfall. The keyed rainbow generator costs less to produce, is easier to use, and can be made very compact as demonstrated in recent months by the number of small solid-state generators being made available. ▲

Color-TV Broadcasting

(*Continued from page 24*)

pulse time. Stated in another way, with New York as a reference, Washington must be timed in *advance* of New York by the transit time of the signal over this distance. Likewise, Cape Kennedy must be timed in *advance* an even greater interval of time.

A system used at *NBC*, known as "audlock", has been devised to solve this synchronization problem. The system may be described as a backward type of sync control that matches both remote sync generators to the New York standard. As the name implies, an audio frequency is used to time-lock the remote sync generator. In the system, shown in block form in Fig. 2, an audlock transmitter is located in the control room in New York and a companion unit is located at both remote points. The audlock in New York is connected to the remote points *via* a rented telephone line. The horizontal line frequency of the New York sync generator is processed by the audlock transmitter to produce a submultiple audio-frequency sine wave of about 4000 Hz, which can be easily and quickly phase-shifted by any desired amount. The audlock receiver in Washington processes the 4000-Hz tone from New York and multiplies it to lock the Washington sync generator. Then, by superimposition of New York and Washington pictures and by means of the phase control, the Washington sync generator can be accurately timed both horizontally and vertically so that the Washington pulses are coincident with the New York pulses on arrival in New York. With the other audlock system, the sync generator at Cape Kennedy can be similarly adjusted so that its pulses are coincident with the New York pulses. Thus, the timing problems between New York and any remote studio are solved. Audlock has been very successful in black-and-white TV and is now being used for color pickups.

The success of audlock has suggested other schemes to eliminate the need for time-control circuits between pickup points and a central control location. One such scheme would use very stable 3.58-MHz oscillators to control the sync generators. The stability of this system must be on the order of one part in 10^{11}. It is reasoned that if a stable 3.58-MHz oscillator is used to time the remote sync generator, it should be possible for New York, on viewing a TV picture from the remote pickup, to arrange by telephone for framing adjustments at one end or the other. Such a system is now in operation for black-and-white TV and requires only daily checking and minor adjustment of phase each morning. Tests in color TV indicate that at this stage the technique does not provide sufficient stability of color subcarrier reference to permit dissolves or special effects due to time lag and short phase delays in the intercity circuits.

Banding

In tape machines, a phenomenon known as "banding" occurs that shows up in a color receiver as horizontal bands of slightly different colors extending across the screen. This is strictly a function of VTR head wear and alignment. The electrical and mechanical characteristics of the four rapidly spinning (1500 ips) VTR heads must be maintained to within a couple of electrical degrees (at 3.58 MHz) to remove this banding. It does not take much tape passage through the VTR to produce the slight head wear that causes these small phase shifts, therefore color shifts. New and improved VTR heads, tape, and maintenance techniques are slowly eliminating this problem.

Color Set Set-up

Most color-TV engineers appear to use a particular method of setting up their home color receivers. This technique is as follows.

First, allow sufficient warm-up time so that all circuits stabilize. Turn off the chroma gain control so that a monochrome picture is produced. Then adjust the set's fine tuning for a clean, sharp monochrome picture just before the picture breaks up into "squiggles" (this is the point of maximum bandwidth just before the video carrier drops off its correct place on the response curve). Next, adjust the contrast and brightness controls for the best monochrome picture. Now bring up the chroma gain for the "best" amount of color, avoiding saturation of the single color areas. Then adjust the tint control until the picture looks natural in its coloration.

The best method of setting both chroma gain and tint controls is the use of so-called "flesh tone" color. This is not a standard color so problems occur. It is best to use a girl's picture to make these adjustments as most girls on color-TV programs are well made up and have almost identical complexions. Men are more prone to skin discoloration and various degrees of tanning; therefore, a chroma adjustment on a man may not be best for the over-all color program.

Many engineers claim that too many color-set owners adjust for the saturated colors that are seen in cartoons rather than for the pastels normally found in nature, and they trace many complaints to this color-for-the-sake-of-color adjustment. ▲

Frequency Synthesizer

(*Continued from page 48*)

operation and reduction of h.f. components in the l.f.o. output, it is often desirable to track the l.f.o. tank.

Simultaneous Crystal Operation

If both the h.f.o. and l.f.o. are connected to the same crystal, each operates essentially as it would without the other. Note that the fifth harmonic of the l.f.o. does not equal the h.f.o. (fifth-overtone) frequency. This may be referred to as correlation offset and is a function of both circuit and crystal. Crystal vendors have demonstrated their ability to independently control fundamental and fifth-overtone frequencies within narrow limits. The circuits should, therefore, be designed with the correlation offset taken into account to establish the exact frequencies required. With the proper choice of C for the h.f.o. crystal, h.f.o. shift with the connections of the l.f.o. is about 0.0002%.

The most serious problem during simultaneous crystal operation is the presence of the l.f.o. fifth harmonic in the h.f.o. output. The inductance L is intended to be a low impedance at the fundamental frequency thereby minimizing fundamental voltage across it due to fundamental crystal current. This fundamental crosstalk appears to cause the fifth-harmonic spurious output in the h.f.o. These spurious components are separated by about 0.1% from the desired h.f.o. frequency and with reasonable care can be maintained 60 dB below the desired output amplitude.

In later versions of this circuit, the crystal is grounded with appropriate L and C coupling, as shown in block form in Fig. 6B. This configuration is much simpler since it does not require a separate L and C for each crystal. The basic oscillator circuits are essentially unchanged.

Both vacuum-tube and transistorized versions of these circuits have been made with comparable performance.

Frequency stability of the synthesized output signal is controlled primarily by the h.f.o. since a given percentage error in the h.f.o. represents a much larger actual frequency shift than the same percentage of l.f.o. error. The frequency stability of the h.f.o. in this system is that of the usual overtone oscillator, or about ± 0.001%.

Frequency stability of the l.f.o. is not as good a circuit as one with a crystal cut for maximum frequency stability on the fundamental mode. With proper oscillator design, stabilities of about ± 0.005% are obtained. In the case of the "Mark III" synthesizer, these stabilities result in an output frequency stability of ± 0.0015%. ▲

IC Phonograph

(*Continued from page* 29)

strap capacitor which ensures full drive during the positive half of the output signal.

Warning! Don't try this circuit with conventional components. It won't work due to the lack of thermal feedback which is present in the integrated circuit.

Service Tips

Because of the unusually good thermal characteristics of the IC, this amplifier should be free from the normal failures found in transistor amplifiers. Since the service technician is not expected to have a supply of these units on his shelf, it is strongly recommended that he connect a No. 53 or 47 pilot light bulb in series with the power-supply lead as indicated on the complete schematic during testing. This will limit the current and indicate a safe idle current (no glow in bulb). If it is ever necessary to replace the integrated circuit, it will be available separately as a replacement part for approximately $6.00.

Any failures are expected to be due to external components such as electrolytics or the power rectifiers. So be sure to replace the components that *caused* the failure before replacing the integrated circuit. The normal technique of replacing a suspected electrolytic with a known good one works here. Note that if C3 is leaky, it will cause high idle current since it disturbs the d.c. feedback path. Because it only affects low-frequency response, the amplifier may be operated with this capacitor removed as a check of its performance. ▲

"Here's another one, Harry."

BOOK REVIEWS

"ELECTRONIC CABLE HANDBOOK" by The Engineering Staff, *Belden Manufacturing Co.* Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 219 pages. Price $3.95. Soft cover.

This comprehensive handbook covers wires and cables ranging from the miniature cables used for phono pickups to those designed for use in outer space. The first chapter explains in detail the design, construction, and handling of various types of modern electronic cable and provides information on state-of-the-art cable design, specifications, and applications.

Specific applications are covered in detail with entire sections devoted to cables for intercom systems, hi-fi, home entertainment systems, FM, two-way radio, etc. Both military and non-military specifications are included in this informative volume.

As an exercise in providing a maximum amount of useful information in a minimum of space, this volume would be hard to beat.

* * *

"CREATIVE ELECTRONICS FABRICATION" by Owen G. Patrick. Published by *Holt, Rinehart and Winston, Inc.*, New York. 253 pages. Price $6.50.

This volume is addressed to students training to become electronics technicians and, secondarily, to those already in the field who wish to upgrade their skills and improve their chances of promotion For this latter group, some of the basic material presented by the author may seem a little too basic, but since new techniques are being adopted constantly, it might be worth their while to test their older methods against the newer ways of doing the job as suggested in this text.

This text is divided into four main parts: Part One covers general procedures; Part Two permits the student to test his skills by building a signal tracer; Part Three deals with tools and their uses; while Part Four goes into the various processes and techniques which the technician will be expected to have mastered.

The book is well illustrated and the writing is such that the student studying on his own should have no difficulty in acquiring a firm theoretical background even if he doesn't have a completely equipped laboratory at his disposal.

* * *

"101 WAYS TO USE YOUR COLOR-TV EQUIPMENT" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 158 pages. Price $2.95. Soft cover.

This is another volume in this publisher's current series under the general title "101 Ways. . . . . ." and follows the same format as the previous volumes in the series.

Since this is a specialized book which tells how color-TV test equipment is to be used, the author has assumed that his reader is familiar with color-TV theory and makes no attempt at providing servicing information. The text is divided into ten main sections covering equipment checks; chroma signal tracing; color sync tests; chroma demodulation tests, matrix tests, bandpass section tests, regeneration tests, sequential chroma tests, convergence tests, and miscellaneous tests.

Each type of test is coded and the code listed in the index to facilitate locating the specific test required. Under each test the author lists the equipment to be used, the connections required, the procedure, and the evaluation of test results. In each case a block diagram of the hookup and other pertinent details are illustrated—such as the correct pattern, scope displays, etc. Where required, partial schematics covering the circuit under test are included.

* * *

"LASERS" edited by Albert K. Levine. Published by *Marcel Dekker, Inc.*, 95 Madison Avenue. New York, N.Y., 10016. 347 pages. Price $14.50. (Vol. 1).

Volume 1 is subtitled "A Series of Advances" and is a compilation of five papers by seven engineers from *Hughes Research Laboratories, Bell Telephone Laboratories,* and *General Telephone & Electronics Laboratories.*

The proliferation of lasers of various types has created a tendency to specialize with the result that engineers actually working in the field are unaware of or untutored in the finer points of other types of lasers. This volume is an attempt to correct this situation.

By assembling the thoughts of specialists in each particular field, the editor has presented a broad spectrum of modern laser technology. This volume covers pulsed ruby lasers, optically pumped pulsed crystal lasers other than ruby, organic laser systems, "*Q*" modulation of lasers, and modes in optical resonators.

Since this volume is written by engineers for engineers, they have assumed the requisite background in electronics and mathematics on the part of their readers. Volume 2 of this series will deal with gas lasers, the injection laser, glass lasers, non-linear optics, optically pumped c.w. lasers, and the frequency stabilization of gas lasers.

* * *

"DIRECT CURRENT CIRCUITS AND MEASUREMENTS" and **"ALTERNATING CURRENT CIRCUITS AND MEASUREMENTS"** by C. J. Anderson, A. Santanelli & F. R. Kulis. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 07632. 337 & 367 pages, respectively. Price $12.00 each.

These two self-instructional programmed manuals are both practical and comprehensive. They can be used by the beginner, the student in an educational or industrial course, or as a brush-up course by those already in the electrical, electronic, or computer fields. Prerequisite is a working knowledge of algebra and general science.

The format is the now-familiar programmed style with correct answers provided for each "frame" and an overall test at the end of each chapter. The text also includes certain lab experiments which can be performed if suitable equipment is available but simulated if not.

Either or both of these volumes could serve as excellent introductions to their respective subjects.

* * *

"MODERN ELECTRONICS" by de Waard & Lazarus. Published by *Addison-Wesley Publishing Company, Inc.*, Reading, Mass. 01867. 347 pages. Price $9.75.

This volume is designed to be used either as an undergraduate text in physics or engineering or a self-teaching device for engineers and scientists seeking more background in electronics. Treating the basic physics of electronic devices and circuits, the purpose of the book is to convey practical information about such circuits and their limitations.

There are ten chapters covering electrons and electronics, electronic tubes, semiconductor devices, basic amplifier circuits, feedback amplifiers, special amplifier circuits, power supplies, oscillators, pulse circuits, and noise. Two appendices cover complex notation for a.c. circuits and typical tube and transistor characteristics.

The treatment is mathematical and the authors suggest that a firm grasp of general physics, calculus, and simple a.c. and d.c. circuit theory are prerequisite. ▲

Soviet Color-TV System

By LESLIE SOLOMON / Associate Editor

Soviet engineers have proposed a color-TV transmission system that has no local color subcarrier oscillator, and is said to be immune from any transmission and reception differential phase and gain distortion.

IN the dozen or so years since the introduction of the NTSC method of color-TV transmission and reception, and despite the experience gathered in the production of over a million operating color-TV sets in the U.S.A., the Europeans have still not decided whether to use the American NTSC system, the French SECAM, the German PAL, the British ART, or now the Soviet NIR (SEQUAM) system.

One major bone of contention among European engineers is that the NTSC system has tolerances that are too tight compared with the tolerances of the manufactured equipment being used. Criticism is aimed at the sensitivity of the NTSC chroma signal to differential phase and gain change, particularly over considerable distances and through many different transmission paths.

Proponents of the SECAM system claim that to ensure a passable image quality using NTSC, the total differential phase must remain less than 12° and 10° in the case of cumulative defects. (It should be noted that a phase change of 5° can produce a noticeable color change in a receiver.) Advocates of SECAM estimate that the total differential phase economically possible on the European networks is 27°, of which 10° is due to radio links. However, a typical American TV network (*NBC*) claims an average of 3° differential phase shift over approximately 3000 miles of its network, coast-to-coast.

In their desire to improve the NTSC signal, French engineers have proposed SECAM (acronym for sequential memory) in which the color subcarrier is frequency-modulated with only one axis transmitted at a time during each horizontal line scanning time. The other axis is transmitted during the following horizontal line scanning time (*i.e.*, $R-Y$, $B-Y$, $R-Y$ . . . etc.). This technique necessitates the use of a one-line delay network and an appropriate switcher at the receiver in order to provide the decoder with the necessary color difference signals.

German engineers came up with the PAL (*p*hase *a*lternate *l*ine) system in which the basic SECAM system is used to modulate the phase of a quadrature-modulated subcarrier, with the phase alternated on successive scanning lines. According to PAL proponents, this enables any phase errors to be corrected.

British engineers suggested the ART (*a*dditional *r*eference *t*ransmission) system which provides a reference signal for decoding the quadrature-modulated subcarrier along the entire length of the active part of the line-scanning interval, riding up and down on the luminance signal, and providing an automatic correction signal to counter any subcarrier amplitude or gain distortion.

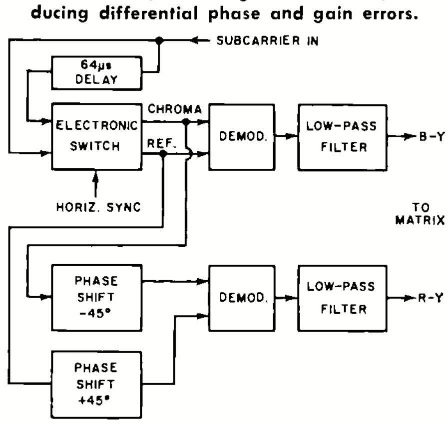
Now Soviet engineers have entered the fray with their NIR system (acronym unknown). Because this system uses a quadrature-modulated subcarrier on alternate lines, it has been unofficially christened SEQUAM. Although no official information has been released on this system (at least at the time of this writing), it is believed to operate as follows.

A substantially conventional NTSC $R-Y$ and $B-Y$ color difference signal, with hue carried as subcarrier phase modulation and with saturation determined by the ratio of the square of the subcarrier amplitude to the luminance (Y) signal amplitude, is carried on alternate lines of any one field. There is *no* reference burst carried on the horizontal sync back porch.

The alternate set of lines within that field carries just the subcarrier with *no* phase modulation (may be fixed at $B-Y$, for example), but whose amplitude is modulated by the instantaneous amplitude of the chroma and Y information.

This means that in any one field, one set of lines carries only the chroma information while the alternate lines carry the subcarrier reference. In the following field, positions are reversed.

Fig. 1. Composite color signal combines both chroma and reference signals so that transmission path changes affects both, reducing differential phase and gain errors.



In the NIR receiver (Fig. 1), the subcarrier input is fed to an electronic switch operating at horizontal line frequency with one input to the switch passed through a 64-μsec (one horizontal line) delay. The output of the switch is arranged so that one output always carries the chroma information, while the other output always carries the reference information.

In the $B-Y$ channel, the chroma and the reference are fed to a synchronous demodulator arranged to produce the $B-Y$ signal. The subcarrier frequency is filtered out, and the $B-Y$ output is conventionally fed to a matrix.

In the $R-Y$ channel, the chroma and reference signals are passed through phase shifters to produce a total of 90° phase difference between the signals, thus producing the $R-Y$ signal, which also has the subcarrier frequency filtered out, then applied to the matrix.

Note that in this method of color transmission, any transmission faults producing differential phase shift or differential gain changes across any horizontal line apply to both chroma and reference signals alike, thus nullifying any distortions. Also of interest is the fact that a local subcarrier oscillator is not required, as the composite color signal contains all required information. ▲

LASER TV DISPLAY

DEVELOPMENT of the laser as a practical, continuous light source has opened the way for a novel and promising new approach to large-screen, high-brightness, high-resolution TV projection.

Developed by Texas Instruments Inc., the new projection system uses a conventional monochrome closed-circuit TV camera to modulate an electro-optical light modulator placed in the laser beam path. A unique electro-optical scanning system is used to generate the raster for this display system.

The developmental model has a monochromatic (red) light, a resolution of 525 lines, a bandwidth of 4.5 MHz, and a brightness of 8 footlamberts on its 30-inch by 40-inch screen.

Two full-color versions are now being considered. One version will consist of three independent lasers, one emitting green, one emitting blue, and the other emitting red light beams. These three beams will be individually modulated by electro-optical modulators with their respective color information, then optically mixed into a single beam for scanning and display.

The second approach involves the use of two lasers, one for red and the other for a blue-green beam that will be split into separate blue and green components, using optical filters, and then modulated, mixed, and displayed.

The full-color design objective is a 1029-line display, 30-MHz bandwidth, and 50-footlamberts brightness on a 100 square foot screen. ▲

Shadow-Mask Color-TV Tubes

(*Continued from page 45*)

does not make the structure equivalent to the high-focus design, as far as potential is concerned, for the Einzel lens has three times the number of gaps at the high-potential difference and therefore three times the opportunity for breakdown. Obviously, the low-focus design has to have even more carefully processed lens cylinders, better polished surfaces, protection after cleaning, and critical cleanup (spot knocking) after exhaust and during high-voltage processing. (Spot knocking is the removal of potential voltage breakdown or arc-over sources between gun elements.)

Shadow Masks

In the progression from round to rectangular color tubes, which was intended to improve the adaptability of the tube to various receiver designs, a new set of circumstances arose. The symmetry of the round bulb and round shadow-mask frame assembly plus the essentially symmetrical mask-frame spring-to-bulb stud-support arrangement minimized distortion and alignment requirements or limits for acceptable color purity. The rectangular bulb and rectangular shadow-mask frame with their irregular shape posed new problems. The lack of symmetry of rectangular bulbs made it necessary to change the temperature gradient in the glass processing, improve the seal edge of the funnel structure, and develop an improved frit in order to maintain shape and provide a strong envelope. The glass face panel on which the screen was printed also had to be specially treated to prevent distortions. These distortions, which occur during the thermal processing steps subsequent to screening, would have affected the purity range and have made the external neck component positioning and electrical adjustment of the tube in the receiver more critical.

The frame which supports the shadow mask went through many design changes including mechanical, annealing, and restriking, all to minimize the effect of distortions on the shadow mask which must show minimum change from the planned curvature after tube processing. Fig. 5 compares a round and rectangular shadow mask.

The shadow-mask curvature match to the face panel must be maintained if the tube is to provide acceptable set-up adjustment range and color purity.

As a point of information, the shadow-mask is made from SAE No. 1010 steel .006 inch thick, and although this is an ordinary type of low-carbon steel, special care is taken to assure uniform reaction of the material throughout the melting, chemical-etching, heat, rolling, forming, and blackening processes that precede its assembly to the support frame.

Most recently, the design of the mask support springs has included changes in material and structure which reduce mask shift due to temperature changes in the mask brought about by electron bombardment during operation. The change in alignment of the holes in the mask and the phosphor triads is minimized between turn on and equilibrium temperature by the compensation provided by a bimetallic spring and mounting arrangement. This correcting or compensating action reduces the chance that there will be any change in alignment between the phosphor dot screen and the aperture mask (shadow mask) and therefore any change in color purity during this period.

Mask hole configuration is not the same for the various tube sizes in the present family of shadow-mask color tubes. The arrangement of the holes, that is, their spacing and their size, must follow certain rules if moiré patterns or beat interference between rows of aperture in the mask and raster scan lines are to be avoided. The 25-, 19-, and 15-inch tube types have center-to-center spacing of apertures of .028, .023, and .025 inch, respectively.

Although mask hole size has an effect on the resolution capability of the tube, a more important factor is the size and shape of the electron gun's beam. This varies according to the current in the beam, the applied focus voltage, the spot quality of the electron guns, and how closely matched they are for optimum focus. For any reasonable beam current, the three guns must be individually capable of producing a good electron beam bundle. To minimize the disparity between the spot sizes of the three guns, they must come to focus at essentially the same voltage. Under typical test conditions of 300 microamperes beam current, modern tubes are designed to provide a resolution of 400 to 450 lines.

Under typical current or drive conditions, the electron beams will cover about five to six holes of the shadow mask, which gives an idea of the color resolution that today's typical shadow-mask color tubes are designed to provide.

The Future

The obvious question that arises at this point is, "Where do we go from here?" The industry has moved very rapidly in these last few years, and there is a need to solidify the present developments. The change to 90° deflection and at the same time to rectangular structures was a real advance yet one which brought with it serious problems in duplicating the performance both visually and electrically of the 21-inch, round 70° tube.

A move to greater deflection angles such as 110°, as was done in the case of monochrome, could come with time, but the problems associated with such a change in a color tube bear essentially no resemblance to the same problems in monochrome. About all that was needed in the case of monochrome was a new wider angle bulb. This is not true with regard to color, for practically everything associated with both the building and application of a wider deflection angle color tube changes and becomes increasingly more difficult and critical. A move in this direction, assuming that performance will not be allowed to be degraded, will require, in addition to all the new manufacturing techniques and equipment changes, new circuitry, circuit components, and tube components. Although circuitry, deflection yokes, convergence assemblies, and purity assemblies can be developed, the question is whether reliability and performance will be acceptable.

Although much research is going into the other-than-shadow-mask types of picture tubes, none is capable of producing acceptable color pictures at this time. It is felt that the three-gun tube will be in use for a very long ime. ▲

Cryogenic Level Controls

(Continued from page 38)

trolled rectifier a.c. static switch provided this action.

The original SCR a.c. static switch appears in Fig. 9. This circuit was designed to handle large amounts of alternating current with a low-current switching device connected across the gates of the SCR's. In the cryogenic level control modification, a thermistor was substituted for the switching device and a time-delay relay was used for the load resistance. The revised circuit appears in Fig. 10.

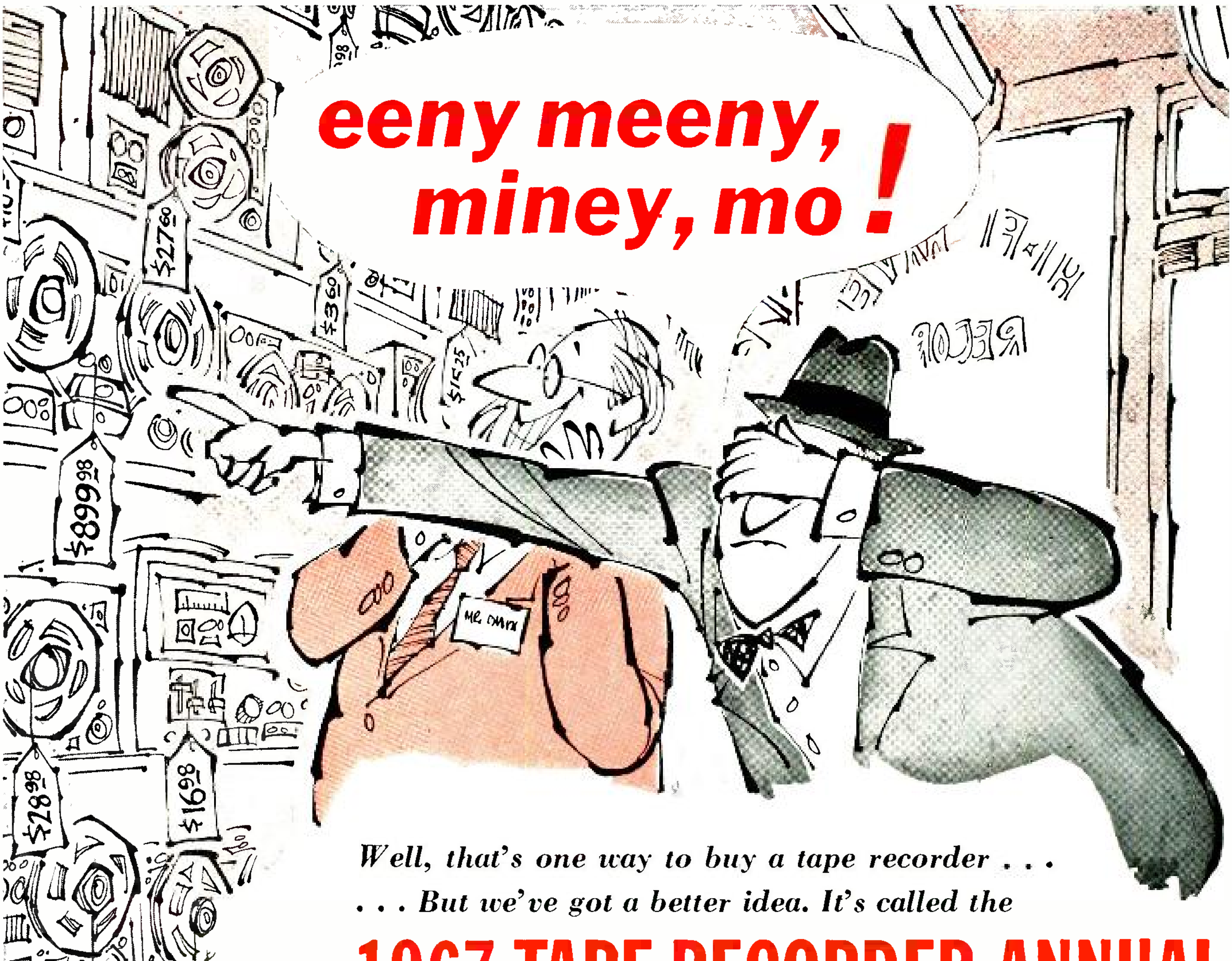
When the thermistor is immersed in liquid nitrogen, its resistance value increases enough to completely turn off the SCR switch circuit. Most of the a.c. line voltage appears across the sensor through the time-delay relay heater which is cool and low in resistance. A small amount of current flows through the sensor to maintain internal heat.

As the liquid level drops and exposes the thermistor, its resistance drops due to warming by internal heat, and the SCR's start to conduct. As current begins to flow through the relay heater, its resistance starts to rise, dropping an increasing amount of voltage. As more voltage is applied to the heater, less voltage is available to heat the sensor due to the bypassing of current through the SCR's. When the SCR switch is turned fully on, very little voltage is left on the sensor. As the sensing thermistor is again covered with liquid, the resistance rises sharply, turning off the SCR switch and shutting off the current to the relay heater. As the heater cools, full line voltage is restored to the sensor for heating.

The transition of the circuit from on to off is smooth and operates flawlessly; heat is applied as needed to the sensor and removed when it could be damaging. The time-delay relay changes the slow rising and falling voltage across the heater to an abrupt "on-off" signal through the relay contacts.

By careful selection of the value and temperature coefficient of the sensing thermistor, along with the proper physical size for the correct power dissipation, the circuit can be made to tolerate line-voltage variations as great as 90 to 140 volts a.c. without seriously affecting the operation and can positively distinguish between liquid and vapor without adjustments of any kind.

In this article we have seen how electronics and solid-state devices have come to the field of cryogenic liquid level control. Like so many other fields of application that were formerly dominated by mechanical devices of various types, this field is now finding use for electronic controls with their improved reliability and sensitivity. ▲



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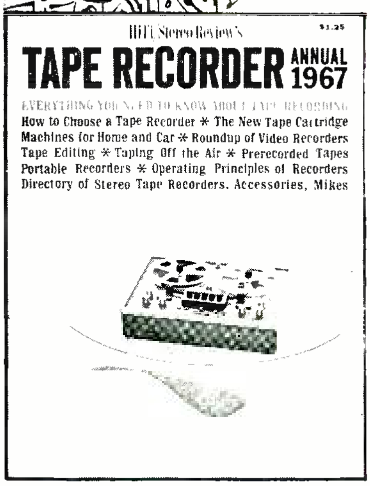

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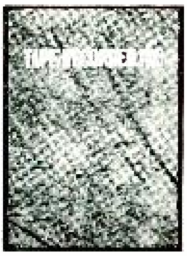

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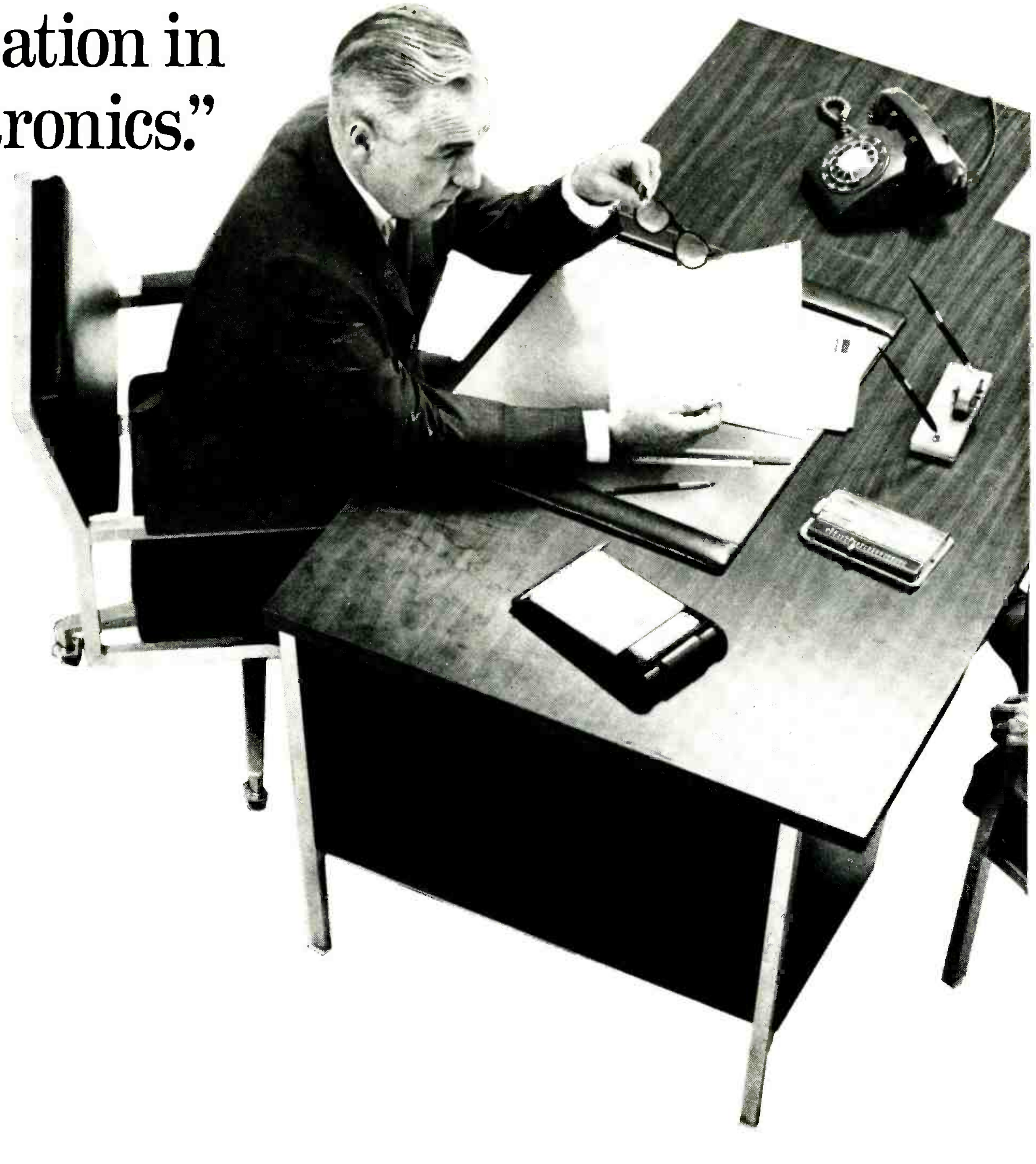

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Chroma Circuits: Sylvania

(*Continued from page* 35)

ence signal, portions of the red and blue signals are applied through $R4$, $R5$, and $R6$ to the grid of the triode section of demodulator $V2$. The values of these three resistors are chosen to provide the correct amplitude ratio between the $R-Y$ and the $B-Y$ signals, as determined by the vector diagram of Fig. 2. By adding the red and blue color-difference signals in the ratio of 0.829 to 0.559, the negative green difference signal (amplitude 1.00) is obtained. The simple triode amplifier provides the necessary polarity inversion, and, at its plate, the correct polarity $G-Y$ signal appears. As in all color-TV receivers, the color-difference signal going to the three CRT control grids is d.c.-coupled by a series resistor and is shunted by a suitable capacitor.

High-Voltage Regulator

The high-voltage regulator is a single triode stage that simultaneously regulates the high voltage and the width of the picture by controlling the d.c. voltage on the grid of the horizontal output tube. As illustrated in Fig. 3, the triode half of the 6CL8A horizontal oscillator is used as the high-voltage regulator and is connected between the control grid of the 42KN6 horizontal output tube and ground. The plate of the high-voltage regulator goes to the control grid of the horizontal output tube by means of $R1$ and $R2$, while $R3$ connects the plate to ground. In effect, the high-voltage regulator triode is connected across $R2$ and supplies some bias voltage to the control grid of the horizontal output tube. The cathode of the high-voltage regulator receives a positive voltage through a voltage divider consisting of $R4$ and neon tube I400. The voltage across the neon tube, which is also the cathode potential, is approximately 55 volts.

The high-voltage regulator receives a positive pulse from a special winding on the flyback transformer. Most of this positive pulse is applied directly to the plate of the triode, but a portion of it is applied through $R5$, $R6$, and $R7$ to the control grid. At the output of the special flyback transformer winding, a positive pulse, approximately 270 volts peak amplitude, is obtained. For the duration of this pulse, the plate of the high-voltage regulator becomes quite positive, the grid voltage also becomes positive, and, even though the cathode is at approximately +55 volts, the tube will conduct. Current therefore flows from the plate through $R3$, setting up a voltage across this resistor. This same voltage is, of course, supplied to the control grid of the horizontal output tube and is partly in parallel with the normal grid bias voltage found on the horizontal output tube control grid. Typical values are approximately −40 volts on the control grid of the output tube and about −25 volts across $R3$. High-voltage regulator potentiometer $R6$ sets the level and the amount of conduction of the high-voltage regulator circuit because it sets the control grid voltage of that tube. Once this control is set, it rarely needs readjustment.

The high-voltage regulator depends on the feedback signal from the flyback transformer winding to determine the level of control. When the picture tube draws too much screen current, this will be reflected as excessive load into the flyback transformer, with the result that the +270-volt positive pulses supplied to the plate of the high-voltage regulator will be considerably reduced in amplitude. With less positive voltage applied to the plate of the high-voltage regulator, less current will be drawn and less control voltage will be applied across $R3$. The over-all result is that the control grid of the horizontal output tube will become less negative, allowing that tube to pass more current and therefore provide more power to the flyback circuit. In this manner, the combination of the high-voltage regulator and the grid bias characteristic of the horizontal output tube compensates for any loading of the flyback transformer due to excessive CRT ultor current. Like the horizontal and vertical oscillator and output tubes, the regulator tube is contained on the main printed-circuit board. None of its values or components is critical, and the relatively simple scheme appears to operate quite satisfactorily over a fairly large range of ultor current variation.

Transistor Noise Gate

In addition to the various vacuum tubes and diodes used in the *Sylvania* DO3-2 color-TV receiver, a single transistor is used in a relatively novel circuit. As illustrated in Fig. 4, a 2N306 transistor ($Q1$) provides the cathode return for sync separator tube $V4$. To understand the operation of this transistor noise-gate circuit, it is necessary to consider the polarity of the video signals. After the second i.f. stage ($V1$), the video detector drives the first video amplifier ($V2$), and from there the signal goes to the second video amplifier ($V3$). The output of the second video amplifier is applied through $C1$ to the grid of sync separator triode $V4$. Tracing the polarity of the composite video signal from the video detector diode, we can see that the synchronizing pulses appearing at the grid of the sync separator are positive going.

Like most color-TV receivers, the *Sylvania* models use a separate 4.5-

MHz sound i.f. Note that the sound detector in Fig. 4 is a diode with its polarity reversed as compared with the video detector. As a result, the output of the sound detector will contain synchronizing pulses of negative polarity. These synchronizing pulses are applied directly to the base of the 2N306 noise-gate transistor. At the collector, which is also the cathode of the sync separator, the pulses coming from the sound detector diode will be amplified and inverted. When signals of the same phase are applied to both grid and cathode of a triode, they cancel each other. The positive-going pulses at the grid, however, have previously passed through two stages of video amplification and are therefore considerably greater in amplitude than those appearing at the cathode. As a result, sync pulses will be amplified by the sync separator. Random noise pulses, occurring between sync pulses, will be cancelled because the time constant of *C1* and *R1* does not favor these short pulses as much as the regular sync pulses.

Because of this discrimination occurring between the random noise and sync pulses, sets using noise gates produce stable CRT pictures even under heavy noise interference.

In many respects, the transistor noise gate illustrated in Fig. 4 acts just like other noise inverter or gating circuits found in both black-and-white and color-TV receivers. The major difference in the *Sylvania* DO3-2 model is the fact that the transistor is connected directly between the cathode and ground of a triode. Another unusual feature is that the signal amplified by the transistor also acts as cathode signal, through C2, for the keyed a.g.c. amplifier. ▲

A.G.C.-OPERATED POWER CONTROL

By A. W. EDWARDS

THIS device operates, unattended, to turn an external 120-volt a.c. appliance on and off with the presence or absence of a signal in the bandpass of a radio receiver. The signal (about –0.4 volt) that triggers the control circuit into operation is taken from the a.g.c. line of the receiver used. A sensitivity control can be adjusted so that it takes a larger voltage to perform the trigger operation. This permits triggering only on signals of proper amplitude and not on short, low-level noise bursts.

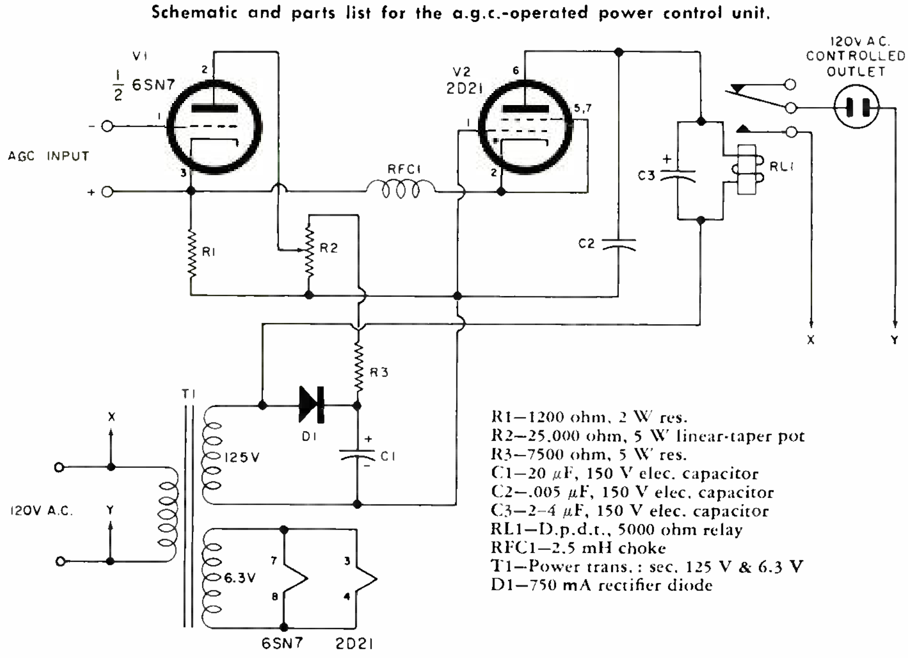
Operation is as follows. With no signal present in the receiver bandpass, the a.g.c. level is substantially zero volts; thus, V1 (see diagram) conducts. The current flow through V1 produces a voltage across cathode resistor R1 which biases thyratron V2 so that it is cut off. No current flows through the thyratron, therefore relay RL1 and the external circuits are both de-energized.

As a signal is picked up by the receiver, the a.g.c. voltage becomes more negative and will cut off V1 at a level dependent upon the setting of sensitivity control R2. As V1 cuts off, the voltage at the cathode of V2 is removed and V2 conducts. Current flows through V2 and then operates relay RL1, placing power at the controlled outlet.

As the receiver signal disappears, the a.g.c. voltage again reduces to zero and V1 conducts, cutting off V2, de-energizing the relay, and removing power from the external circuit.

Capacitor C2 and RFC1 were added to reduce the r.f. noise generated in the thyratron ▲

Schematic and parts list for the a.g.c.-operated power control unit.



R1—1200 ohm, 2 W res.
R2—25,000 ohm, 5 W linear-taper pot
R3—7500 ohm, 5 W res.
C1—20 μF, 150 V elec. capacitor
C2—.005 μF, 150 V elec. capacitor
C3—2–4 μF, 150 V elec. capacitor
RL1—D.p.d.t., 5000 ohm relay
RFC1—2.5 mH choke
T1—Power trans.: sec. 125 V & 6.3 V
D1—750 mA rectifier diode

V.H.F. HAM BAND SCANNER

ONE of the major problems of working the v.h.f. ham bands is that the receiver must be tuned across the band many times before a signal is heard. Many mechanical solutions come to mind, but the use of motors, gearing, and mechanical coupling presents too many difficulties.

The electronic solution used by ZL2APC (reported in "Break-In", the Journal of the N.Z. Association of Radio Transmitters, Inc.), was designed to be incorporated into a 144-MHz receiver, but can be used on other bands.

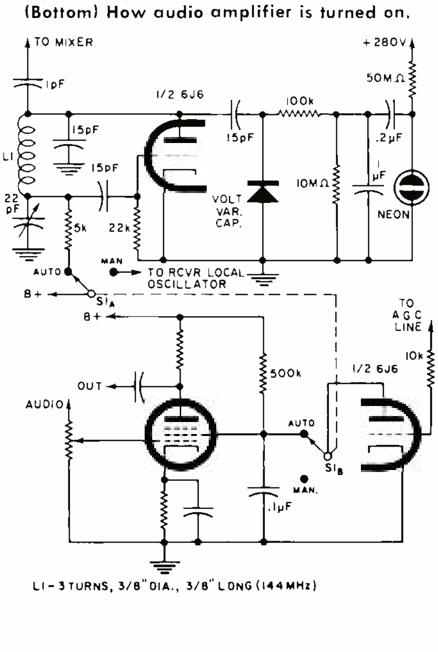
The electronic band scanner is coupled with a new approach to squelch circuits to eliminate the need for long hours of tuning and having to listen to all types of background noise.

The basic scanner circuit shown in Fig. 1 uses a single triode, a neon lamp, a voltage-variable capacitor, and a few common components. The values of all components and voltages are shown as examples and may need slight modifications for some particular use.

The r.f. output of the triode is coupled to the mixer in parallel with the set's local oscillator. Switch *S1A* is operated so that the "B+" is connected to the selected oscillator, disabling the other. The tuning circuit consists of *L1* and its tuning capacitor.

The saw-tooth waveform used causes the oscillator to always tune one way, without wasting time on the retrace. Time constants for the saw-tooth circuit are chosen so that the speed of scanning is within the parameters of the receiver. Too rapid a scan is not desirable since a receiver with normal a.g.c. characteristics would not unmute

Fig. 1. (Top) Electronic sweep generator. (Bottom) How audio amplifier is turned on.



L1—3 TURNS, 3/8" DIA., 3/8" LONG (144 MHz)

in the brief time that the signal remained in the i.f. passband. This rules out a scan derived from the power-line frequency. This system uses an approximate three-second scan generated from a neon-lamp relaxation oscillator.

The saw-tooth voltage for changing the frequency is created by a three-second relaxation oscillator consisting of a neon lamp and *RC* network. The neon-lamp oscillator generates about 70 volts, too much for the voltage-variable capacitor. A resistive voltage divider cannot be used because it would affect the charging cycle; therefore a capacitive divider consisting of a .2-μF and a 1-μF unit in series is used. The .2-μF capacitor should be a low-leakage type.

To achieve proper operation, it was found necessary to shunt a 10-megohm resistor across the 1-μF capacitor.

A positive-going saw-tooth, about 12 to 14 volts amplitude, appears across the 1-μF capacitor and is coupled to the voltage-variable capacitor through a 100,000-ohm isolating resistor.

Three non-linear effects are present to affect the tuning characteristics. One is the exponential charging curve of the saw-tooth capacitor; another is the non-linear change in capacitance with applied voltage common to all voltage-variable capacitors; and the third is the non-linear change of frequency with a linear change in tuning capacitance common to all resonant circuits. As a result of the interaction of these three factors, the tuning characteristics are non-linear in the relationship between elapsed time and frequency. The frequency scan is initially rapid, with the rate of tune decreasing towards the end of the scan period.

To make the signal audible as the scanner passes across it, the lower circuit of Fig. 1 is used. The particular receiver used had a pentode audio amplifier, and the screen circuit was modified as shown. Screen voltage is now derived through a 500,000-ohm resistor. The second half of the 6J6 is connected to the screen as shown with its control grid driven by the a.g.c. voltage. In the absence of a.g.c. (no signal), the triode conducts and lowers the screen voltage of the pentode, causing a reduction in the audio output.

When a signal appears in the receiver passband, the negative-going a.g.c. voltage cuts the triode off, allowing the screen voltage to rise. This produces a sudden increase in volume that is easily heard. The second part of the function switch (*S1B*) is arranged so that this triode is removed when the receiver is operating normally. ▲

NEW PRODUCTS & LITERATURE

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, fill in coupon on the Reader Service Card.

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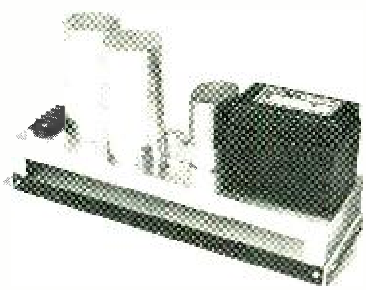
POWER-SUPPLY LINE

A line of newly engineered a.c. power supplies is now available as off-the-shelf items at electronic parts distributors.

The expanded line includes seven new models and 13 redesigned units. The new units have tight regulation, fast response, isolation, current limiting, high efficiency, and reliability, according to the manufacturer. Rated input range is 100 to 130 V a.c. at 60 Hz while output is held constant to ±1% or less for a.c. input variations as great as ±15%.

The supplies will operate within specifications at an ambient temperature range from 0 to



50° C. Output voltage will change about 1% for every 40° C change in ambient. Total ripple content does not exceed 1% r.m.s. Sola

Circle No. 126 on Reader Service Card

AUTOMATIC TIMER

An all-purpose timer which will switch up to 1000 watts over a 24-hour period, is designed as a timer and reminder device for use with music systems, the tape recording of radio programs, time-lapse photography, window displays, water and lighting systems, among others.

The timer is offered in four principal models, each of which is available in free-standing or panel-mount versions. Both 12- and 24-hour types are included. Yale Audio

Circle No. 1 on Reader Service Card

LOGIC DIAGRAM SYMBOLS

A kit of dry transfer symbols conforming to MIL-STD-806B and to ASA-STD-Y32.14 is now available. It features all the commonly used logic functions such as "and," "nand," "or," "nor," shift-registers, flip-flops, time delays, and assorted waveforms.

A special heat-resistant drafting adhesive affords easy transfer to paper, vellum, tracing cloth, and nylon with only light pressure from an ordinary ballpoint pen. The symbols are printed with a 0.020 line width which blends with both pencilled and inked lines. Datak

Circle No. 127 on Reader Service Card

HEAT-SHRINKABLE END CAP

A new heat-shrinkable Type SR rounded end cap for insulating wire terminations, splices, and junctions in virtually all electronic and electrical equipment is now available.

In addition to non-splitting, non-rupturing characteristics, even when used over irregular surfaces, the end caps will form a quick permanent insulating bond and still function as insulators or as an encapsulation. They have no sharp edges and do not constitute an abrasion hazard to nearby wires.

The end caps are available in five sizes: 1/16", 1/8", 1/4", 3/8", and 1/2", expanded i.d., and will

shrink in excess of 50%. The end caps are UL rated at 125° C. Electronized Chemicals

Circle No. 128 on Reader Service Card

TOOL MAGNETIZER

A lightweight (less than 4 ounces), small-size (smaller than a cigarette package) tool magnetizer/demagnetizer is now being marketed as the "Sure-Nuf."

To magnetize a screwdriver, for example, the tool is inserted in one of the holes in the device and then drawn out. To demagnetize the tool, it is drawn across one of the outside metal plates. The process may be repeated hundreds of times with the same tool. The permanent magnets never need recharging. New Enterprises

Circle No. 2 on Reader Service Card

COLOR TEST ADAPTER

A new 9-pin novar color test adapter, designed for measuring the cathode current of 6JE6 and 6KM6 horizontal output tubes, is now available as the Model 2599.

The unit provides alligator clip test leads running from the interrupted No. 3 pin of the adapter. When the test adapter is installed between tube and tube socket, it is possible to measure cathode current and make the necessary circuit adjustments. Pomona

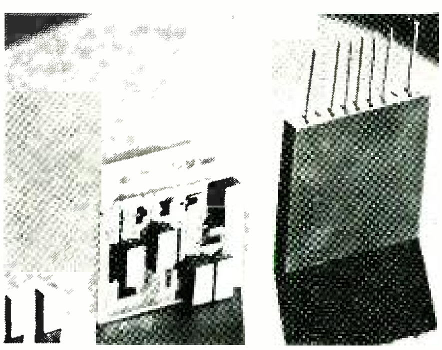
Circle No. 3 on Reader Service Card

MINIATURE CHIP CAPACITORS

Miniature capacitors for microelectronic circuitry are now on the market as "Glass-K" chip capacitors. The new units exhibit a high capacitance-to-volume ratio which is made possible by a new dielectric material. Extremely small and light, the tiny chip capacitors are suitable for the tight tolerances and packaging flexibility of hybrid circuitry.

The new capacitors are available in two sizes: 0.190" long x 0.095" wide x 0.080" high with a maximum capacitance of 0.1 μF; and 0.190" x 0.070" x 0.060" in a capacitance range of 0.012 μF to 0.051 μF. Working voltage is 50 V d.c. for an operating temperature range of −55 to +125° C.

Detailed performance curves and tables for both "Glass-K" chip capacitors and encased ca-



pacitors are available on request. Corning Electronics

Circle No. 129 on Reader Service Card

PROGRAM RELAY

The new 1460 series program relay is capable of switching 15 amperes at 125/250 volts a.c.

This compact, economical relay mounting up to three form-C snap switches is ideal for use in sequential controls such as door operating devices, vending machines, and other general repetitive industrial or appliance load applications where electric motors or incandescent lights must be started, stopped, and cycled frequently through a pre-set function. Cornell-Dubilier

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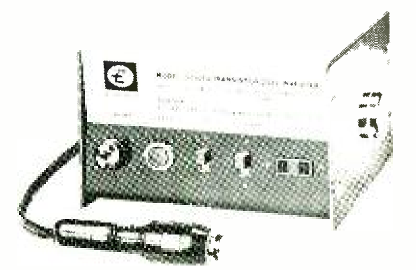
COMPACT INVERTERS

Two compact inverters, one a 125-watt transistorized unit for operating portable TV sets, lights, p.a. systems, etc. and the other specially designed to compensate for low power factor in tape recording, are available as the TI-100A and TI-100R, respectively.

The TI-100A may be plugged into the cigarette-lighter socket or connected directly to the



12-volt battery by means of a color-coded adapter accessory. Automatic thermal overload protection and a "start" switch for rapid starting of "hard-to-start" items are featured in this model. It measures 3½" h. x 6¼" w. x 6¼" d. and weighs 6¾ pounds.

The TI-100TR delivers 125 watts continuous a.c. power from a 12-volt car battery or other 12-volt d.c. source. It is equipped with JEDEC-type transistors and is designed for greatest efficiency at higher output loads. Electro Products

Circle No. 4 on Reader Service Card

SELECTOR SWITCH LINE

The Series 211 and 212 selector switches are now being offered with new polycarborate insulated shaft extensions and spacers. These switches are designed for instrument and other applications requiring isolation of all or part of the circuitry and a 100-million megohm minimum insulation resistance. The isolated portion of the circuit can be floated up to 10,000 volts above ground.

Shaft extensions are available in 3/8" to 1 7/8" lengths. Spacer length is 15/16". Chicago Telephone of California

Circle No. 131 on Reader Service Card

82-CHANNEL TV ANTENNA SYSTEM

A new solid-state, 82-channel home TV antenna system has just been introduced, providing outputs for up to four sets. Used with a "Color-axial" antenna, the "Colorcaster-4" all-channel amplifier will provide sharp, brilliant pictures in black-and-white and color, plus sharp FM-stereo signals, according to the company.

Since the amplifier is solid-state and is used with coaxial cable, the makers expect it to have a long, trouble-free life. Jerrold

Circle No. 5 on Reader Service Card

MINIATURE RELAY

The Model 373-1A-V relay combines miniaturization with high insulation resistance for applications in semiconductor test equipment, instrumentation test sets, and other equipment where high insulation resistance must be maintained and space is critical.

Insulation resistance exceeds 1×10^{14} ohms, measured at 90 V d.c. and 40% humidity. The relay occupies only 0.02 cubic inch, measures 0.19" in diameter and weighs 1.1 grams. Operate time is 0.40 msec maximum while release time is 0.018 msec maximum. Contacts are rated at 7 watts, 125 mA. Wheelock

Circle No. 132 on Reader Service Card

VARIABLE SPEED CONTROL

A new variable speed control unit for use with all a.c.-d.c. motors up to 7½ amperes is being marketed as the "Select-A-Speed."

The control is designed to be used with power drills, sanders, electric saws, mixers, blenders, floor polishers, and many other motorized tools. The new unit reduces the speed without reducing torque. It will control universal and brush-type motors and heating elements from 0 to 100 percent of motor rpm. A dual-mode switch on the control box has settings for full or variable speeds. It uses an SCR and has an automatic built-in circuit breaker to prevent damage from overloads. It is rated to 900 watts. Trans-Tek

Circle No. 133 on Reader Service Card

CUTTING & FORMING TOOL

A new tool for quick, accurate, low-cost forming and cutting of component leads is now on the market as the "Cut-n-Form" plier. This single cut and bend plier is a time saver on the production line or with small trial setups. Tough, long-life Delrin jaws insure uniform quality and eliminate scratching, nicking, or flattening of lead wires since there is no metal-to-metal contact. Henry Mann

Circle No. 134 on Reader Service Card

HI-FI—AUDIO PRODUCTS

MUSICAL INSTRUMENT SPEAKER

A speaker designed especially for use with the guitar and other sound-amplified musical instruments is now available as the Model 417A.

An aluminum dome improves the crispness of the sound and the bass response is especially effective with the guitar. The speaker is a 12-inch unit and has an 8-ohm impedance. Altec Lansing

Circle No. 6 on Reader Service Card

COMPACT SPEAKER SYSTEM

An entirely new series of "Achromatic" speaker systems were included among the items recently introduced at the Hi-Fi Show.

A new compact speaker, the W20, offers a wide range of sound at moderate price by utilizing a high-compliance, low-resonance full 8" woofer with "Flexiprine" suspension and a new advance-design Mylar-domed pressure tweeter.

Other speakers in this new line include the W30C, the W40C three-way system, and W60C three-way bookshelf or floor speaker system, the W70C three-way lowboy system, and the W90C six-speaker consolette. Wharfedale

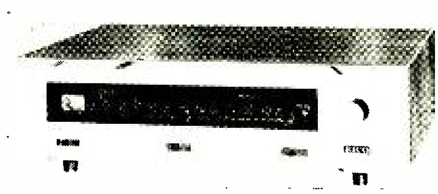
Circle No. 7 on Reader Service Card

SOLID-STATE AMP & TUNER

The new solid-state "Cortina" line includes the Model 3200 FM-MPX automatic stereo tuner and the Model 3070 70-watt stereo amplifier, both of which are being offered in kit and wired versions. Each unit measures only 3⅛" high x 12" wide x 7¾" deep and is housed in a durable steel cabinet covered in Danish walnut vinyl.

The amplifier features all silicon transistors, a frequency response of 5 to 100,000 Hz ±1.5 dB, harmonic distortion of less than 0.8%, and hum and noise 72 dB below rated output. Channel separation is 50 dB. Complete control facilities are provided.

The tuner is a wide-band instrument with five tuned circuits of the front end containing



two r.f. stages, all coupled to a four-stage, double-tuned i.f. circuit. Sensitivity is 2.4 μV for 30 dB quieting (IHF), channel separation is 40 dB, harmonic distortion is less than 0.75%, and capture ratio is 4.5 dB. Eico

Circle No. 8 on Reader Service Card

SPEAKER SWITCHING SYSTEMS

Two new stereo speaker switching systems which allow instant, multiple-output selection of up to eight speaker systems are now on the market as Sound Control Center Models 641 and 642.

The heart of the new systems is an 8-station switching device with frequency response through the internal switching network from d.c. to 30,000 Hz with negligible switching loss. No external power is required for operation. Power handling capability is 100 watts maximum into a 4-ohm load.

The Centers are housed in a wrinkled black enamel cabinet with brushed aluminum escutcheon and decorator-styled push-buttons with beveled edges and easily identifiable numbered faces. Switchcraft

Circle No. 9 on Reader Service Card

"RUMBLE-FREE" TURNTABLE

The new "Servomatic" turntable employs a servo control amplifier resulting in virtually unmeasurable rumble. The motor speed is monitored by the servo which maintains rotation of the turntable at a constant rpm. The unit is powered by a low-speed d.c. servo motor operating at about ⅙th the speed of conventional turntable motors. This reduces rumble-producing mechanical vibration to an absolute minimum at

its source. A belt-drive coupling between the motor shaft pulley and the turntable acoustically isolates the turntable from the slightest remaining vibrations.

The "Servomatic" operates at 33⅓ and 45 rpm. A built-in illuminated strobe disc and speed control permit adjustment of the table to the precise rpm desired. Sony.

Circle No. 10 on Reader Service Card

LIGHTWEIGHT PORTABLE RECORDER

The recently introduced Uher 4000-L tape recorder is lightweight yet incorporates all of the features of the earlier portable. The new unit features a new high-frequency motor, built-in digital counter, new solid-state design; brushed aluminum panel; and an all-metal case. It weighs less than 7 pounds but is fully equipped for either a.c. or battery operation. Martel

Circle No. 11 on Reader Service Card

STEREO CARTRIDGE FOR CHANGERS

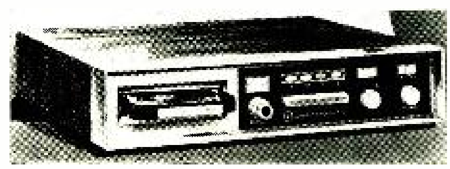
The new 888E has been designed specifically for use in record playing systems that require a somewhat higher tracking force than is recommended for the standard 0.2 x 0.9 elliptical stylus.

This stereo/mono cartridge has a frequency response of 10-30,000 Hz; output voltage is 8 mV per channel; channel separation is more than 30 dB; load impedance is 47,000 ohms. Vertical and horizontal compliance is 12×10^{-6} cm/dyne and tracking force is ¾ to 6 grams. The stylus is a 0.4 x 0.9 mil elliptical diamond. There is a four-terminal output and mounting is on standard 7/16" or ½" mounting centers. Tracking angle is 15 degrees. Empire

Circle No. 12 on Reader Service Card

HOME CARTRIDGE RECORDER

An 8-track stereo cartridge recorder/playback unit has just been released for use in the home. It is designed to play in conjunction with existing speaker/amplifier systems, such as home stereo record player combinations. It contains all of the standard operating features of the firm's automobile player plus fast forward speed with a built-in automatic stop at the splice and a track-change control to permit automatic or manual selection of the track to be played. Other features include a rear-illuminated light indicator that shows which tracks are being recorded or played. A tape



footage indicator shows what part of the tape is recording or playing at any point in the cycle.

The new unit is housed in a natural oiled-walnut cabinet with a brushed gold and black front panel. It will accommodate the firm's line of prerecorded tapes and is not compatible with other 8-track systems on the market. Orrtronics

Circle No. 13 on Reader Service Card

NEW AUDIO COMPONENTS

A number of new audio components has been added to the firm's line including two magnetic cartridges, the 220 and the 990E; two speaker models, the ADC-19 (a console 44" w. x 32" h. x 15¾" d. and featuring six speakers) and the 505 budget system; and the ADC 606 FM receiver, a 9" deep unit designed for bookshelf mounting. Audio Dynamics

Circle No. 14 on Reader Service Card

NEW TAPE-RECORDER LINE

Fourteen new solid-state home audio tape recorders, ranging from battery-operated reel-to-reel portables to deluxe 4-track cartridge recorders and Stereo-8 cartridge players, have just been announced.

The top of the line is the YHG47, a solid-state 7" reel-to-reel stereo recorder which can be operated in either a vertical or a horizontal position. It operates at three speeds (7½, 3¾, and 1⅞ ips), has four tracks, and features capstan drive.

It is housed in a vinyl-covered wood cabinet in black with simulated walnut-grain trim.

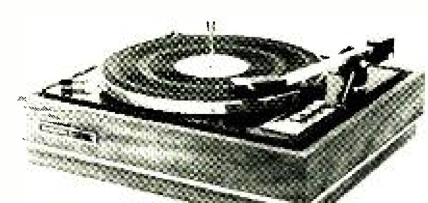
The least expensive unit is the YHS12, a solid-state mono, battery-operated 3" reel-to-reel recorder/player. It operates at 3¾ & 1⅞ ips, has two tracks, and capstan drive. It comes in a black plastic case. RCA Victor

Circle No. 15 on Reader Service Card

AUTOMATIC TURNTABLE/CHANGER

In keeping with the current trend of providing record changing facilities in a unit of turntable quality, the PW-50H has been put on the market.

This new Miracord component is modern in design with square push-buttons and a slim, extra



long arm. It also features fingertip cueing, positive anti-skating control, all-metal tonearm lock, illuminated speed indicator for all four speeds, and a direct-reading tracking force dial.

An entirely new motor mounting and drive system has been designed to give absolutely inaudible rumble to the rugged hysteresis motor. This system includes an improved motor mounting, a new idler drive wheel, and the acoustic isolation of all parts which might contribute to rumble.

Although designed to track cartridges at forces as low as ½ gram, it can also accommodate cartridges requiring tracking forces up to 6 grams. Benjamin

Circle No. 16 on Reader Service Card

COMPATIBLE CARTRIDGE PLAYERS

The "Auto-Sonic" line of tape players now includes new "compatible" units capable of playing four- and eight-track cartridges. Some of the units also provide FM reception.

The "Portamount" series consists of units designed for use in either car or home with no installation required. The 603M/48 is an all-chrome system while the 603M/48FM also provides FM radio reception. The ST100 is a four-track compact auto player with the Model ST300 a deluxe version with indicator light.

The Model ST308 is a four- and eight-track compatible unit which is also available with an FM radio as the ST300/CM.

All of the players come with a choice of four 5" round speakers with chrome grilles included in the price. The company also has a line of home players. S.J.B. Inc.

Circle No. 17 on Reader Service Card

PROFESSIONAL TAPE RECORDER

An all-new, all-silicon, solid-state "Tapesonic" recorder of broadcast quality is now available featuring three speeds (3¾, 7½, and 15 ips) with a frequency response up to 26,000 Hz.

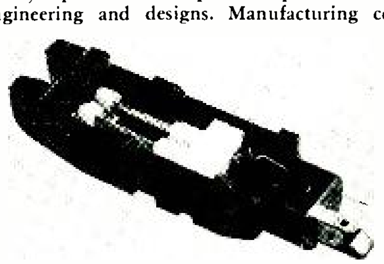
The new unit will record in stereo or mono; has three separate heads; no pressure pads; A-B switch for each channel; automatic stop; four electric push-buttons; adaptable for remote control; three motors with hysteresis direct drive; two electronic mixing inputs per channel for mic, radio, and phono; six silicon diodes; one zener diode—all in five epoxy-glass modular plug-in units. The recorder will handle up to 10½" NAB reels.

The recorder is offered in ¼-track stereo, ½-track stereo, ½-track mono, and full-track models. Premier

Circle No. 18 on Reader Service Card

CERAMIC STEREO CARTRIDGE

A new stereo cartridge, the first in the 5000 series, represents a unique concept in cartridge engineering and designs. Manufacturing com-



plexity has been reduced 80 percent over previous designs, making possible a reduction in the margin of error in alignment yet at a lower cost to the customer.

The small ceramic cartridge is well suited for use in the popular light-mass tonearms. Electro-Voice

Circle No. 19 on Reader Service Card

SOLID-STATE TAPE RECORDER

The new Model 423 is a three-motor, three-speed, solid-state stereo tape recorder whose three motors permit dynamic braking and eliminate all complicated mechanical linkages. In addition, it comes equipped with hyperbolic heads which do not require pressure pads. Although the tape path is curved, the recorder features easy, straight-line tape loading by introducing a swing-away pinch roller.

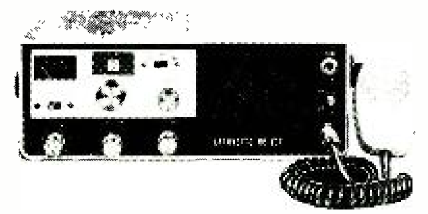
The record/playback amplifier circuit consists of all-silicon transistors on plug-in boards. Frequency response is 50-15,000 Hz @ 7½ ips, 50-10,000 Hz @ 3¾ ips, and 60-5000 Hz @ 1⅞ ips. The recorder accepts 7" reels and is available with a walnut enclosure and optional remote control accessory. Viking

Circle No. 20 on Reader Service Card

CB-HAM-COMMUNICATIONS

SOLID-STATE CB TRANSCEIVER

The HE-20T is a completely solid-state two-way CB radio with a push-pull modulated seven-stage transmitter. The circuit incorporates 13 transistors and ten diodes and features a dual-conversion, tunable 23-channel superhet receiver with a mechanical filter, automatic series gate



noise limiter, variable squelch, "S" and relative r.f. output meter, spotting switch, earphone jack, p.a. provision, and built-in 117-volt a.c. and 12-volt positive- or negative-ground d.c. power supplies.

The transceiver is supplied with a fused d.c. line cord, dynamic mic with coiled cord, a set of crystals for channel 9, and mobile mounting bracket. Lafayette

Circle No. 21 on Reader Service Card

158-168-MHz MOBILE ANTENNA

A new low-profile antenna designed for mobile applications is now being marketed as the Type 25714. This unity gain folded monopole provides a horizontal radiation pattern within ±½ dB of a perfect omnidirectional configuration.

Although originally designed for service in the railroad radio service frequencies, it will provide a v.s.w.r. of less than 1.5 in the 158-168-MHz band. The antenna is mounted on the vehicle roof by means of five ⅜" bolts and nuts. Andrew

Circle No. 135 on Reader Service Card

PORTABLE BASE STATION

A portable base station for use with CB walkie-talkies, that includes an AM radio, is now available as the Y7060. The new solid-state unit can receive all 23 CB channels and transmit voice or Morse code on channel 14. Effective range is up to a mile, depending on conditions.

Uses include monitoring local CB activity, talking to other CB stations, serving as a wireless intercom, and as a portable or home AM radio. Features include a built-in telegraph key and a key jack for use with an auxiliary key. Signals are audible to the sender as well as the receiver, which aids in practice.

The Y7060 operates on six "D" cells and an optional a.c. converter is available. Weight is 5 pounds and the unit is 12.5" wide x 5.5" high x 6" deep. General Electric

Circle No. 22 on Reader Service Card

FIVE-BAND TRANSCEIVER

A five-band SSB-AM-c.w. transceiver with 200 watts p.e.p. SSB input on all bands, 80 through 10 meters, is now being marketed as the Model 200. The new unit also offers c.w. operation plus compatible AM operation with separate AM detection. Frequency determination is by means of a pre-mixed crystal-controlled front-end and a single v.f.o. which tunes the same range on all five bands, thus providing high stability as well as identical calibration and tuning rating between 80 and 10 meters.

A mobile mount is included and the unit may be operated from a number of available a.c. and d.c. power supplies. National Radio

Circle No. 23 on Reader Service Card

AUTOMATIC POLICE/FIRE SIGNAL

The new "Dialalarm" Model 400 is a twin-channel emergency alarm system which dials and calls the fire department, police, or other sources of help by push-button or remote activation.

The equipment is activated manually. It can be integrated into existing security systems and be activated automatically by heat, smoke, or illegal entry. When the source of help is contacted by telephone, the prerecorded emergency telephone message is transmitted. Nite-Day Fire Protection

Circle No. 136 on Reader Service Card

CB BASE STATION

A CB base station which has the ability to reject almost all interference from adjacent channels has been introduced as the "Titan."

The circuit features a built-in Collins mechanical filter which cuts interference from adjacent channels to almost zero—90 dB or better. The multi-function meter serves as a monitor on both the transmitter and antenna system. It measures forward power directly into a dummy load, power through the antenna, and standing wave ratio.

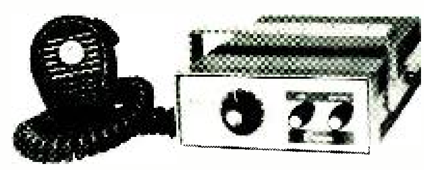
To minimize television interference it has a built-in low-pass filter. The unit comes equipped with all 23 transmit crystals. The chassis features all-aluminum parts and has handles on the front panel. Tram

Circle No. 24 on Reader Service Card

SOLID-STATE CB UNIT

A new 8-channel CB transceiver, designed for mobile operation, is now available as "The Bronco."

This low-cost, solid-state unit features crystal



control on both transmit and receive functions. It comes complete with the channel-11 crystal installed and features simple installation of additional crystals for channels desired.

The unit measures 2-5/16" x 5⅝" x 8¼" and delivers 3¼ watts minimum output from the legal 5-watt r.f. power input. Frequency stability is rated at 0.005% with modulation at −90%, +100%. Metrotek

Circle No. 25 on Reader Service Card

MANUFACTURERS' LITERATURE

WIRE & CABLE GLOSSARY

A new 63-page booklet covering common terms, expressions, and units employed in the electrical wire and cable industry has been published. Available in a handy 4" x 6" pocket size, the "Glossary of Wire & Cable Terminology" is in its third edition and has been revised and enlarged. Standard Wire & Cable

Circle No. 137 on Reader Service Card

RELAY CHART

Complete technical information on a line of relay products is contained in a new 4-page selector chart. Included are miniature general-purpose, general-purpose, program, bistable, time-delay, and telephone relays, as well as timers and d.c. contactors. Cornell-Dubilier

Circle No. 138 on Reader Service Card

SYSTEM POWER SUPPLIES

A new 8-page "Designers Guide to the Specifying of System Power Supplies" has been made available. Illustrated with performance curves and circuit diagrams, the booklet covers definitions; procedures for validating the power-supply specification; methods of protecting the power

supply and its load from each other; and size, heat, and cost considerations. Trio Laboratories
Circle No. 139 on Reader Service Card

LOCKING FASTENERS

Information on a wide variety of locking fasteners is contained in a new 48-page illustrated catalogue (No. 880). Included are metal and nylon nuts, nut and screw combinations, flanged, weldable, and capped nuts, and special devices. MacLean-Fogg
Circle No. 140 on Reader Service Card

COAXIAL CABLES

Technical information on all known RG-type coaxial cables is contained in a newly revised engineering data sheet (E502ED). Cables are indexed numerically for easy reference, and specifications include impedance, capacitance, dielectric material, size and type of conductors, jacket materials, type of shield, diameter, weight, and other pertinent information.

Along with the data sheet, the company is offering a 4-page brochure entitled "What is Coaxial Cable?" Standard Wire & Cable
Circle No. 141 on Reader Service Card

LANGUAGE-LAB EQUIPMENT

A complete system of continuous-loop tape cartridge, magnetic tape recorders, and associated equipment suitable for use in the classroom and language laboratory is described in a new 10-page applications bulletin (No. 1-66).

Numerous photographs of typical installations are shown, along with a block diagram of a 30-position lesson laboratory. KRS Instruments
Circle No. 142 on Reader Service Card

LAMP CATALOGUE

A new 12-page illustrated catalogue describing a line of miniature, subminiature, and micro-miniature incandescent lamps has been released.

Featured in the booklet (No. 104) is a wide range of automotive lamps for 6-, 12-, and 28-volt service. Hudson
Circle No. 143 on Reader Service Card

COMPONENTS CATALOGUE

A new combined catalogue and supplement (No. 700), covering more than 20,000 electronic products, is now available. Described and illustrated in the publication is a complete line of panel and chassis hardware, digital modules, solder terminals, coils and coil forms, r.f. chokes, and capacitors, as well as a wide variety of connectors. Cambridge Thermionic
Circle No. 144 on Reader Service Card

CHART RECORDERS

Thirty-three miniature strip-chart recorders for current, voltage, power, events, pressure, and temperature are described in a new 16-page catalogue.

Included in the booklet is a section on controllers, self-powered units, and various accessories. Additional information is given on chart paper and drive-motor specifications. Rustrak
Circle No. 145 on Reader Service Card

TRIMMER CAPACITORS

A new 16-page catalogue (No. 766) covering standard precision non-rotating-piston trimmer capacitors has been published. More than 300 types of capacitors in printed-circuit, vertical, and panel-mount styles are included. Voltronics
Circle No. 146 on Reader Service Card

PULSE DEFINITIONS

"The New Pulse," a compilation of 45 proposed standard pulse definitions, is now available. Covered in the 24-page illustrated glossary are explanations of monotonic phase, baseline, continuous waves, leading and trailing edges, pulse width, and initial and terminal corner distortion. E-H Research Laboratories
Circle No. 147 on Reader Service Card

SCR CIRCUITS

A new 4-page short-form catalogue (Bulletin 5000) on SCR controls has been released. Block diagrams of seven types of single- and three-phase (full and half wave) SCR control circuits are presented in the booklet, with cross references to the company's applicable SCR controls. Complete specifications are provided on all devices.

The back page of the catalogue contains a listing of general terms used in the industry, including on-to-off ratio, conduction angle, and bias. Firing Circuits
Circle No. 148 on Reader Service Card

MODULAR POWER SUPPLIES

A new 22-page catalogue (No. 766) of d.c. modular power supplies and voltage references is now being offered. Products may be selected according to center voltage, regulation, and shielding, and hundreds of cross-combinations are possible.

Additional information is provided on thermal characteristics and a variety of optional features. CEA
Circle No. 149 on Reader Service Card

SLIDE SWITCHES

Described and illustrated in a new 8-page catalogue (No. S-330) is a wide line of "double-wipe" slide switches. Complete specifications on the general-purpose, tandem, quadrum, rocker, and miniature devices featured in the booklet are supplied. Switchcraft
Circle No. 150 on Reader Service Card

SEMICONDUCTORS

A new 20-page condensed catalogue covering a full line of semiconductor products has been made available. General-purpose diodes, temperature-compensated reference devices, rectifiers, thyristors, and a wide variety of zener regulators are included, as well as a number of solar cells and photoelectric readouts. Hoffman
Circle No. 151 on Reader Service Card

MEMORY SYSTEMS

A new 8-page illustrated technical bulletin (M6612) which discusses the new FX-12 family of small, low-cost memory systems has been released.

Complete details on construction and principles of operation are provided, along with information on modes of operation, logic levels, and power supply requirements. Five generic classes of applications are described, as well as numerous examples of specific applications. Ferroxcube
Circle No. 152 on Reader Service Card

MICROWAVE SOURCES

A new technical paper, eighth in a series, discussing important secondary characteristics of microwave sources and outlining a new approach which combines the best features of solid-state and vacuum-tube technologies has been made available. Sperry Electronic Tube Div.
Circle No. 153 on Reader Service Card

PULSE TRANSFORMERS

Seventeen types of pulse transformer packages are described and illustrated in a new 4-page data sheet (No. 202). Covered in the booklet are four-pin square packages as well as round, rectangular, radial-lead, and flat-pack configurations. Open construction transformers are also discussed. Contemporary Electronics
Circle No. 154 on Reader Service Card

GENERAL-PURPOSE RELAYS

Information on general-purpose a.c. and d.c. Series 50 relays, which are available in more than 100 standard types in 1-, 2-, and 3-pole contact forms, is presented in a new 4-page illustrated catalogue.

Electrical and environmental characteristics as well as mechanical data covering both open and dust-covered types are supplied. Sigma
Circle No. 155 on Reader Service Card

FERRITE CORES

A new 32-page engineering reference manual which discusses the application of ferrite cores to the design of power magnetics has been published.

Design procedures, including full mathematical treatment, are separately explored for linear low-level transformers, linear power inductors, and linear power transformers. Bulletin 330 also includes a full set of core-group charts and curves which provide complete technical specifications, dimensions, and winding data for more than 100 standard ferrite cores.

In addition, a handy wire table for design calculations and a chart of nomenclature and symbols are supplied. Ferroxcube
Circle No. 156 on Reader Service Card

DIODE SWITCH BULLETIN

A technical bulletin, No. 7035, has been issued covering a new high-performance diode switch which provides isolation of 90 dB for microwave communications system applications.

The publication provides complete operating and mechanical specifications, performance curves, as well as an outline drawing and photograph of the device. Microwave Associates
Circle No. 157 on Reader Service Card

CERAMIC DISC CAPACITORS

An 8-page specification catalogue covering a wide variety of ceramic disc capacitors is now available. Included are temperature compensating, general-purpose, high-capacitance 12- and 30-volt d.c. types; bypass, coupling units at 50 volts d.c.; and bypass, coupling capacitors at 500 volts d.c. Nucleonic Products
Circle No. 158 on Reader Service Card

CABLE & ACCESSORIES

A new 14-page catalogue which describes and pictures a complete line of coaxial cables, connectors, cable accessories, rigid lines, delay lines, and coaxial cable assemblies has just been issued.

Also included are full listing of electrical characteristics, performance, and specifications. Phelps Dodge
Circle No. 159 on Reader Service Card

REACTANCE SLIDE RULE

Boonton Electronics Corporation, 523 Pomeroy Road, Parsippany, N.J., 07054 is now offering a slide rule which provides rapid, convenient means for calculating reactance and either "Q" or dissipation factor of capacitors and inductors from 10 Hz to 10 GHz. It is also useful for determining the resonating capacitance and inductance for a given frequency.

Copies of the slide rule will be sent on company letterhead request only and are furnished without charge. ▲

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VOLUMES 75-76

As a service to our readers we are again presenting a complete listing of all feature articles which appeared in ELECTRONICS WORLD during 1966. We suggest you keep this for reference.

TEST EQUIPMENT & MEASUREMENTS

PRODUCT REPORTS

ELECTRONICS MARKET PLACE

COMMERCIAL RATE: For firms or individuals offering commercial products or services. 70¢ per word (including name and address). Minimum order $7.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.
READER RATE: For individuals with a personal item to buy or sell. 40¢ per word (including name and address). No Minimum! Payment must accompany copy.
GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. Additional words may be set in bold caps at 10¢ extra per word. All copy subject to publisher's approval. **Closing Date:** 1st of the 2nd preceding month (for example, March issue closes January 1st). **Send order** and remittance to: Hal Cymes, **ELECTRONICS WORLD,** One Park Avenue, New York, New York 10016

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50	.05	.20
100	.10	.40
200	.20	.60
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600	.35	1.20
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5A INSUL BASE

PRV	
50	.10
100	.20
200	.40
400	.60
600	1.00
800	1.25

TOP HAT & EPOXY 750 MA

PRV	
50	.05
100	.07
200	.09
400	.12
600	.20
800	.25
1000	.50
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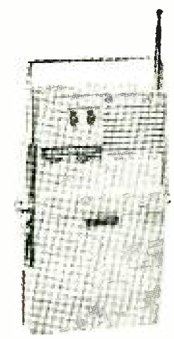

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Lowest Price Ever!

$148

If crystal & tuning is desired add $45.00
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T51G series dynamotor power supply TX narrow banded RX wide banded $148

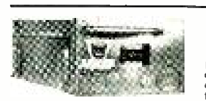
T51G series vibrator power supply TX narrow banded RX wide banded $178

Fully narrow banded (TX & RX) $198

T51GGV vibrator power supply TX narrow banded RX wide banded $188

Fully narrow banded (TX & RX) $208

Above prices include accessories less crystals and antenna (less accessories, deduct $30.00)
To tune unit to desired frequency including new antenna and $45.00



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30 watt vibrator power supply fully narrow banded complete with accessories less crystals and antenna $178

Add $45.00 for tuning to desired frequency and new antenna.

We Buy Late Model Equipment for Cash —Write: Wire or Phone!

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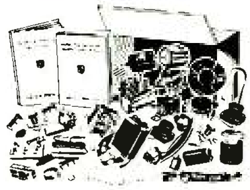

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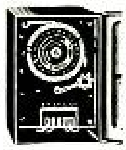

■ (ITEM #158) -- Zenith 115-VAC program timer. Use for periodic signalling, work breaks, school classes, turn on radio for newscasts, etc. Adjustable clips permit switching on or off any time during 24 hour period. Self [illegible] clips for multiple programing. Also has "skip a day" feature. Contacts can handle up to 15 amps. [illegible] 8 lbs. Gov't Cost over $30.00

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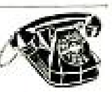

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F.O.B. **$4.99**

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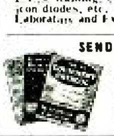

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ELECTRONICS WORLD DECEMBER 1966

ADVERTISERS INDEX

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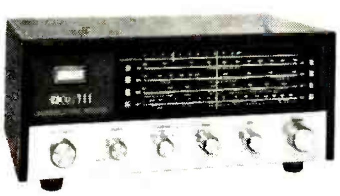

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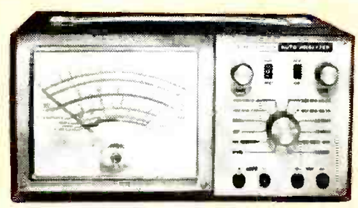

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Keep your car or boat engine in tip-top shape with this completely portable, self-contained, self-powered universal engine analyzer. Completely tests your total ignition/electrical system. The first time you use it — just to tune for peak performance — it'll have paid for itself. (No tune-up charges, better gas consumption, longer wear) 7 instruments in one, the EICO 888 does all these for 6V and 12V systems; 4, 6 & 8 cylinder engines.

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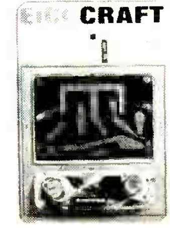

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CIRCLE NO. 120 ON READER SERVICE CARD

10 facts you should know about color-bar generators

If you are going to buy a color-bar generator *—or even if you already own one*—here are several facts you should know.

While other types of test instruments may lack one or more features, they may still be useful in skilled hands—*provided* the user is aware of their shortcomings and *provided* he has other means of determining what he must know.

This is not true of a color-bar generator.

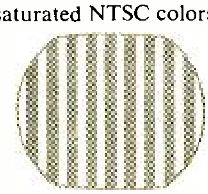
A color-bar generator should allow you to walk away from an adjusted receiver knowing that the owner can turn it on and receive color broadcasts in full-fidelity color and sound.

Not all color-bar generators can give you this assurance.

Let's talk facts.

FACT NO. 1: ***A gated-rainbow type generator is accepted as the standard of the service industry***

You do not need fully saturated NTSC colors to achieve perfect adjustment any more than you need an FCC-type broadcast signal for tuner and if-amplifier alignment. The gated-rainbow type signals are used by virtually all TV manufacturers in establishing service procedures for their sets.



Gated rainbow color-bar pattern

Urgent service needs for a trustworthy color-signal source were met years ago when RCA introduced the *gated-rainbow* system.

Today, this basic system is used in nearly all service-type color-bar generators. The waveforms and procedures in nearly all color-TV service notes are based on this system.

FACT NO. 2: ***All gated-rainbow type generators are not alike***

In spite of their basic circuit similarities, available models differ in their features, accuracy, and ultimate usefulness. Some of these differences are critical.

FACT NO. 3: ***The offset subcarrier oscillator must be controlled within a few cycles of its true frequency***

This oscillator controls the phase angles (hues) of the color-bar pattern. It is the *heart* of the color-bar generator.

The subcarrier oscillator should be within ±20 cps of its fundamental frequency of 3.563795 megacycles. *In the crystal-controlled RCA WR-64B Color-Bar/Dot/Crosshatch Generator, this deviation is kept well within the ±20 cps limit.*

FACT NO. 4: ***Provision must be included to prevent the subcarrier oscillator from drifting off frequency***

The subcarrier oscillator must not only be accurate when the instrument is *new*—it must *stay* accurate. Top-quality components minimize undesirable frequency changes.

Check, for instance, the trimmer capacitor used in the 3.56-Mc subcarrier oscillator. *You'll find a piston-type ceramic capacitor—not a flat mica type—in the RCA WR-64B.*

FACT NO. 5: ***The generator must have an rf-sound carrier to assure proper setting of the fine-tuning control***

Unless your color-bar generator has this essential feature, it may produce a perfect color-bar pattern on the receiver, *but at the wrong setting of the receiver fine-tuning control. In such cases, the receiver may not correctly reproduce a color program.*

The WR-64B has this necessary feature. With it, you can accurately set the fine-tuning control *before* making color adjustments. *In the WR-64B the rf-sound carrier is also crystal-controlled.*

FACT NO. 6: ***The rf picture carrier must be exactly on frequency to assure that the color subcarrier is correctly placed in the receiver bandpass***

Drift, faulty adjustment, or aging of components in the rf oscillator section can move the generator picture carrier off frequency. This shift, in turn, will also move the color subcarrier signal away from its correct position in the receiver bandpass. In some receivers, this shift will affect accuracy of color-circuit adjustments.

A separate crystal-controlled oscillator is used in the WR-64B to keep the picture exactly on frequency.

FACT NO. 7: ***The axes of the output color-bar pulses should lie on the zero axis—and not on elevated brightness pedestals***

Elevated pulses necessitate use of an oscilloscope for accurate setting of receiver phasing. A generator having zero-axis color-bar pulses, such as the WR-64B, does not require use of an oscilloscope for checking phasing in the customer's home.

FACT NO. 8: ***The generator should not require frequent adjustment of internal counter circuits***

All color-bar generators contain circuits which develop vertical and horizontal sync, and dot-and-bar-pattern signals, by dividing or counting down from a higher frequency: usually 189 Kc. If one of these circuits is unstable, the patterns can jitter, ripple, jump sync or contain the wrong number of dots or bars.

Conventional R-C circuits are used in the counters of most generators. *But the RCA WR-64B uses inherently stable iron-core inductors in its counters,* thereby assuring long-term counter-circuit stability.

FACT NO. 9: ***The proper way to check receiver color performance is to feed the generator signal into the antenna terminals***

Color performance depends on overall receiver condition—not on that of a single section alone. A color-test signal fed directly into the video amplifier—rather than through the antenna terminals—will not provide a proper check of the complete receiver. *The only method you should use in adjusting the receiver, therefore, is the rf-signal-input method*—the method provided by the RCA WR-64B.

FACT NO. 10: ***There is no "best" dot size or bar width for convergence adjustments***

Generator dot size or bar width has no significance for convergence adjustments.

Veteran technicians, however, have found that very small dots or thin bars are difficult to use under average lighting conditions. If receiver brightness is turned up to overcome this handicap, blooming will result. Proper convergence cannot be achieved under this abnormal condition.

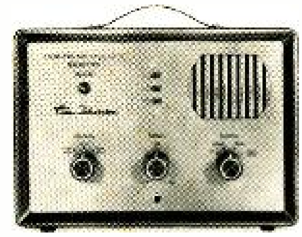
The dot and bar size of the WR-64B is small enough to permit exact, speedy adjustment, and large enough to be useful under average lighting conditions.

These are ten specific facts you should know about color-bar generators. They add up to this

FACT: ***The new RCA WR-64B has all the features you need for complete color-circuit adjustment***

It's the *one* color-bar generator that meets all servicing requirements—from the company that pioneered and developed the color-TV system now in universal use: RCA!

Order it today from your local Authorized RCA Test Equipment Distributor.



$189.50* *Optional distributor resale price. May be slightly higher in Alaska, Hawaii and the West. Prices subject to change without notice.

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