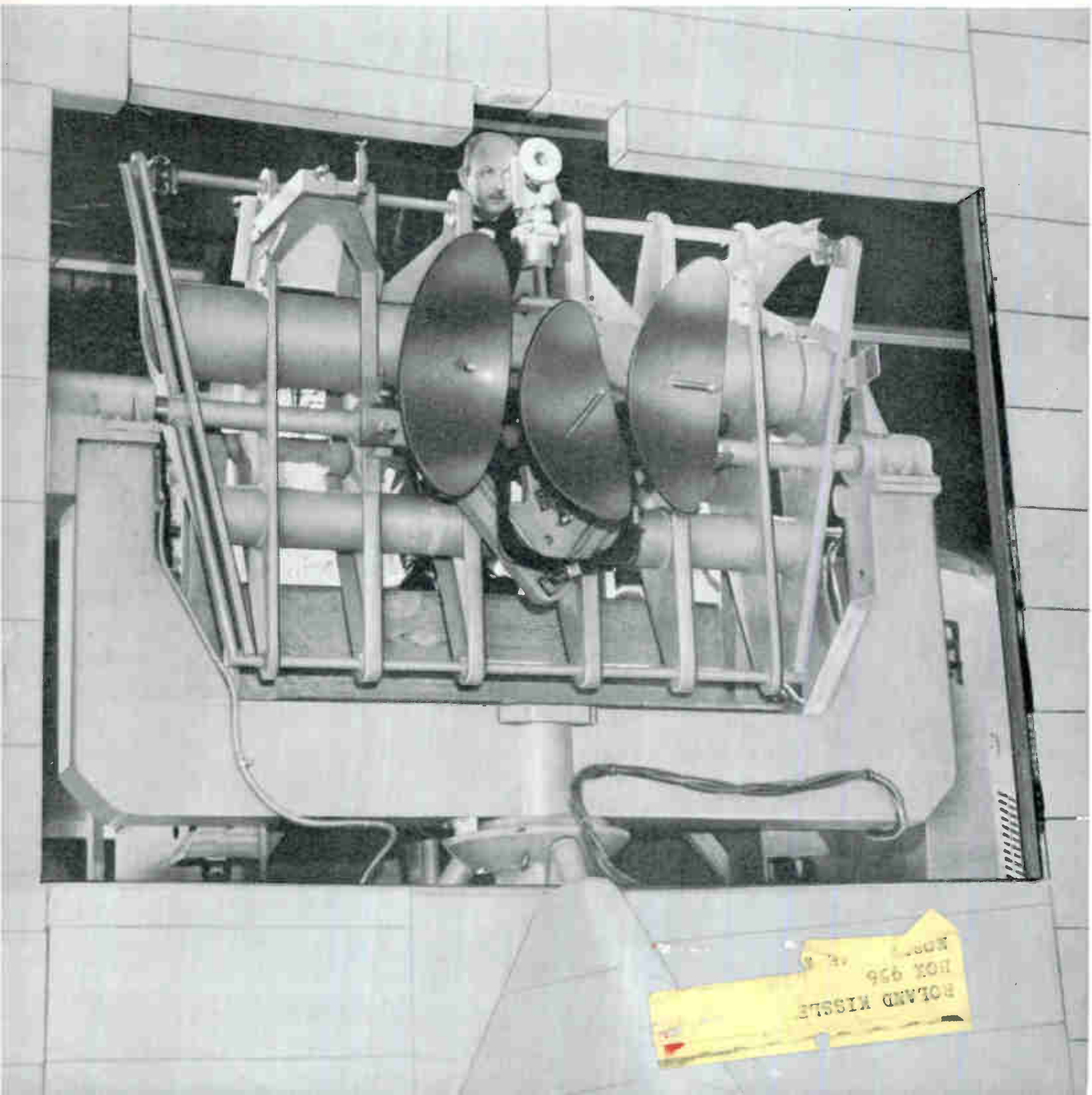
January 27, 1961

electronics

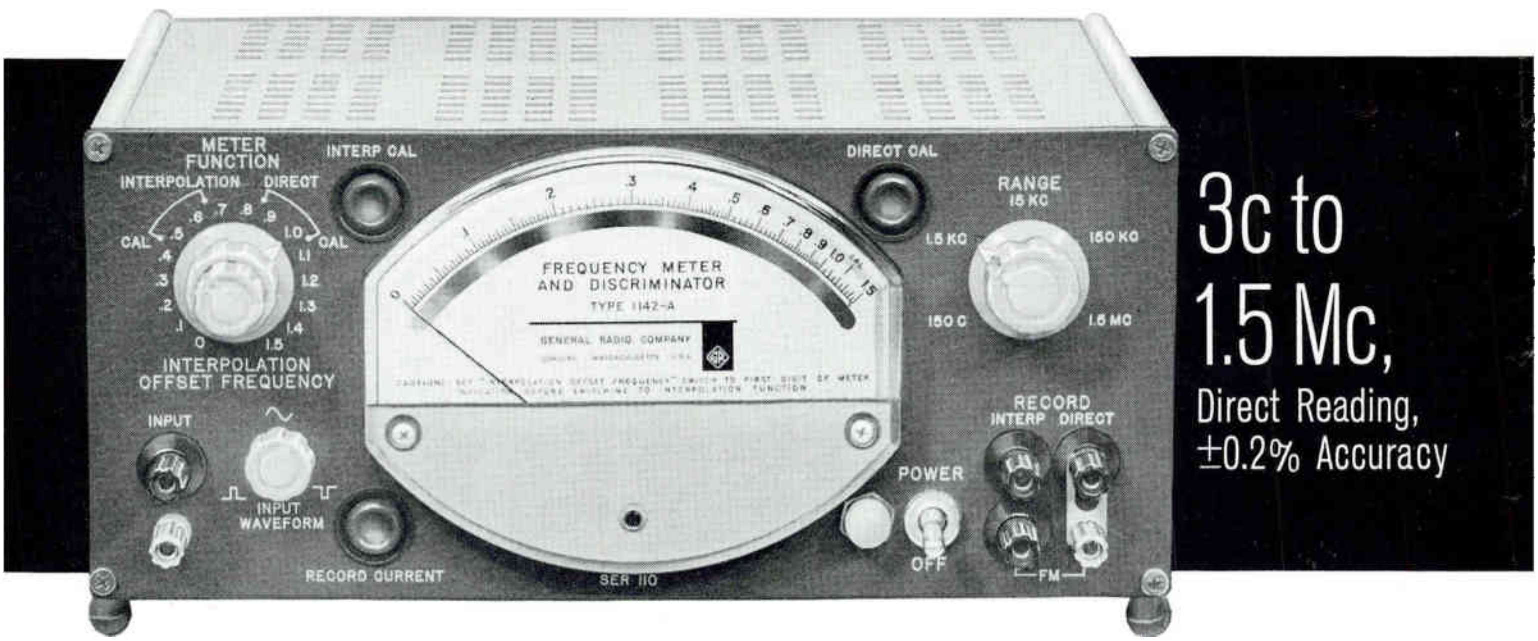
Boresighting facility (below) uses antenna in anechoic tunnel to align B-58 bomber antennas to within 0.01 degree. *See p 46*

Parametric amplifiers for tracking deep-space probes. *See p 41*

A McGraw-Hill Publication 75 Cents



New Frequency Meter and Discriminator



3c to 1.5 Mc, Direct Reading, ±0.2% Accuracy

. . . Simple, Direct Frequency Measurements

. . . Simplifies Recording of Drift and Stability

. . . A Highly Linear Pulse-Count Discriminator for Measurements of FM Deviation and Incidental FM.

FREQUENCY METER

- Logarithmic meter maintains constant accuracy, even at one-tenth of full scale.
- Calibrated interpolator . . . effectively expands meter scale by a factor of 10 . . . permits readings to 3 significant figures from any of the 15 preset references on each range.
- Higher frequency measurements can be made by heterodyne techniques. This method also permits drift measurements up to one part in 10^9, or better, when using stable frequency standards.
- Readings independent of input waveform. Sensitivity: 20 mv rms from 20c to 150 kc, rising to 200 mv at 3c and 1.5 Mc.
- Built-in calibration.

DISCRIMINATOR

- Output: 15v, full scale, on all ranges
- Low Noise: Residual fm more than 100 db below full output
- Linearity: Same as output current accuracy statement

RECORDER OUTPUTS

- Adjustable output provides current proportional to input frequency up to 5 ma to drive recorders.
- Interpolator output for high-impedance recorders provides voltage proportional to frequency deviation from preset references.

Type 1142-A Frequency Meter and Discriminator . . . $495

ACCURACY

Output Current: ±0.05% of range setting +0.05% of measured frequency, below 15 kc; ±0.1% of range setting +0.1% of measured frequency above 15 kc

Additional Meter Error: Direct reading, ±1% above 10% of full scale. Interpolating, ±0.1% of range switch setting.

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January 27, 1961

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W. W. MacDONALD, Editor

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High Voltage Supply Specifications

	PS4222	PS4230	PS4232
DC Output Range	35-215 volts 0-1.5 amps	90-300 volts 0-1.5 amps	115-325 volts 0-1.5 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.1% or 0.2 volts over entire input range (whichever is greater)		
Regulation (load)	Better than 0.1% or 0.2 volts for no-load to full load (whichever is greater)		
Transient Response	Output remains within regulation limits for step-function change of ±10 volts in 105-125 volt input range Output remains within regulation limits for changes from no-load to full-load or full-load to no-load		

Low Voltage Supply Specifications

	PS4305	PS4315	PS4330
DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range (whichever is greater)		
Regulation (load)	Better than 0.05% or 5 mv, no-load to full-load variation (whichever is greater)		
Transient Response	Output remains within regulation limits for line voltage steps of ±10 volts within input range Output recovers in 100 usec for no-load to full-load or full-load to 50% load step changes.		

*400 cps available on order

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electronics
January 27, 1961 Volume 34 Number 4

Published weekly, with Electronics Buyers' Guide and Reference annually, as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N.Y. Printed in Albany, N. Y.; second class postage paid.

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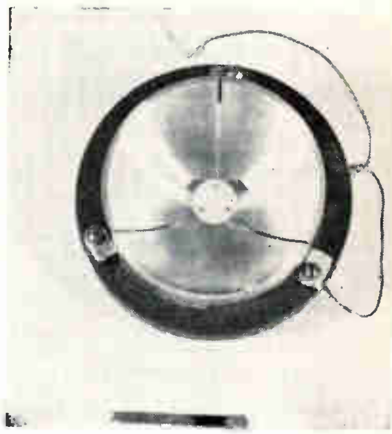
CROSSTALK



ULTRASONICS. The 43-Kc transducer shown mounted in its test parabola in the accompanying photo (Arma) is typical of the advanced transducers being developed for future applications of ultrasonics. For a roundup of ultrasonic equipment in industry today, turn to Associate Editor Vogel's article beginning on p 52. His story reveals characteristics and performance data of typical equipment for such industrial applications as cleaning, drilling and welding.

TRAFFIC & PARKING. You can't have one without the other, as the song says, so in this week's issue we're giving you both.

On p 18, Assistant Editor Dulberger tells you what's doing in electronic parking. On p 22, Associate Editor Emma reports on developments in electronic vehicular traffic control.

Today parking the nation's automobiles is a $500-million-a-year industry that relies on electronic vehicle counting, computers, equipment for fee calculation, display and collection, and so on. The yearly market for electronic parking equipment is roughly $5 million. And it is expected to mushroom with the explosive demand for urban facilities.

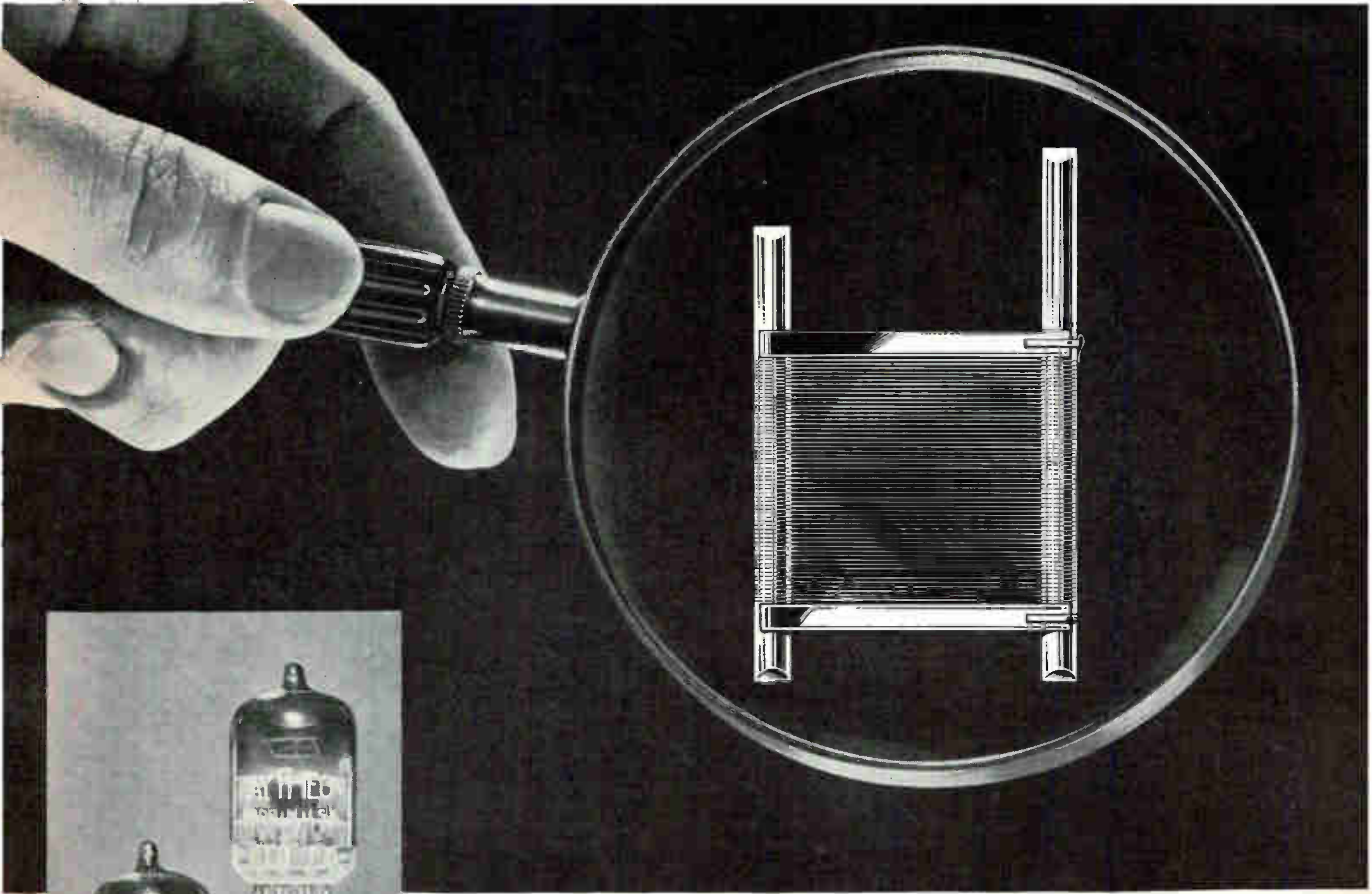
As for the traffic control market, the motto appears to be: "Keep them moving and do it electronically."

The market is expected to run close to $15 million this year. State and municipal authorities will be buying electronic equipment to control trucks and autos on our streets and highways. Some systems will be simple pedestrian pushbuttons at isolated intersections, while others will be elaborate detection networks relying on computers and broadcast sites. In the scheme of things to come, traffic experts even say they may go to closed-circuit tv.

Coming In Our February 3 Issue

MORE ON MEDICAL ELECTRONICS. Associate Editor Bushor's series on medical electronics continues next week with a report on monitoring, analysis and visualization techniques. In addition to learning about physiological monitoring, analysis and correlation systems, you'll be brought up to date on such visualization techniques as x-rays, fluoroscopy, ultrasonics and fiber optics.

IN ADDITION. A variety of interesting feature material to appear next week includes subsurface communication by R. N. Ghose of Space Electronics Corp., a sonar thumper for charting the ocean subbottom by Assistant Editor Dulberger, and a method of predicting radio interference by J. H. Vogelman of Capehart Corp.




CK 6688
CK6922
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COMMENT

Biological Effects of Microwave Radiation

Since a simple electronic device—an audio-frequency amplifier—has a different frequency characteristic if two varying signals are applied at the same time, it should be expected that man's nervous system, which is much more complex, would be affected by microwave radiation.

The nervous system responds to direct current and to heat. These are at opposite ends of an extremely wide range of frequencies. Is it reasonable to assume that none of the frequencies in between can have any effect just because no easily observed response has been found?

It would seem more reasonable to seek other biological effects, even if the fact mentioned above were the only evidence in favor of it. However, the following also suggest that effects other than heating exist:

Experiments have found delays from three to nine days between a single exposure to microwave radiation and the formation of cataracts in the eye of an animal.

Ophthalmologists say that the use of microwaves is one of the simplest methods yet devised for producing cataracts experimentally; obviously, it's not the simplest way to heat an eye.

One experimenter found that exposure of chicken embryos to moderate-strength microwave radiation stimulated the growth. Lower-strength radiation caused no changes; higher strengths damaged the tissue; the stimulation of growth could not be obtained by use of ordinary ways of heating the embryos.

Experimenters found damage to an organ from a single ten-minute exposure to radiation at 2,450 Mc, which caused temperatures between 30 and 35 C in the organ. When using ordinary means for applying heat, damage was not observed until the temperature exceeded 40 C.

Experimenters have developed a test method which is sensitive to microwave radiation for showing effects on the endocrine system of male rats. Forty-percent differences were found between the effects of thermal and microwave radiation at 24 Gc in 5, 10 and 15-minute exposures at 0.25 watt per sq cm level on the uptake in the glands of radioisotope zinc-65.

A person knowing that all the medical investigations have been made using only a few different frequencies and that unexpected frequency characteristics have been found in inorganic dielectrics, would expect biological effects that are not only dependent on the microwave frequency but also on the duty cycle and the pulse repetition frequency. This would be expected when pulsed microwave energy is used instead of c-w. So far, most biological experimenting has been done with c-w radiation.

There is also subjective evidence of other effects. I met a man who made adjustments on a radar antenna for a period of several months even though he became nauseated and vomited many times. He finally became unable to sleep and asked for a transfer. After three months at his new location and free from exposure to microwave radiation he felt that his health was again normal.

The fact that seagulls and pigeons have been observed to become confused in a radar beam—at distances which preclude appreciable heating—may also be considered as evidence of other effects.

Most biological experiments have been performed using makeshift electronic equipment and techniques. Today there is a great need for medical men with basic knowledge of electronics and an interest in using electronic measurements. There is also a great need for electronic measurement engineers with basic knowledge of biology and physiology and with an interest in developing new electronic measuring equipment and techniques for discovering biological effects. Many investigators have concluded that heating is the only biological effect of exposure to microwave radiation. But it seems likely—according to the evidence discovered—that unless other probable effects are sought, healing effects of incalculable value may be overlooked. And to everyone's loss.

H. R. MEAHL

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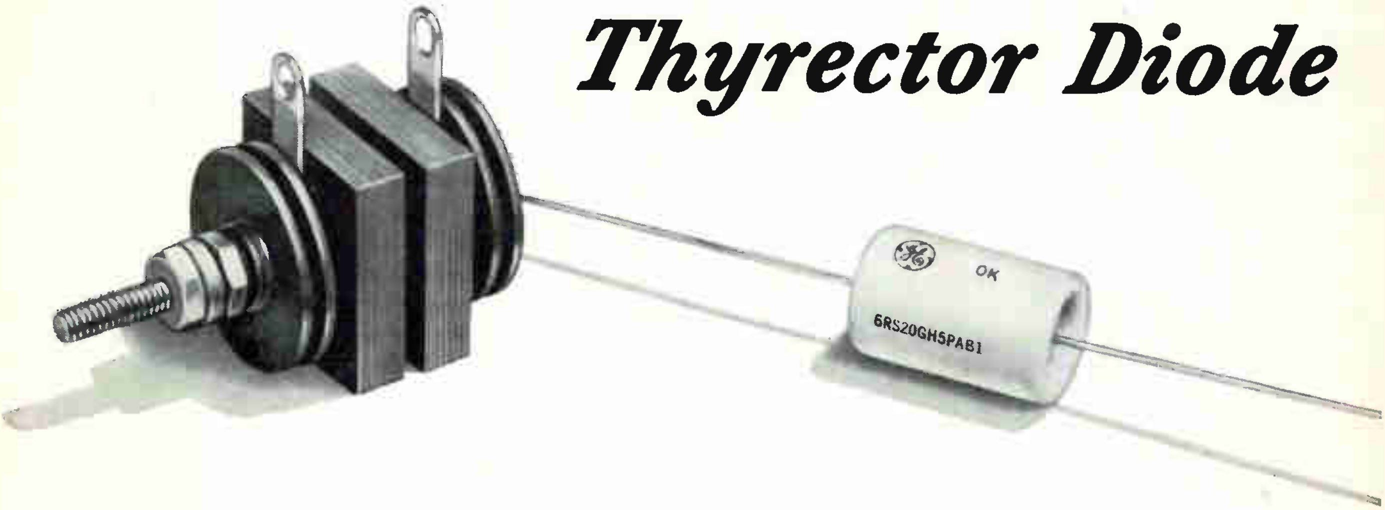

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☐ Technical Data on Thyrector Diodes. ☐ "A Portable Transient Voltage Indicator for Semiconductor Circuits." ☐ "Rectifier Voltage Transients: Their Generation, Detection and Reduction." ☐ Specs on G-E Silicon Rectifiers with Transient PRV Ratings.

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This new, inexpensive hp plug-in lets you

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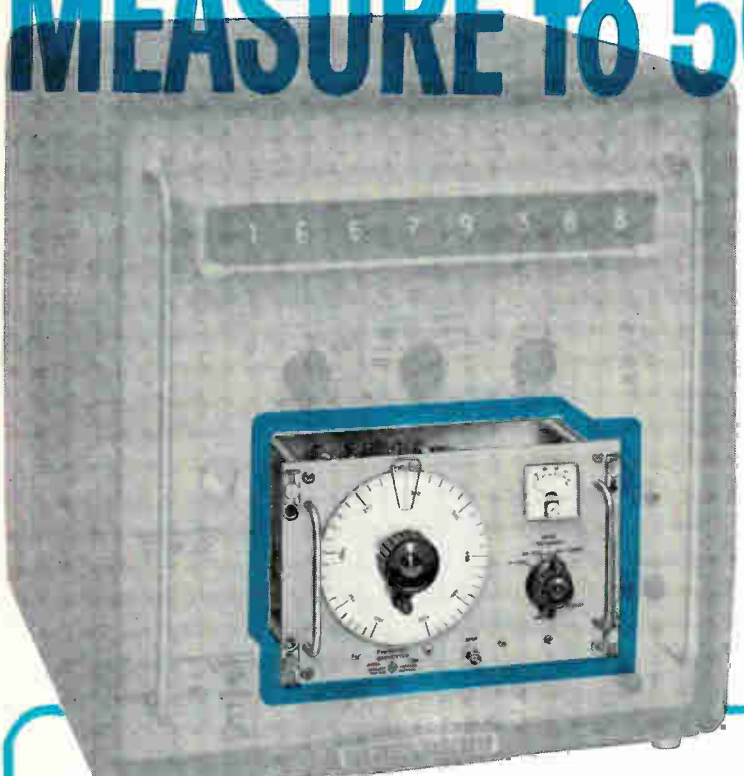
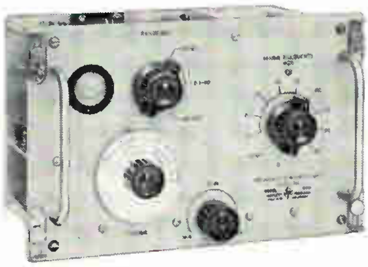


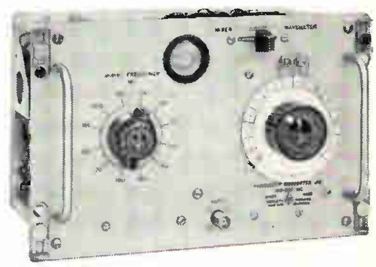
Simple operation with plug-ins—high sensitivity—ideal for telemetering, mobile, production, general purpose measurements

Now hp offers a completely new, 500 MC plug-in — materially improving the versatility and usefulness, as well

Still more versatility for 524 series counters!
Order the measuring capability you need now—later add other plug-ins to increase counter usefulness.



hp 525A Frequency Converter
$250.00, extends counter range to 100 MC



hp 525B Frequency Converter
$250.00, extends range to 220 MC

hp IS HEADQUARTERS FOR ELECTRONIC COUNTERS

Standard of the industry for frequency, period, phase and time interval measurement — accurate, dependable, versatile, economical!

hp 524C/CR ELECTRONIC COUNTERS (shown above)

Measure to 10.1 MC individually, to 500 MC with plug-ins, to 18 KMC with external accessories*. The hp 524C/CR also measures time interval 1 μsec to 100 days or period 0 cps to 100 KC, automatically, directly, without tedious calculation or interpolation. Big, bright in-line readout. Maximum resolution 0.1 μsec; stability $3/10^8$ short term and $5/10^8$ per week. High sensitivity, high impedance, hp 524C (cabinet — shown above) $2,300.00; hp 524CR (rack mount) $2,275.00.

hp 524D/DR Electronic Counter

Offers electronic features identical to those of hp 524C/CR except that it has eight-place neon columnar readout. hp 524D (cabinet) $2,150.00; hp 524DR (rack mount) $2,125.00.

**with hp 540B Transfer Oscillator and hp P932A Waveguide Mixer*

hp 523CR ELECTRONIC COUNTER

10 cps to 1.2 MC with new 0.1 v sensitivity. Bright in-line readout. Measures time interval 1 μsec to 10^6 sec and period 0.00001 cps to 100 KC and phase angle. Stability $2/10^6$ per week. Improved circuitry prevents triggering by unwanted signals, noise. Results appear in seconds, msec, μsec or KC with automatic decimal. hp 523CR (rack mount) $1,485.00.

hp 523DR Electronic Counter

Offers electronic features identical with those of hp 523CR but has six-place neon columnar readout. hp 523DR (rack mount) $1,285.00.

COUNTER ACCURACY!

as frequency range, of popular hp 524 series 10 MC electronic counters.

Combined with the hp 524C 10 MC counter, for example, the 525C plug-in offers measurement with high sensitivity to 500 MC yet retains measurement accuracy and even increases resolution at high frequencies. Also preserved are 524C measuring ease, digital recorder output capability and its big, bright in-line display.

Specifications hp 525C

Range: Counter converter, 100 to 500 MC; counter amplifier, 50 KC to 10.1 MC. Direct connection for 0 to 10.1 MC.

Accuracy: Retains accuracy of 524 Counter.

Registration: 9 places, 1st two on converter dial, next 7 displayed by counter.

Input Voltage: 20 mv rms min., 50 KC to 10.1 MC; 100 mv rms min., 100 to 500 MC.

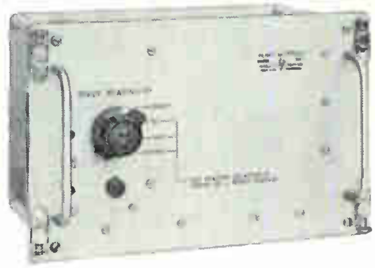
Input Impedance: Approx. 700 ohms, 50 KC to 10.1 MC. Approx. 50 ohms, 100 MC to 510 MC.

Price: hp 525C, $425.00.

hp 526A Video Amplifier
$175.00, increases sensitivity to 10 mv

hp 526B Time Interval Unit
$175.00, for time interval measurement 1 μsec to 10^7 sec.

hp 526C Period Multiplier
$225.00, increases period measuring accuracy with 100, 1,000, 10,000 cycle multiples



hp 522B/BR ELECTRONIC COUNTER

Popular hp 522B/BR measures frequency 10 cps to 120 KC, period 0.00001 cps to 10 KC, time interval 10 μsec to 10^5 sec. Reads direct in cps, KC, seconds, milliseconds. Time base stability $1/10^5$ per week; counts automatically, resets, action repetitive. Applications include measurement of production line quantities, nuclear radiation, power line frequencies, very low frequencies, and, with transducers, a wide array of physical quantities and phenomena. hp 522B (cabinet) $915.00; hp 522BR (rack mount) $900.00.

hp 521 INDUSTRIAL COUNTERS

hp offers five Model 521 counters, all useful in measuring frequency, random events per unit of time, and, with transducers, speed, rps, rpm, weight, pressure, temperature, etc. Direct readings, display time variable or "hold"; four instruments cover frequency range 1 cps to 120 KC; the fifth measures to 1.2 MC. Two models with big, bright, in-line numeric readout, three with columnar neon display. Prices, $475.00 to $875.00. Cabinet and rack mounts available.

Data subject to change without notice. Prices f.o.b. factory.

See your nearest hp representative or write direct for information, demonstration of any hp electronic counter.

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Siegler Cloud Analyzer Radar fills the critical gap in air safety in the airport terminal area!

Until recently, airport weathermen could only *guess* depth and density of clouds *directly above the airport*—the most critical area in guidance of today's high performance aircraft.

Now a unique new radar—the new Cloud Analyzer developed by Siegler's Olympic Radio and Television Division—eliminates this gap in air safety. Provides continuous *knowledge* of height, density and upper limits of clouds directly over the airport, up to 60,000 feet.

Cloud Analyzer Radar, developed for the U.S. Air Force, is now in operation by the U.S. Weather Bureau at the National Airport in Washington, D.C., Hanscom AFB, Bedford, Massachusetts, Cape Canaveral, and will soon be in operation for the Department of Defense and the Federal Aviation Agency in the 433L Automatic Weather System.

The Olympic Division of The Siegler Corporation also produces the monitor and transfer system for the important TACAN program, and the AS-111 Radio Direction Finder.

Selection of Siegler for these and other major projects shows recognition of the superior performance of all Siegler divisions, under the basic corporate concept: *Progressive management of diverse activities with outstanding military, industrial, commercial and consumer capabilities — in order to bring to each of these fields the strengths of the others.*

CAREER OPPORTUNITIES are available for engineers and scientists. Write for complete information.

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ELECTRONICS NEWSLETTER

Agency Predicts Substantial Rise In Scientific Instrument Sales

BUSINESS & DEFENSE SERVICES Administration last week reported the expectation that sales of scientific and industrial instruments will "increase in 1961 substantially over the $4.5 billion estimated for 1960."

Level of capital expenditure by industry and public utilities will hover around 1960's $20-billion level, but the proportion of this spent for modernization is expected to rise from 69 percent in 1960 to 80 percent in 1961. Increased use of onstream analysis and control devices, and computer-controlled process systems, will also give electronics a bigger share of the capital-expenditures dollar. Further, the industries where automatic techniques are taking firmest hold—petrochemicals, and food and beverage manufacture—are spending more on plant expansion and modernization this year than last.

Union and EIA Seek Import Limitations

ELECTRONIC INDUSTRIES ASSOCIATION and Local 1031 of the AFL-CIO International Brotherhood of Electrical Workers both struck out last week at competition from Japan's electronics industry.

EIA, through its executive v-p J. D. Secrest, again went on record with the thesis that ". . . the federal government must give serious consideration to the development of reasonable and effective electronic import controls." Secrest also said the Association wants the removal of import restrictions against U. S. products which Japan now has on her books.

Chicago-based Local 1031, whose 22,000-odd members work mostly in companies producing tubes, switches, tuners, vibrators and other consumer electronics products, put 83 employers on notice that its members will refuse to work on tv and radio parts imported from Japan and other low-wage countries after May 1. The 83 employers operate 137 plants which have contracts with the union.

Meanwhile, Chicago public relations executive Lee Schooler told a meeting of the Association of Electronics Parts & Equipment Manufacturers that overprotectiveness can be fatal. He urged the development of new products and services with consumer appeal, and suggested that companies emphasize the extra values of quality and technical assistance offered by U. S. manufacturers.

Electronic Nerve Cell Will Simulate Learning

AIR FORCE has given Melpar a contract to build an electronic nerve cell with the power to simulate elementary thought processes. The single cell, called Artron (for artificial neuron), will learn by reward and punishment to recognize correct and incorrect approaches to a problem; it will be given enough leeway to enable it to experiment and try new approaches.

Contract also covers a study of generalized machine learning, and provides for digital-computer simulation of a network of Artron cells. Wright Air Development Division's bionics computer branch is handling the contract for the Air Force.

Melpar figures that future development of the nerve-network principle may result in better automatic weather prediction. Other possibilities: unmanned vehicles for exploring the surfaces of planets without the need for remote control; high-speed military gaming machines that can formulate their own strategy.

Controlled Current Used for Anesthesia

SURGEONS at the University of Mississippi last week used 700-cps current controlled by an amplifier to anesthetize a woman for an operation.

The current was connected to the patient's temples by electrodes. The patient remained unconscious as long as the current was on. Within a minute after the switch was turned off, the woman awoke. There was no report of discomfort or anesthetic reaction; she returned to her room immediately after awakening, instead of being taken to a recovery room.

Air Agency Now Using High-Speed Weather Net

FEDERAL AVIATION AGENCY last week began transmitting aviation weather data at 850 words a minute, eight times as fast as most people talk. The Agency's automatic data-interchange service uses an 850-wpm teletypewriter circuit connecting five cities. In each weather area—centered at Cleveland, O., Atlanta, Ft. Worth, Tex., Kansas City, Mo., and San Francisco—information is gathered at 100 wpm instead of the former 75 wpm. Low- and high-speed circuits talk to each other over paper-tape equipment.

FAA also announced last week the completion of tests that show the feasibility of recording crew conversations in the noisy ambient of transport aircraft. Tests in three FAA craft used area pickup microphones with cardioid sensitivity pattern, did not require sophisticated mounting. Electronic noise-filtering and cancelling techniques improved the intelligibility of crew conversations, tests indicate.

Seek Data to Identify Reentering Objects

BELL LABORATORIES has given Avco's Everett, Mass., research laboratory a contract for theoretical and experimental study of decoy discrimination for Army's Nike-Zeus countermissile. Aim of the contract is to identify the characteristics of radiation emitted by objects reentering the atmosphere, and to develop optical sensing apparatus.

Radioastronomers to Observe New Soviet Instruments

TWO U. S. RADIOASTRONOMERS are this week visiting new radiotelescope installations in the Soviet Union. R. N. Bracewell of Stanford University and George Swenson of the University of Illinois plan to see research instruments at Moscow, Leningrad, Simferopol, Byurakan, Abastuman, Serpukhov, Gorky and Pulkovo.

In particular, the two scientists want to see a 70-ft paraboloid at Serpukhov that the Soviets are using for millimeter-wave reception. Strongest radiation from planets falls in the millimeter band; the two existing U. S. instruments that receive in this range are only 10 ft in diameter. Also at Serpukhov is the new movable Mills cross antenna with kilometer-long arms.

West Germany Increases Radio-Tv Exports

RADIO AND TELEVISION manufacturers in the Federal Republic of Germany estimate that 1960 exports increased by at least $25 million over 1959's figure. The value of exports in 1959 was $117 million; estimates for the year just ended range between $140 million and $150 million. Export value of radio and tv sets during the first nine months of 1960 showed an increase of about a third, to $97.6 million.

Tv production during the first nine months was 1.59 million units worth $216 million, up from 1.29 million units worth $171 million for 1959's first three quarters. Of this production, 25 percent—395,-000 sets worth $45 million—were exported. Principal West German markets include Europe, Latin America and the Far East.

Moon May Have Peculiar Ionosphere

UNIVERSITY OF MARYLAND physicist S. F. Singer last week told the American Astronautical Society that a "peculiar type of ionosphere" may exist above the moon's surface. He said that despite a low lunar atmospheric density of less than 100 hydrogen atoms per cu cm, an electron density of 10,000 per cu cm may be found near the lunar surface and may play a role in communication with the moon at low radio frequencies.

The causative mechanism, as he described it: Solar ultraviolet photons constantly bombard the lunar surface and liberate photoelectrons. Those of the highest energies escape into space and leave behind a positively charged moon whose approximate potential is 30 to 40 v. The bulk of photoelectrons —emitted at the rate of several hundred billion per second per sq cm—do not have enough energy to escape. They spend a little time above the lunar surface before returning under the influence of a strong electric space-charge field. This field kicks out small positively charged dust particles from the surface. Because of their positive charge, they reduce the negative space charge of the electron cloud and allow it to expand to a greater distance, perhaps a meter; the electron field is also reduced. The dust particles fall back to the surface, but others rise up to take their place, creating a "dust ionosphere" made up of positively charged dust particles and electrons.

Companies Exchange Semiconductor Patents

AGREEMENT to exchange nonexclusive patent licenses and technical information about semiconductor components has been signed by Texas Instruments Incorporated and International Telephone & Telegraph. As part of the accord, TI will supply a portion of ITT's overseas needs for semiconductor devices and components.

TI figures the agreement will provide more business for its plants in England and France, as well as "access to the latest technical requirements of systems developments." ITT reports the deal will ensure a supply of quality semiconductor components for its worldwide work in telecommunications and industrial electronics.

New Propulsion Methods May Widen Controls Market

QUICKENING OF PACE in the search for new methods of rocket propulsion is implied by comments in a report from one of President Kennedy's special task groups. The unconventional system would result in new markets for electronic monitoring and control equipment.

The report stressed other-than-chemical systems, stated: "Above all, we must encourage entirely new ideas which might lead to real breakthrough. One such idea is the Orion proposal to utilize a large cluster of small nuclear bombs for rocket propulsion."

Project Orion started in 1958 as a feasibility study of the use of controlled nuclear pulses to propel space vehicles. General Atomics division of General Dynamics is handling the work for the Air Force.

Experimental Memory Uses Capacitive Readout from Cards

PUNCHED-CARD MEMORY using a special type of punch card and a capacitive readout device was reported last week by International Business Machines.

Readout device provides random access to any of the 960 possible hole positions of the card, which can be used as an 80 × 12 matrix for binary data. The special cards are sandwiches of aluminum foil between sheets of paper. The readout device comprises several pairs of printed boards; one has horizontal conductors printed on it, another has vertical conductors. Holes punched in the card are detected by the shift in capacitance at the intersection where the hole occurs.

Capacitance Bridge Measures Thread Denier

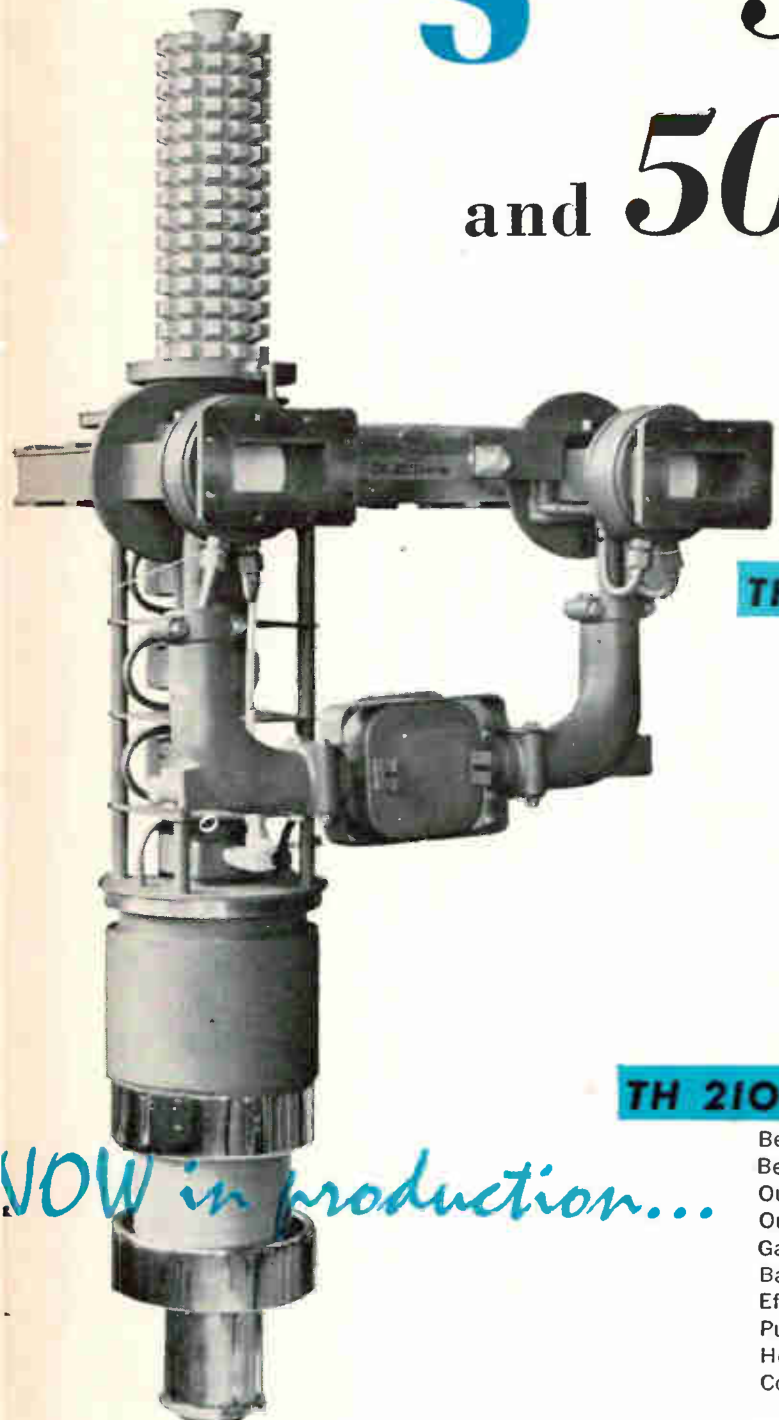
ELECTRONIC TECHNIQUE for measuring the linear density—the denier —of thread was patented recently by British Nylon Spinners Ltd.

Previous capacitive devices passed the filament between the plates of a fixed capacitor, presented some difficulty in holding capacitance values steady in production-line ambients, also in sensing slow changes in density. New patent describes a device for moving the filament rapidly in and out of the capacitor as it travels. Frequency of the rapid dither is zeroed out in a null-balance capacitance bridge; slower significant changes caused by change in denier are measured off the bridge.

COMPAGNIE FRANCAISE THOMSON-HOUSTON

S BAND 30 MW AMPLIFIER and 50 KW PREAMPLIFIER

KLYSTRONS FOR RADARS AND LINEAR ACCELERATORS



TH 2011 KLYSTRON

	Wide Band Tuning	Max. efficiency Tuning
Beam voltage	240 kV	240 kV
Beam current	210 A	210 A
Output peak power	20 MW min.	22.5 MW
Output average power . .	20 kW min.	22.5 kW
Gain	40 dB	60 dB
Bandwidth at 1 dB	60 Mc/s	15 Mc/s
Efficiency	40%	45%
Pulse duration	3 μs	3 μs
Cooling water flow (body and collector) .	1 g p m	1 g p m
Water pressure	14 lbs/Sq. in.	14 lbs/Sq. in.
Cooling	Vapodyne system	

NOW in production...

TH 2101 KLYSTRON

	Wide Band Tuning	Max. efficiency Tuning
Beam voltage	29 kV	29 kV
Beam current	8.5 A	8.5 A
Output power, peak . . .	50 kW min.	70 kW appr.
Output power, average	100 W min.	140 W approx.
Gain	42 dB	70 dB
Bandwidth	60 Mc/s at 1 dB	5 Mc/s
Efficiency	about 20%	about 30%
Pulse duration	3 μs – 10 μs	3 μs – 10 μs
Heating voltage	7.5 V	7.5 V
Cooling water flow (collector)	two quarters p m	two quarters p m
Inlet water pressure . .	14 lbs/Sq. in.	14 lbs./Sq. in.

THOMSON CFTH HOUSTON

HOMSON ELECTRIC COMPANY, INC. 50 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

Write for Catalog

WASHINGTON OUTLOOK

THE FINAL Eisenhower defense budget carries both good and bad news. The good: increased expenditures on military electronics (reflecting the volume of shipments). The gray news: a downturn in new contract awards. The budget covers the fiscal year starting next July 1.

Washington Officials estimate fiscal 1962 outlays for military electronics at $5.4 billion, $100 million over this year's rate of spending. The estimate for new defense orders for electronics—including both production and R&D—is $5.3 billion. This is $300 million under the current rate.

These figures are based on unofficial but authoritative estimates that electronics accounts for 25 per cent of the military aircraft dollar, 35 percent of missile spending, 12 percent of shipbuilding costs, and 30 percent of the overall research and development budget, and that costs for so-called "pure" electronics—ground radars, communications, and the like—amount to roughly $1 billion.

As the budget shapes up in detail, no overall figure on electronics is available. Indeed, conjecture on military electronics funds is made more difficult in the new budget because of the omission for the first time of total Defense Dept. figures on "pure" electronics.

THE BUDGET SHOWS a $793-million reduction for next year in overall procurement-production and R&D contracting plans. The current level of contracting runs to $19.8 billion. On the expenditure side, however, which represents disbursements for shipment of equipment and R&D performance, the budget shows a boost from $17.9 billion this year to $18.8 billion in the new year. This reflects the acceleration in arms contracting approved by Eisenhower this past summer.

Over the next three months, it is anticipated here, the Kennedy Administration will order wide-sweeping revisions in the Eisenhower defense budget, earmarking extra funds for a wide variety of weapons projects. These changes could add as much as $2 billion.

AIR FORCE CONTRACTING for ground communications, radars, and related equipment is scheduled for a slight cutback next year, under present planning. Chief factor: substantial completion of the Sage, Dew-line, and BMEWS projects. New orders next year will total $727.5 million, compared to $756.6 million this year.

Once again, the Army was turned down on its plea to begin production on Nike-Zeus anti-ICBM missiles and radars. Only $250 million is set aside for new contracts to continue R&D, about $50 million less than this year.

Both missile procurement contracting and shipments will rise from $3.9 billion to $4 billion. New orders for aircraft production will fall from $6.6 billion to $5.6 billion. R&D contracting will fall off $302 million from the current $4.7 billion rate. But actual outlays will be hiked $240 million to a total of $4.4 billion next year. Of this, military space projects will be allotted $584 million, $73 million more than this year.

ON THE CIVILIAN SPACE SIDE, NASA spending will hit $1.1 billion next year, up $195 million over this year. Of this sum, R&D programs will total $819.8 million, an increase of $148.8 million, construction will fall off $23 million to $99.8 million.

Biggest chunk of NASA's budget will be earmarked for the Saturn superbooster project. Costs will total $250 million, $20 million more than this year. A 50 percent cut in funds to set up tracking facilities is scheduled in the new space agency budget. In addition, costs will taper off for Project Mercury and development of the Scout, Delta, and Centaur boosters which will be nearing the operational stage.

Some $68.6 million is being earmarked for development of an active communications satellite—with $10 million slated to come from industry. Project Apollo, to develop an advanced manned spacecraft, will jump from $1 million this year to $29.5 million.

TRANSMITTING TUBE

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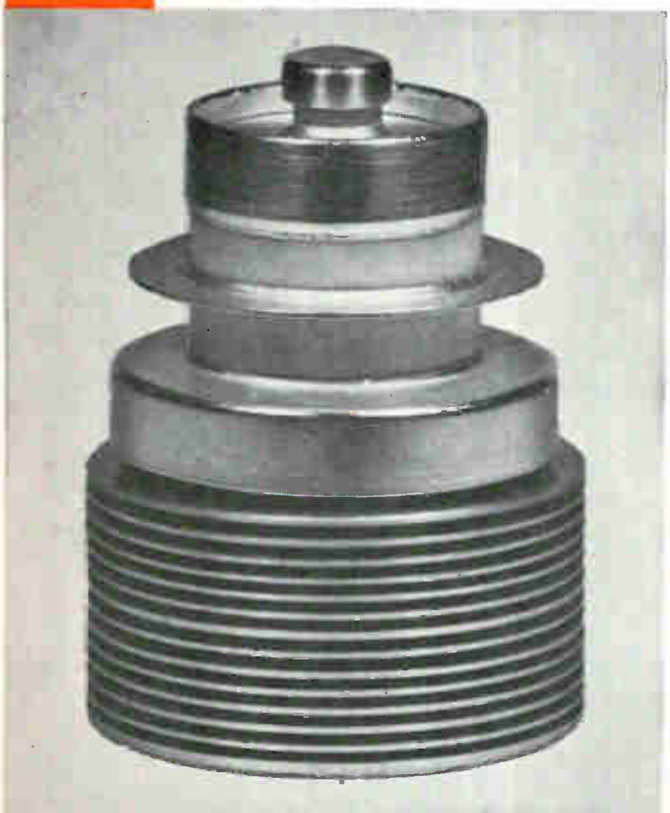
CERAMIC TRIODE F6007

1000 MCS

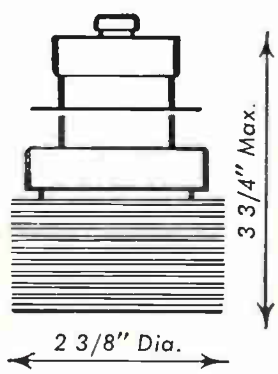
CATHODE		INTERELECTRODE CAPACITANCES			Gain Factors	Trans-conduct-ance	MAXIMUM CHARACTERISTICS						Output Power at Nominal Frequency	Nominal Frequency
Ef	If	Cathode to Grid	Grid to Plate	Cathode to Plate			Plate voltage	Grid bias	Cathode d.c. current	Grid d.c. current	Plate dissi-pation	Grid dissi pation		
V	A	P F	P F	P F	K	MA/V	KV	V(a)	A	M A	W	W	W	MCS
6.3	5	20	8	0.07	80	35	3	–200	0.7	150	600	8	400	1000



Typical Operations F = 1000 MCS Class C Telegraphy

USEFUL POWER	100 Watts	400 Watts
Plate Voltage	1000 V	2000 V
Plate Current	300 mA	500 mA
Dissipated Power	200 W	600 W
Bias	–40 V	–80 V
Grid Current	60 mA	100 mA
Drive Input Power	10 W	35 W

This tube was developed under French Air Force contract number STTA 9604/60



can be operated at:

- **350 c (662 F) outside temperature**
- **50 G shock**
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CIRCLE 15 ON READER SERVICE CARD

GENERAL PURPOSE, TYPE BX-1000

The original BEAM-X switch represents a breakthrough in electronic switching. It is the lowest cost, lightest weight, highest speed, smallest size, 10-position electronic switching device. It has found wide usage in Military Systems, Computers, Instrumentation, Industrial Control, Aircraft and Missiles.

SHIELDED, TYPE BX-2000

The BX-2000 BEAM-X switch is completely shielded magnetically and still electrically identical to the BX-1000. The shielded construction permits direct stacking in applications where space conservation is vital. All BEAM-X switches are designed to drive NIXIE® tubes, printers and perform any decimal switching function.

HIGH CURRENT, TYPE BX-3000

This High Current BEAM-X switch is specially designed for areas of heavier work load. This switch provides more than twice the output current of the BX-1000, and is capable of driving multiple NIXIE indicator tubes, both local and remote. The characteristics of low cost, long life, ruggedness, high temperature operation and reliability remain the same, as in all BEAM-X switch types.

THREE NEW BEAM-X® SWITCHES

FILL A WORLD OF DESIGN NEEDS

In countless applications where switching functions exist — counting, distributing, multiplexing, coding, timing, matrixing, converting, and decoding — the BEAM-X switch has revolutionized circuit design. Now the Burroughs Electronic Tube Division has developed a new family of BEAM-X switches to fit varying applicaton requirements. Each switch represents a real savings in cost, size and weight, and provides an increase in circuit performance and reliability.

ANOTHER ELECTRONIC CONTRIBUTION BY

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

AUTOMOBILE PARKING: A Market

By LEON DULBERGER,
Assistant Editor

PARKING THE NATION'S automobiles has become a $500-million-a-year industry that relies on electronic vehicle-counting, direction and fee computing equipment to automate operations.

The U. S. Chamber of Commerce reports that by early 1960 about $4¾ billion was invested in private and municipal parking facilities.

Industry experts place the yearly market for electronic parking equipment at roughly $5 million, expect it to grow with the explosive demand for urban facilities. Example is New York City's aim to build $94 million worth of off-street parking in six years.

Parking executives have come to favor multilevel parking ramps, and where there is more space, parking fields, over the more complex elevator, or other mechanical handling garage. They expect the multilevel ramps and fields to provide the future volume market for electronic parking equipment. Ramps and fields allow the driver to do the work, avoiding expensive lift gear. They do not bog down in rush hours, with lines of cars waiting for lift services; can be counted on to run at a profit.

In cities where space is at a premium, mechanical parking of cars by lifts is justified, with the latest designs using computer control for automatic operation.

Automation of parking ramps and fields is desired to reduce personnel and eliminate "knock down," where attendants do not turn in full receipts, a serious problem in the way of profits.

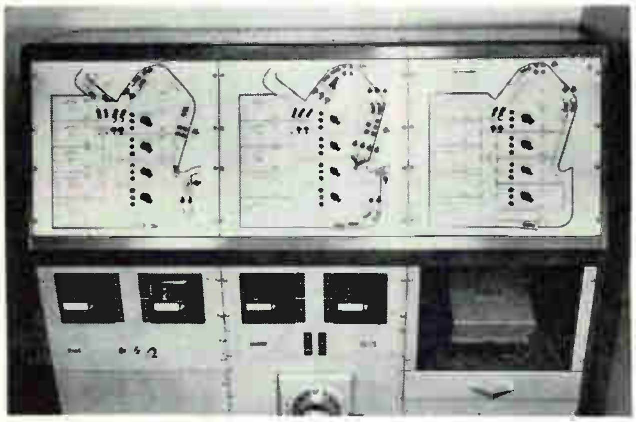
Electronics now makes available sophisticated equipment for ticket issuing, gate raising, traffic direction, car counting; fee calculation display and collection. Vehicle detectors that do not require motion, demand little maintenance and resist false counts are now on the market.

A system of parking ramp counters to indicate availability of bay space, and a computer operated traffic direction system has been pioneered by Rampark, Inc., Rochester, N. Y., in several installations in that city. Vehicles are detected by treadles and photoelectric beams. In a new underground 1,900 car garage being built in Rochester, ultrasonic detectors will be used. Rampark has been awarded a contract for the first half of the electronics, including the control computer and a graphic display console. The panel will show condition of traffic guidance signs that are automatically controlled by the computer, indicate when bays are near or at capacity by a system of panel lights, and make available manual override of traffic signals.

Detectors at bay entrances connect to directional circuits in the counter to prevent error caused by backing-out movements as autos prepare to leave the garage. Reverse and forward movements can-

Ultrasonic automobile detectors (left), built by General Railway Signal Co., are installed overhead, control hospital parking gates

Parking computer by Universal Match Corp. calculates time and charges, displays amount in lights and records transaction



Graphic control panel for computer-directed ramp garage, built by Rampark, Inc. Ultrasonic detectors provide input signals

For Ultrasonics and Computers

cel leaving the total correct.

Trott Electronics, Inc., Rochester, N. Y., will build the equipment for the city by arrangement with Rampark.

As part of a major urban redevelopment plan, New Haven, Conn., is building a 1,400-car ramp garage, has awarded General Railway Signal Co., Rochester, N. Y. the contract for ultrasonic vehicle detection and control. The company's Checkar system will give information on available space, counting cars in, subtracting them when they leave. It will automatically illuminate direction signs, print out parking totals for record. GRS has installed similar gear in other cities, also uses its pulsed ultrasonic detectors, which operate in the 20 Kc range, for gate control of small lots, and highway vehicle counting.

Ramp installations use overhead mounting of detectors, and circuits that allow output to counters when the fixed-distance, pavement reflection is absent. Thus variations in number of axles; vehicle weight, shape and speed do not affect accuracy of count.

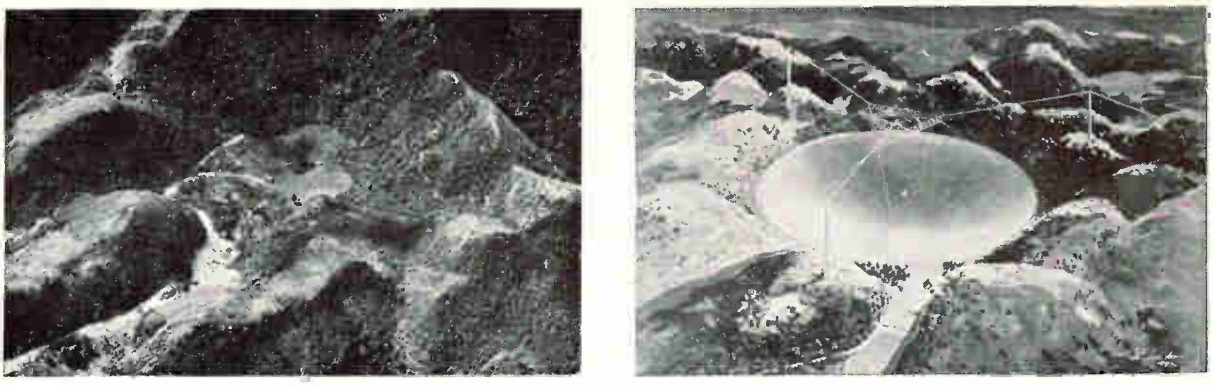
Beam pattern is set to avoid triggering by a pedestrian passing under the beam, dirt and vibration do not affect operation.

A parking charge computer has been placed on the market by Universal Match Company, St. Louis, Mo. The machine called Unipark, employs a transistor logic circuit, runs to 28 days, nonredundant, with an accuracy of 2½ minutes. A ticket is issued on entrance to the parking facility, and punched in time. On leaving the ticket is placed in a time-out slot, the charge is computed and displayed on a large sign for the customer and attendant's observation. New rates can be set at any time without technical personnel. A running account of tickets issued, tickets computed and money received is kept on a non reversible totalizer.

Unipark may become a completely automatic parking fee collection system by mating it with the electronic bill changing, cash-acceptor built by National Rejectors, Inc., St. Louis, Mo., a subsidiary of Universal Match.

Taller Cooper division of American Electronics, Inc., Brooklyn, N. Y. has for some time been marketing automatic gate, fee computing and collecting equipment for the parking industry, plans to use electronic techniques more in future designs. An electronic operated pressure treadle circuit is being designed to provide greater sensitivity needed for the new small cars, and faster response.

The firm has just designed a new magnetic vehicle detector system, completely transistorized, using detector probes half the size of a cigarette which can be buried in the pavement. No vehicle motion is required as a result of a permeability modulation technique. The method also eliminates drift and resultant false outputs often plaguing the balanced oscillator type of detector.



Natural bowl (left) in Puerto Rico will hold world's largest, most powerful radio telescope. Feed mechanism suspended above fixed dish will have capacity to rotate 360 degrees in azimuth and scan 20 degrees either side of vertical. Two of the towers now under construction will be 250 ft high and the third will be 365 ft

World's Largest Dish to Aid A-Blast Detection

ENGINEERS were pushing the state-of-the-art this week in electronic equipment for radio and radar astronomy as construction continued on towers for the 1,000-ft. Arecibo Radio Observatory telescope in north-central Puerto Rico.

Left undiscussed in the torrent of scientific applications is the value of the giant instrument to U.S. defense as part of a network for detection of the ionospheric effects of nuclear explosions, a key concern in disarmament debates.

The $6 million radio telescope, which will nestle in a natural bowl-like configuration, will be the nucleus of the major new Department of Defense observatory. The reflector of the telescope will cover more than 18 acres and is expected to be completed in November of this year.

Under supervision of the Electronics Research Directorate at Air Force Cambridge Research Laboratories, Cornell University is prime contractor for design and construction.

Major purpose of the project is construction of the most sensitive instrument ever built for probing the complex structure of the ionosphere, but radio astronomers are already plotting hundreds of other experiments—radar probes of distant planets, mapping of the moon for explorations, solving the mystery of nonthermal radiation from Jupiter, studying the dynamics of particle fluxes in the solar system.

Conception of the Arecibo Radio Observatory resulted from a proposal by Prof. William E. Gordon of Cornell, originator of a theory of incoherent scattering of electrons, who suggested the technique to be used for experimental verification of the back-scattering theory. The 1,000-ft dish will be used to study density and temperature of the ionosphere, the drift of the upper and lower ionosphere, and detection of natural and man-made disturbances and shocks.

Among electronic features of the observatory will be a line feed suspended 435 ft above the wire-mesh reflector to correct for spherical aberrations; a duplexer designed by MIT Lincoln Laboratory with a 50-microsec recovery time and low insertion loss; a BMEWS-type transmitter modified for versatility, stability and increased reliability; and a two-channel receiver with a 10-Mc bandwidth and embodying modular techniques for flexibility.

The line feed is being developed by Technical Research Group, Inc., using principles of correcting for spherical aberrations by a phased line source. The principles were formulated at Air Force Cambridge Research Laboratories more than a decade ago. In a major departure from the normal paraboloid configuration, the bowl will be a segment of a sphere, permitting the fixed antenna to scan a larger segment of the sky than would be possible with a parabola. By moving the line feed, it will be possible to detect incoming waves and to direct radar signals over a cone of 40 degrees. But the special feed is necessary because waves from a spherical surface do not have a common focus.

The transmitter, being built by Levinthal Electronics Products, Inc., will permit initial operation of the telescope as a radar at 430 Mc, with a beamwidth of ⅛ degree. Using two klystrons, the transmitter will have a peak power of 2½ megawatts and 150 Kw average power. It will have a c-w capability of 150-200 Kw average and will use a linear driver amplifier to modulate. Two-microsecond up to 10-millisecond pulses will be continuously variable, and the pulses can be square or gaussian. The transmitter will permit a continuously variable pulse repetition rate from 1 cycle per second to 1,000 cps, with stability of 2½ parts in 10^9.

The receiver designed by Cornell will have two channels: the first a gated radiometer for pulse integration, and the second a spectrum analyzer. It is hoped that within the first year of operation, low-noise devices such as parametric amplifiers and masers can be used in the front end.

Among factors influencing selection of the Arecibo site, says the Air Force, were the natural bowl-like configuration, location in a relatively radio-noise-free area, latitude within 23½ degrees of the Equator permitting planetary investigations with 20 degrees of beam scan, and favorable political climate.

The towers and antenna structure will be built to withstand winds of 30 mph without deviation, and with a survival capability against winds of up to 140 mph.

Equipment will be added at a later date for operation well below and above the initial operating frequency of 430 Mc. Hydrogen-line studies will be planned, and investigations are underway for development of a line source for 1,420-Mc operation using 800 ft of the 1,000-ft dish. DOD agencies and their contractors will be granted use of the installation.

Blue Scout Launches Four Radiotelescopes

BLUE SCOUT launched from Cape Canaveral earlier this month carried four small radiotelescopes above the ionosphere for the first time.

The four units measured low-frequency cosmic noise and relayed the measurements to earth. Ionospheric absorption and refraction normally block the lower frequencies of cosmic radio noise.

Each unit was made up of a transistor receiver the size of a pocket radio, and a collapsible antenna that extended on command to a length of 10 ft. Total weight of all four units was under 10 lb. They operated at frequencies between 700 Kc and 13 Mc.

Wideband Microwave Device Blocks D-C and L-F

DEVELOPMENT of a wideband microwave device that may improve the sensitivity of communications links, radar and other microwave gear is announced by Sylvania. The coaxial component acts as a bandpass from 2.5 Mc to 11 Gc while isolating all frequencies from d-c to 2.5 Mc. Bandwidths of conventional d-c blocks provide isolation from 1 to 8 Gc, 2 to 10 Gc or 4 to 13 Gc.

New low-vswr unit should improve microwave sensitivity by eliminating ground-loop currents at 60 cps and providing low-frequency isolation in 50-ohm coaxial systems. At frequencies between 2.5 Mc and 11 Gc, insertion loss amounts to 0.2 db or less.

Radio, Radar and Computers Help Control Highway Traffic

By THOMAS EMMA,
Associate Editor

THIS WEEK IN NEW YORK, traffic control experts are studying results of recently completed radio propagation tests in Manhattan. The reason: to plan installation of a radio system to control traffic on four major East Side avenues.

Plans like this, and others by city and state vehicular traffic control authorities across the nation indicate rising interest in unsnarling today's traffic jams electronically. Budget excerpts from major cities show sizable expenditures during 1958 and 1959 for electronic traffic control gear. Some examples: Washington D. C., $135,000; New York, $125,700; Philadelphia, $975,000; Birmingham, Ala., $280,000; Albuquerque, N. Mex., $100,000. And there are many others. Although no exact figures are available, estimates of the present market for vtc gear hover at about $15 million.

Signal pole houses radio receiver and control gear, responds to signals broadcast from central control location

To control traffic electronically, three basic systems must be integrated: detection, computation and instruction. Traffic authorities must know how many vehicles are in motion in their territory, must figure out how to move them at optimum speeds, and must arrange traffic signals to accomplish this. Traffic signals presently are either controlled by fixed-time systems or actuated by the movement of the traffic itself. In the fixed-time method, traffic surveys are taken in advance and the results used as input programming for signal control systems. Instructions are sent by cable or radio.

In the traffic actuated system, three basic vehicle detection devices are used; pressure plates in the intersection roadbed, induction loops buried under the surface and radar detectors. Some municipalities use all three. New York City, for example, has about 100 main intersections under automatic surveillance. Of these about 50 percent are induction loops, 30 percent are pressure plates and 20 percent are radar. Radar detectors cost about $370 each, but save in installation cost since they require no digging or repaving to set up. Automatic Signal division of Eastern Industries, a manufacturer of control systems, says the detectors can be positioned as close as 12 ft from each other without interfering.

As data is collected it is fed to central control locations. Growing use of radio to transmit this information is due to the reduced cost of radio as compared with laying cables. In New York, for example, a cable system costs about $50,000 a mile as against $15,000 a mile for radio, according to a spokesman for the traffic bureau.

An example of data processing for control as the information arrives at headquarters may be seen in the ASD system. Pulses from the detectors are fed to a cycle computer that analyzes traffic-flow information continuously. Based on input data, the computer determines which of six control cycles will afford maximum efficiency of traffic movement.

Information from the cycle computer is then fed to a system selector that specifies the portion of green, red and yellow time for the traffic lights being controlled. This cycle length is next processed through a cycle generator that converts the information into an electrical output, and with the aid of a generator-translator circuit sends it to amplifier channels for broadcast to intersection control boxes.

A recent installation in New York City made by Motorola uses radio to control traffic signals along a 4½-mile stretch of roadway in Queens borough. The system operates in fixed-time with a number of alternate programming sources set up on punched tape in accordance with traffic surveys on the more than 60,000 vehicles that use the road daily. The New York City office of the Director of Intersection Control told ELECTRONICS the system, presently operating at eight intersections, can be expanded to cover a total of 50 intersections. Radio transmissions in the 960-Mc band control traffic lights from a broadcast site in the borough. Central control in Manhattan sends signal information to the Queens site by cable. Paper tape in cartridge form can be inserted into the control actuators to meet changing situations when deviations from established programming are required.

As the market grows for electronic control gear companies such as Eastern Industries, Motorola, Eagle Signal, El-Tech, RCA, Philco and Sylvania will probably be joined by others. Among developments in vehicular control, wider use of closed-circuit tv is expected.

- three times the power dissipation...150 mW
- twice the collector current...200 mA
- higher junction temperature...100°C

at the same price as standard 2N398 devices

Here is a truly significant improvement in high-voltage, milliwatt transistors. Motorola's 2N398A ... an alloy-junction, PNP germanium unit ... offers three times as much power dissipation and twice as much collector current as standard 2N398 devices. It also offers a higher junction temperature ... 100°C. And, it costs no more than standard 2N398 units.

The Motorola 2N398A, with a collector-base rating of 105 volts, is designed for use as a driver for 28-volt systems, nixie tubes, indicator and neon bulbs and similar industrial applications. Mechanical ruggedness of the 2N398A, housed in the industry-standard TO-5 package, is assured by Motorola's unique "quad-mount" structure. "Quad-mount" provides four-point mounting of the sub-structure and two connections to the base tab rather than the customary single connection. This enables the device to pass the most stringent shock, vibration and 20,000g acceleration tests.

	V_{CB} volts	V_{CE} volts	V_{EB} volts	TEMPERATURE Junction and/or Storage Limits
2N398A	105	105	50	−65°C to +100°C

IMMEDIATELY AVAILABLE — Motorola 2N398A transistors are available in 1 to 999 quantities at factory prices from your Motorola Semiconductor Distributor. Call him, today.

FOR COMPLETE TECHNICAL INFORMATION and name of your nearest distributor write for Data Sheet #DS4006. Please address inquiries to Technical Information Department, MOTOROLA SEMICONDUCTOR PRODUCTS INC., 5005 East McDowell, Phoenix, Arizona.

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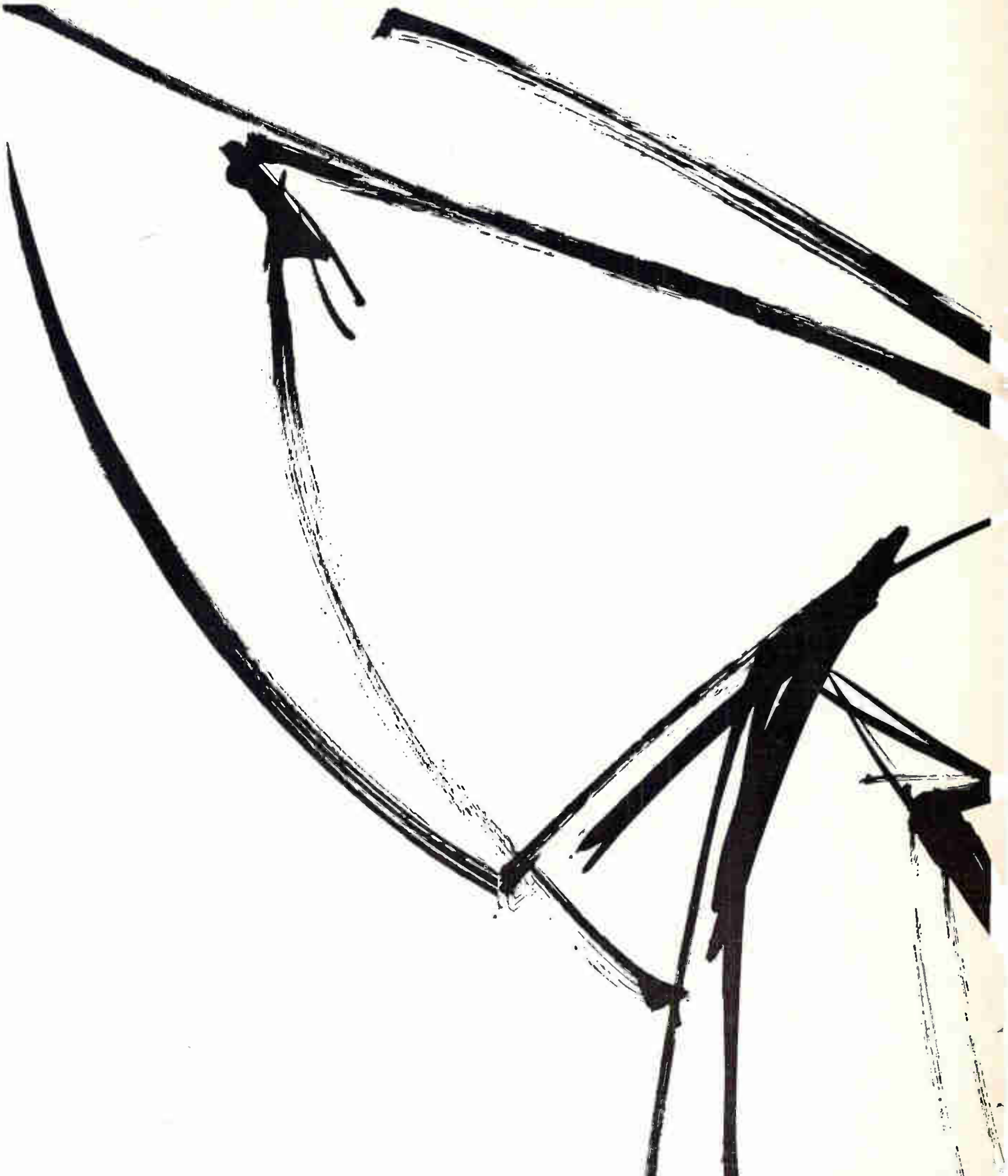
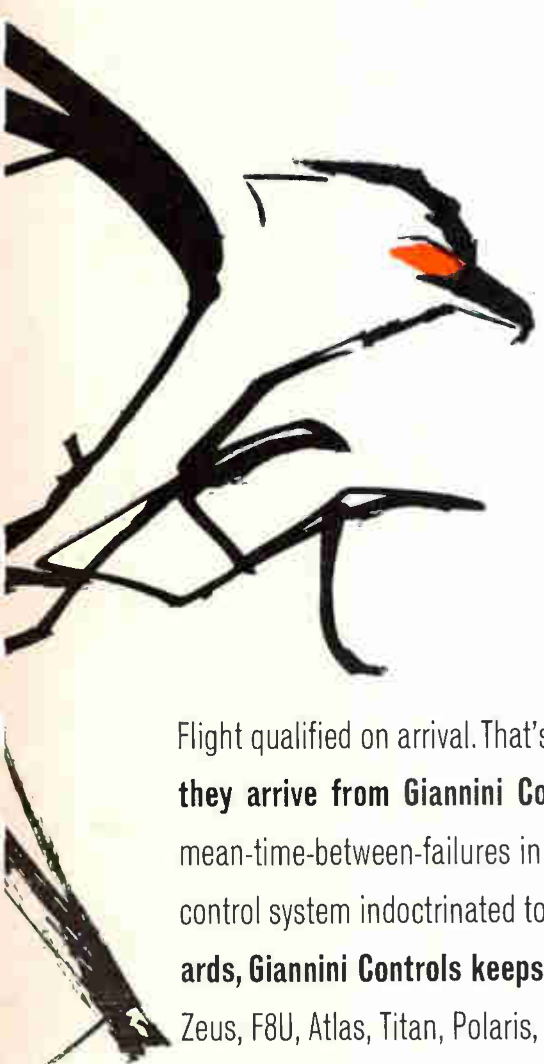
CIRCLE 23 ON READER SERVICE CARD





Along with depth finders, radiotelephones dominated the show. This Raytheon unit has eight crystal controlled channels, broadcast band, corrosion proof plastic panel, epoxy painted aluminum cabinet

New Equipment At The Boat Show

NEW YORK—This year's National Motor Boat Show, which ended Sunday, saw introduction of new marine electronic products by smaller firms, continued expansion of already extensive product lines by larger companies.

Total marine electronics sales for 1960 reached about $11 million in the pleasure boat field and over $3 million for commercial fishermen. Combined sales are expected to pass $15 million for 1961, but some observers feel the market is near overcrowding and will fall short of this goal.

The use of transistors in marine designs still continues to find favor, though there is a dissenting voice here, too. They allow compact designs and operation at reduced battery drain, both important in the small boat field.

Complete radiotelephones are now made available for these smaller vessels (down to 14 ft) with all features usually found in larger versions. In remote ports, many service technicians are not trained in transistor technology. This has led many firms to continue with straight vacuum tubes and hybrid designs.

A unique sonar instrument for salvage was introduced by Edo Corp. It is a self-contained, battery-operated unit carried underwater by a skin diver, has a range of 400 yds, uses special earphones to supply echo information to the diver. Military uses for the instrument are being considered.

Removable, bulkhead-mounting miniature broadcast and marine band transistor receivers, imported from Japan, and labeled by American companies, were displayed. A transistorized tachometer was shown by Aqua Meter.

Many firms have introduced flashing-light depth sounders, similar in design to the original Raytheon unit. While there is continued interest in this device by boat owners, many feel that the dozen or so firms may shake down due to oversupply.

Sperry Piedmont Co. has added an illuminated azmith ring to its five-mile radar, to provide enhanced 24-hour operation.

Bendix introduced an all-transistor, portable depth recorder, and a single-null, transistor direction finder.

A Motorola automatic direction finder designed for aircraft use is being sold for marine use, adapted for that market by a marine distributor.

Raytheon's new line of compact radiotelephones feature improved squelch circuitry, transistors where advantageous, and splash proof cabinet construction. Raytheon now leases over $½ million worth of electronic gear to the commercial boating industry, is aiming more of its sales efforts toward commercial marine users in the future.

Both Johnson and Evinrude have introduced a transistor-regulated alternator generator for their 75-hp outboards, providing a five amp current at low rpm, allowing operation of accessory gear even when the motor is idling. The transistor and regulator assembly are made for the firm by the Delco-Remy div. of GM.

London Banks Adopt U. S. Magnetic Ink Standards

LONDON—Clearing banks have decided to adopt U. S. standards for magnetic ink character recognition in check sorting systems.

After months of study the banks chose the system known as type font E-13B over the FRED characters developed in Britain by EMI Ltd. and over the CMB system evolved in France by De La Rue Bull Machines.

The E-13B type font, developed under the auspices of the American Bankers Association was adopted for U. S. inter-bank use three years ago and is coming into active use in many U. S. banks.

Expectations are that the British decision will give a big advantage to such U. S. manufacturers as Burroughs, IBM and National Cash Register currently producing MICR equipment. Because of the wish for English bankers to install equipment as soon as possible, initial orders will probably be for equipment available from U. S. sources, according to London spokesmen.

New Thermoelectric Hardware Appearing

DALLAS—The science of converting heat directly into electrical energy, given a big boost in the last few years with the development of new solid-state devices, is now beginning to make its way out of the laboratories.

At a symposium here recently on thermoelectric energy conversion, cosponsored by the Department of Defense and seven professional societies, three half-day sessions were devoted to papers describing hardware. At the last conference two years ago, most papers were on measurements and theories. Over 500 scientists from around the country attended the meeting this year.

Thermoelectric generators exploit the Seebeck effect in converting heat to electricity (Peltier effect is applied when electric current is used for cooling). Thermoelectric generators include special bimetallic and semiconductor junctions.

Westinghouse Electric announced it had delivered to Northern Illinois Gas Co., Aurora, Ill., a 100-watt thermoelectric generator for use at a remote pipe-line pumping station. The generator will burn propane and convert the heat into power that will provide cathodic protection and charge batteries for a microwave relay system.

The unit is made up of two 50-watt sections stacked one on the other. Its output is 11 volts at 10 amperes d-c. A static converter operating at 88 percent efficiency changes this output to 48 volts at 2.1 amperes d-c. Northern Illinois Gas plans to use the unit to investigate additional industrial applications.

Westinghouse also told of designing an experimental generator for the SNAP-X nuclear space vehicle. The prototype generator will deliver 250 watts of electrical power, using heat from nuclear reactor cylinders.

Boeing Airplane Co. told of a solar thermoelectric converter it has under investigation. The device uses an array of small paraboloidal mirrors. Each mirror concentrates solar radiation on a thermoelectric junction. The theoretical performance of the system has been explored, and experimental units built and tested.

Participants at the meeting said there now seems to be general agreement that rocket heat can be used to generate and supply electrical power on long-range space probes. The Air Force is reported to have been supporting work on a 100-watt generator that would run off isotopes.

Radio Corp. of America's James R. Anderson said his firm has built and tested a one-ton air conditioner for submarines. It is a thermoelectric unit. Anderson concluded that practical thermoelectric air conditioners having adequate performance can be built using currently available thermoelectric materials.

Concerning industrial applications, most participants said much research and improvement is needed to get prices down and unit efficiency up.

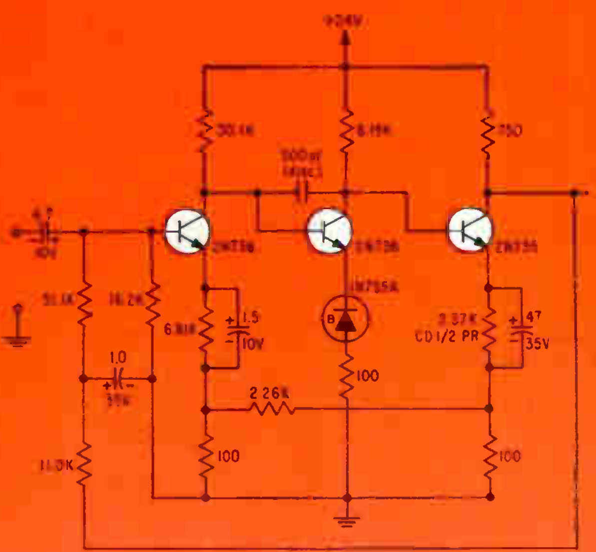
Some remote locations such as off-shore oil wells seem a natural for the thermoelectric devices. Electricity could be converted from the heat from gas flares to run safety lights, telemetering equipment and other devices. Since the heat-conversion generators have no moving parts, they would be relatively maintenance free.

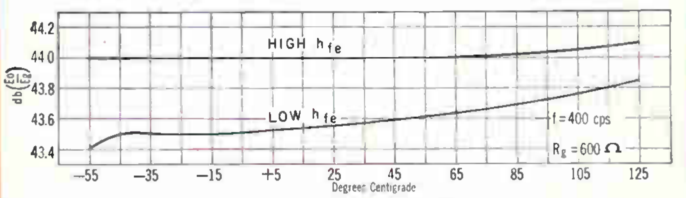
Testing Solar Cells

Photofloods test International Rectifier Corp.'s 9,260-solar cell battery for Tiros II at RCA Astro-Electronics division

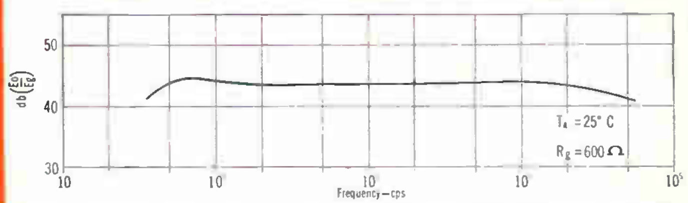
HOW TO GET FLAT FREQUENCY RESPONSE

FROM 37 CYCLES TO 45 KC





Voltage Amplification vs. Ambient Temperature



Frequency Response of Typical 2N735-2N736 Transistors

Specify TI 2N734 Series Silicon Transistors for Your Amplifiers!

For your audio/servo amplifiers, power supplies and medium-speed switches, design in TI 2N734 Series Silicon Transistors. Obtain a flat frequency response of ±1.5 db from 37 cycles to 45 kc . . . guaranteed beta at 25°C (1 ma at 1 kc) (5 ma at 1 kc) (5 ma at 30 mc) and at −55°C (5 ma at 1 kc) . . . guaranteed 500-mw free-air dissipation . . . reduced equipment size and weight with TO-18 package.

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GUARANTEED MINIMUM BETAS

Symbol	Parameter	Test Conditions	2N734	2N735	2N736
h_{fe}	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE}=5v I_E=5ma f=1 kc T_A=25°C	20	40	80
h_{fe}	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE}=5v I_E=1 ma f=1 kc T_A=25°C	15	30	60
h_{fe}	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE}=5v T_A=-55°C I_E=-5 ma f=1 kc	12	20	40
$\|h_{fe}\|$	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE}=5v I_E=5 ma f=30 mc T_A=25°C	1	2	2

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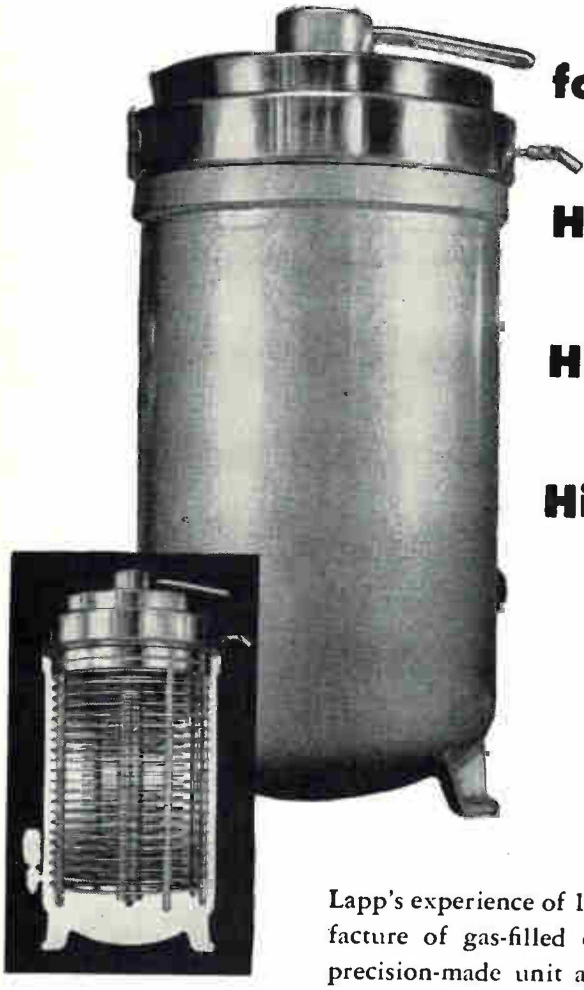


MEETINGS AHEAD

Jan. 29-Feb. 2: Electrical Engineers Exposition, AIEE; Coliseum, New York City.

Jan. 29-Feb. 3: Super Power Tubes, AIEE; Statler-Hilton Hotel, New York City.

Jan. 31-Feb. 2: Cleveland Electronics Conference; Engineering & Scientific Center, Cleveland, O.

Feb. 1-3: Military Electronics, PGMIL of IRE; Biltmore Hotel, Los Angeles.

Feb. 1-3: Solid Propellant & Rocket Conf., ARS; Hotel Utah, Salt Lake City, Utah.

Feb. 3-4: Industrial Engineering Institute, Annual, Latest Developments in R&D; Univ. of California, Berkeley, Calif.

Feb. 1-4: Electronic Representatives Assoc., Annual Convention; Ambassador Hotel, Los Angeles.

Feb. 7-9: Electrical Manufacturers Assoc.; Veteran's Memorial, Columbus, O.

Feb. 13-16: Information Storage and Retrieval Machine Indexing; American Univ., Washington, D. C.

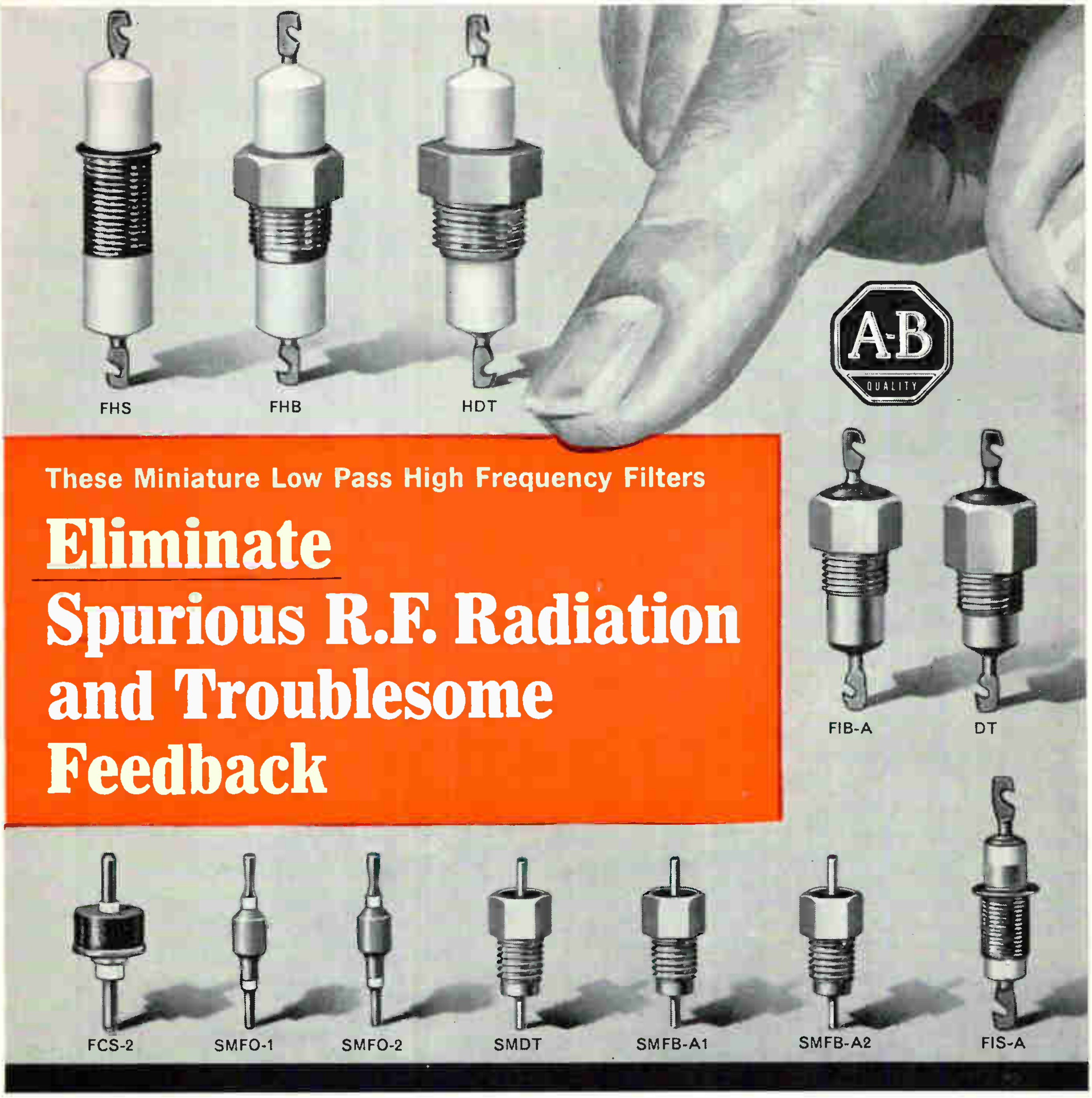
Feb. 14-16: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, South Texas Section of the Society for Nondestructive Testing Inc.; Gunter Hotel, San Antonio, Tex.

Feb. 15-17: Solid State Circuit Conf., International, PGCT of IRE, AIEE; Univ. of Penn. & Sheraton Hotel, Phila.

Feb. 17-21: Electronic Components Exposition, International, French Fed. of Electronic Ind., Port de Versailles, Paris.

Mar. 9-10: Engineering Aspects of Magnetohydrodynamics, PGNS of IRE, AIEE, IAS; University of Penn., Philadelphia.

Mar. 20-23: Institute of Radio Engineers, International Convention, All PG's; Coliseum & Waldorf-Astoria Hotel, New York City.



Allen-Bradley Low Pass Filters

Prevent Undesired Radiation...100 Mcps to 8000 Mcps

Where—at high frequencies—conventional feed-thru capacitors become useless—these Allen-Bradley low pass filters insure effective filtering of undesired frequencies. Their performance surpasses the theoretically ideal capacitor—the effective filtering actually increases with frequency over a wide band. And here's another "plus" feature—there are none of the undesirable parallel resonances experienced with standard tubular capacitors. Thus, unusual attenuation—75 db and more—is possible in the frequency range from 100 Mcps to 8000 Mcps.

Although designed for low power applications, the Allen-Bradley low pass filters are available in ratings up to 2000 volts and with maximum d-c or low frequency a-c current ratings up to 20 amperes. These miniature filters provide single hole mounting—directly on metal shields. Also, they are usually interchangeable with conventional feed-thru capacitors, but provide far greater suppression of undesired radiation and feedback. Send for Technical Bulletin 5410.

Allen-Bradley Co., 110 W Greenfield Ave., Milwaukee 4, Wis • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

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...from Ampex

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Through installment purchases, you are investing in your Ampex data recorder while it works for you.

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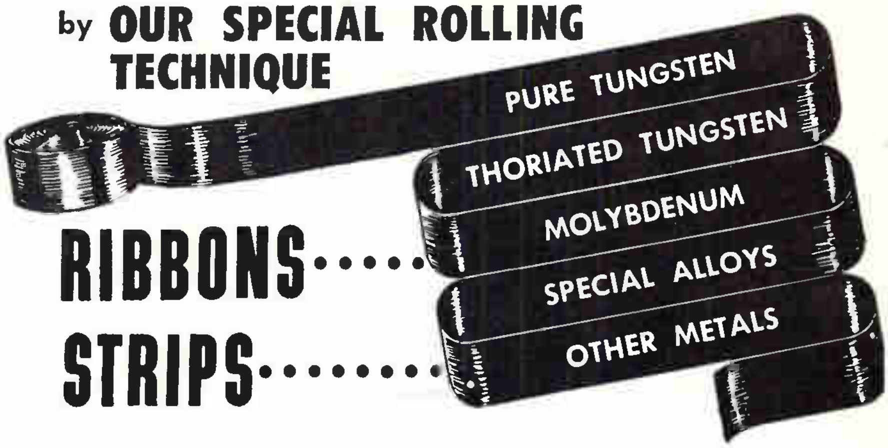

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Note: for highly engineered applications—strips of TUNGSTEN and some other metals can be supplied

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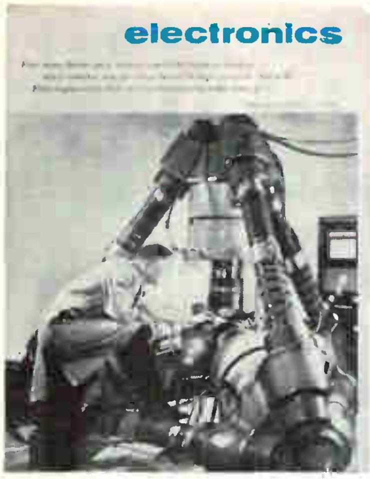

KEEP YOUR EYE ON THE BOX SCORE!
Circulation: 52,286 paid
Editorial: 3,487 pages in 1960
Costs: $980 a page (13 time rate, B&W)

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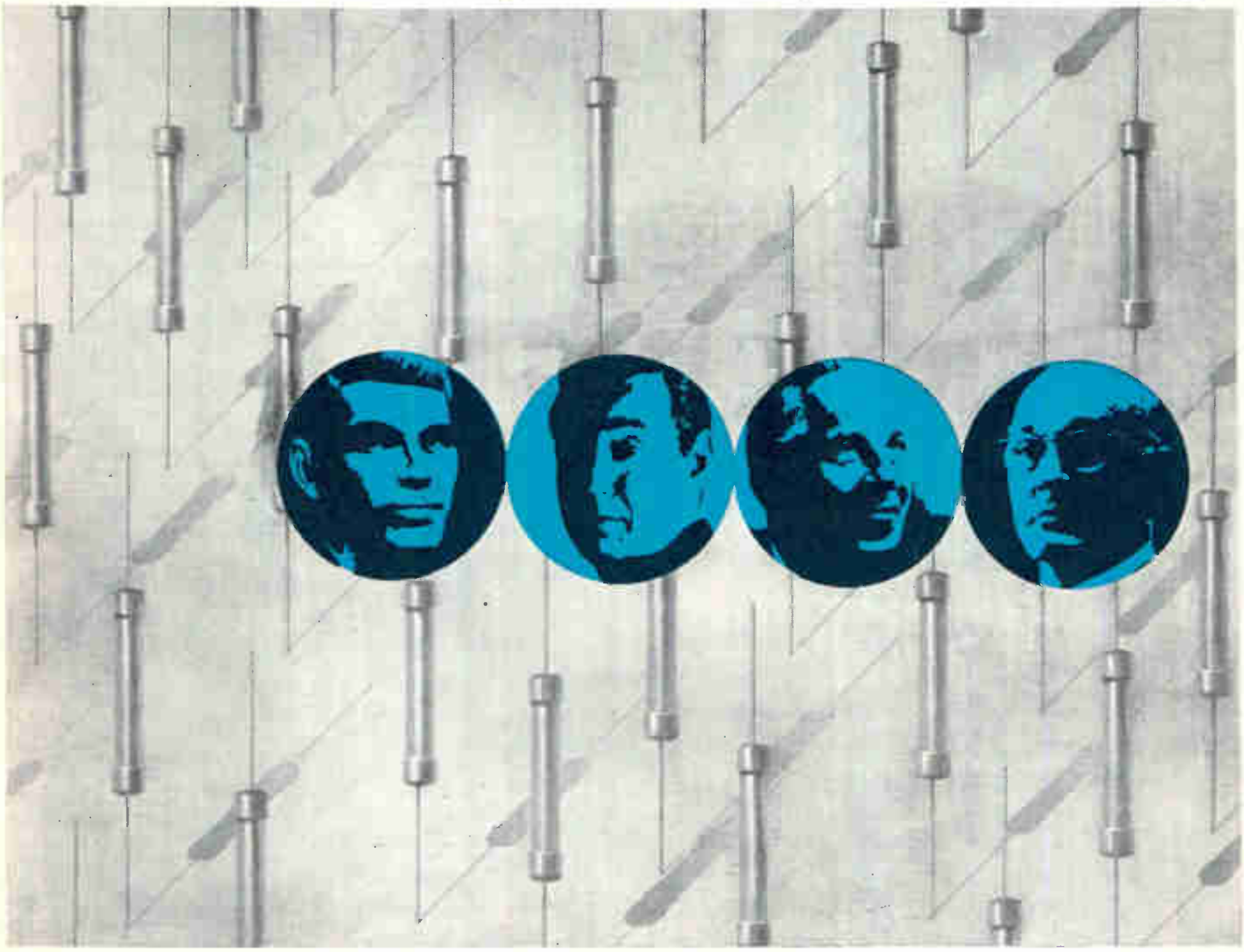
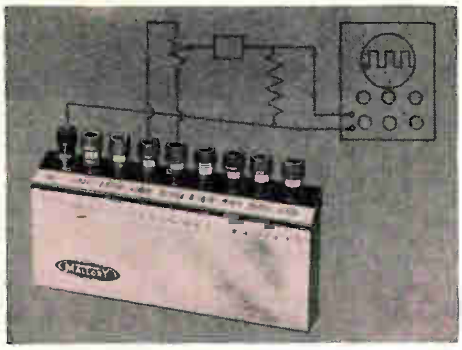
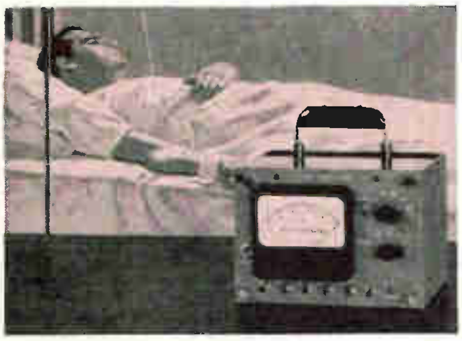
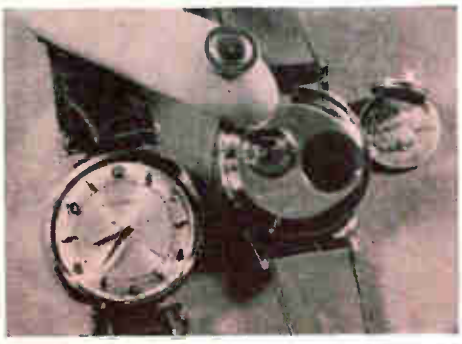




PRECISE VOLTAGE REFERENCE SOURCE for instrument calibration and lab tests, Mallory Mercury Reference Battery is accurate within ± ½% of stated voltage. Glass-free, rugged construction. Can't be damaged by overloads. Eight voltage outputs, 0 to 10.8 volts, in 1.35 volt steps.



HYPOTHERMIA PRECEDING HEART SURGERY involves remote measuring of temperatures. The Tele-Thermometer from Yellow Springs Instrument Co., Inc. does this exacting work, with Mallory Mercury Batteries providing needed high electrical capacity per unit size. (2.5 volt cells, .66" dia. by 1.3", rated 1000 milliamp-hours.)



FIRST ELECTRONIC TIMEPIECE ACCUTRON, by Bulova, guaranteed accurate to one minute per month, is designed to run a full year without battery change. To power the mechanism, Mallory Mercury Batteries assure long life, constant voltage discharge and freedom from gassing and leakage.

Miniaturization . . . portability . . . extra long life . . . name the extra sales factor, and Mallory Mercury Batteries can add it! Want fewer battery changes, longer storage life, fade-free service? Mallory offers far longer life, far higher capacity per unit size than conventional batteries! Batteries must have wide temperature range? Mustn't leak? Make yours Mallory! Their constant discharge voltage is ideal for transistor circuitry, too.

There's a wide availability on a broad line of single or multiple voltage cells. Custom power packs developed on request. Write Mallory, the mercury battery pioneers, for consultation and engineering data.

Mallory Battery Company
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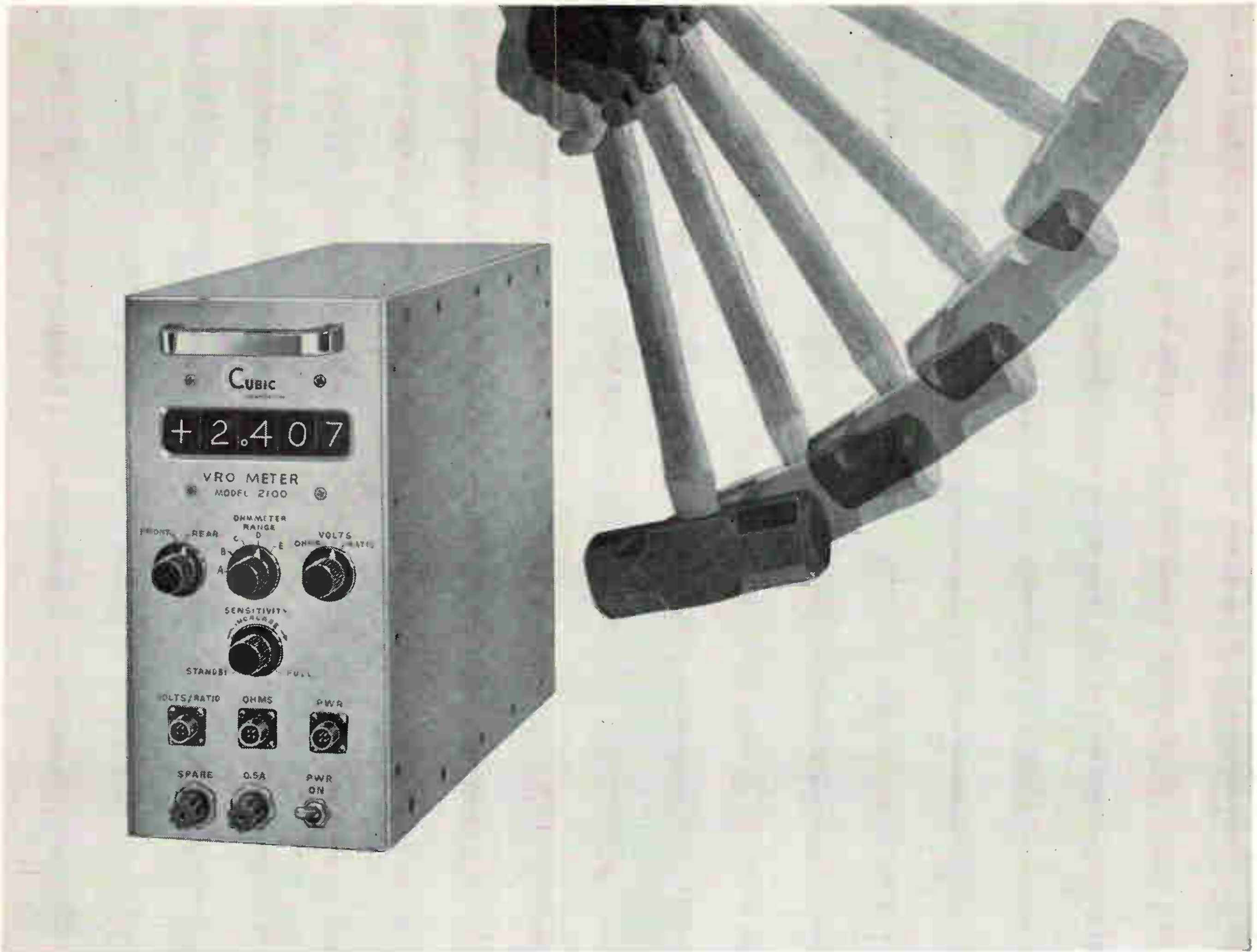

Cubic precision digital voltmeter withstands 50G shock

A new militarized version of the Cubic precision digital voltmeter is guaranteed to withstand shocks as high as a bone-crushing 50 G. The ability to shake off punishment that would wreck ordinary voltmeters, and to keep on performing perfectly for years and years under the hardest kind of use, is built into *every* Cubic digital voltmeter. These meters are "operator-proof" – they will not be damaged by any except the most flagrant misuse. Even voltages 100% over the top of the highest range will not harm them.

The advanced engineering of Cubic's transistor-driven stepping-switch design provides extraordinary reliability and accuracy. Cubic digital voltmeters achieve 99.997% repeatability, for precise accuracy again and again. Attenuator accuracy is 0.003% for wide-range precision. Bridge linearity of 0.003% is attained with carefully matched quality components. Noise rejection (60 cps) is 80 db.

Cubic's digital readout is simple, reliable and the easiest to read at a glance. Extra quality components throughout ensure minimum maintenance requirements. Before buying *any* digital instrument, investigate the best. *Write for descriptive literature to Dept. E-100, Industrial Division, Cubic Corporation, San Diego 11, Calif.*

BRIEF SPECIFICATIONS – MODEL 2100

ENVIRONMENTAL

shock test: will withstand 50G Navy shock test, and shipboard vibration

humidity: 100%

salt spray and fungus resistant

ELECTRICAL

volts: 0.01% accuracy from 1 millivolt to 1000 volts, automatic ranging and polarity

ohms: 0.1 ohm to 10 megohms, manual ranging

input power: 25 watts

ratiometer provision and switching

MECHANICAL

size: $5\frac{1}{2}$" wide, $11\frac{1}{4}$" high, 14" deep

weight: 35 lb

cubic CORPORATION

General Instrument Semiconductor... Exclusive!

NOW... MADT® COMPLETES GI SPECTRUM OF SWITCHING SPEEDS...DC to 50 Mc

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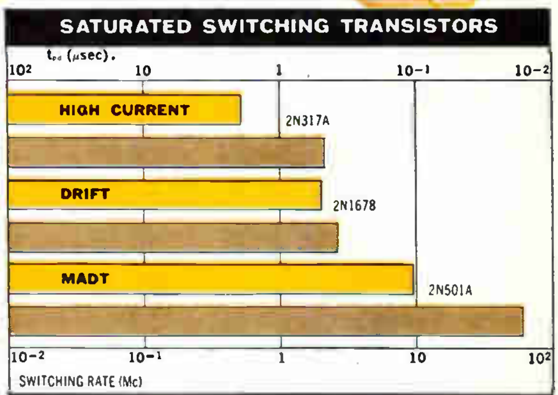
DRIFT 5 Mc

ALLOYED-JUNCTION 2 Mc

Only General Instrument offers the *MADT*, *Drift*, and *Alloyed-Junction Transistors* for all your switching needs! The new GI MADT completes the entire switching spectrum from dc to 50 Mc, as illustrated above. GI computer semiconductors are immediately available, realistically priced, and produced by advanced manufacturing techniques to assure highest quality and long life.

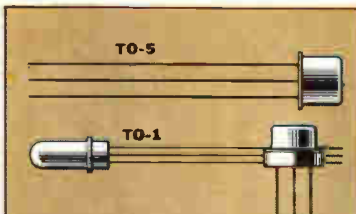


Saturated Switching Speeds for three GI PNP transistor families. Shaded bar represents speeds obtainable with speed-up capacitor.

YOU CAN DEPEND ON GI FOR ALL YOUR COMPUTER NEEDS

Devices • Full Specifications • Engineering Assistance

General Instrument is your single source of supply for a full range of germanium computer transistors, companion diodes, logic encapsulations and rectifiers. In addition GI provides *complete* engineering and reliability design data. The abbreviated specifications below, for example, illustrate the range of data available from GI on its entire line of computer semiconductors. Write today for device information, engineering data and applications assistance on your special computer problems. Contact General Instrument for the name of your local stocking distributor.



Abbreviated specifications are given at right for three transistors from the broad line of GI switching units. Alloyed-Junction type 2N317A is supplied in JEDEC TO-5 case; 2N501A in TO-1; and 2N1678 in TO-9.

RATINGS and CHARACTERISTICS	ALLOYED-JUNCTION		DRIFT		MADT	
	Conditions	2N317A	Conditions	2N1678	Conditions	2N501A
RATINGS						
BV_{CBO}		2[illegible]		[illegible]		15 v
BV_{EBO}		20 [illegible]		4 [illegible]		2 v
P_C		150 [illegible]		120 [illegible]		60 mw
$T_{j\,max}$		100°C		85°C		100°C
CHARACTERISTICS						
I_{CBO}	V_{CB} = 5 v	2 μa max	V_{CB} = 10 v	5 μa max	V_{CB} = 5 v	5 μa max
h_{FE}	I_C = 400 ma V_{CE} = 0.25 v	20 min 60 max	I_C = 20 ma V_{CE} = 0.25 v	25 min	I_C = 10 ma V_{CE} = 0.5 v	20 min
f_{hfb}	V_{CB} = 5 v I_C = 1 ma	20 Mc typ	V_{CB} = 5 v I_C = 1 ma	25 Mc min 50 Mc typ	V_{CE} = 0.5 v I_E = 2 ma	130 Mc typ*
V_{BE}	I_C = 400 ma V_{CE} = 0.25 v	0.95 v max	I_C = 20 ma V_{CE} = 0.25 v	0.6 v max	I_C = 10 ma I_B = 1 ma	0.45 v max
V_{CE} (SAT)	I_C = 400 ma I_B = 40 ma	0.2 v max	I_C = 20 ma I_B = 0.8 ma	0.25 v max	I_C = 10 ma I_B = 1 ma	0.20 v max
t_{ON} (t_d+t_r)	I_C = 400 ma $I_{B(ON)}$ = 20 ma $I_{B(OFF)}$ = 10 ma V_{CC} = 9 v	600 nS max	I_C = 20 ma $I_{B(ON)}$ = 1 ma $I_{B(OFF)}$ = 1 ma V_{CC} = 20 v	400 nS typ	I_C = 20 ma $I_{B(ON)}$ = 2.2 ma $V_{B(OFF)}$ = + 0.5 v	13 nS typ
t_{OFF} (t_s+t_f)		1200 nS max		400 nS typ		14 nS typ

*Gain-bandwidth Product, f_T

®T. M. Philco-GI Micro Alloy Diffused-base Transistors Are Fully Licensed Under Philco Patents

Now Eimac's 2C39A gives you more ruggedness than any other competitive tube. *Plus* a higher maximum temperature rating of 250°. . . and less dielectric loss at higher frequencies for increased efficiency, power output. *And all at no increase in cost!* Get the only ceramic tube built to 2C39A specifications. Get it only from Eimac. . . world leader in power tubes, microwave tubes, amplifier klystrons. Contact your local Eimac representative for quantity price quotations. Eitel-McCullough, Inc., San Carlos, California.

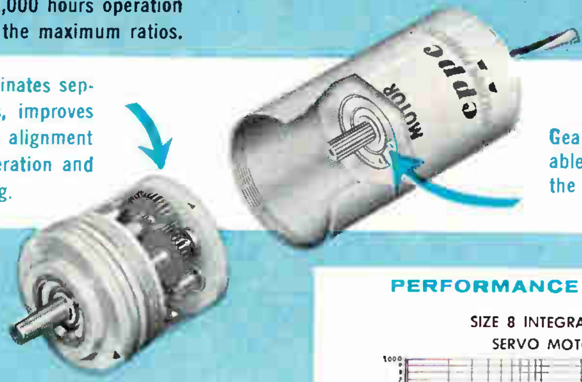
NEW SIZE 8 INTEGRAL GEARHEAD MOTORS

3 Times Torque Load Capacity*

of comparable size 8 gearheads

*Will sustain 20 in-oz torque load for 1,000 hours operation and 100 in-oz momentary overload at the maximum ratios.

CPPC one-piece gearhead housing eliminates separate gear plates and fastening posts, improves and maintains accuracy through exact alignment of gear clusters, assures smoother operation and more expedient inspection and servicing.



Gearhead and motor are selectable, individual parts enclosed in the same common motor housing.

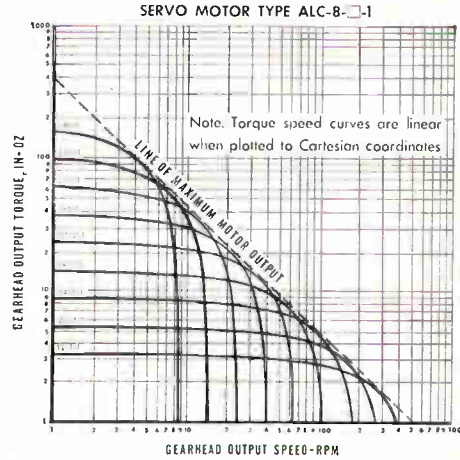
Clifton Precision, pioneers in postless gearhead construction, introduces the finest in gearhead design—cage-type, one-piece gearhead housing machined from a single block of metal. In these units, exact duplication of gear centers is accomplished through simultaneous boring of permanently integrated bearing plates (patent pending). Positive and permanent alignment of gear clusters composed of AGMA precision Classes II and III hardened-steel gears integral with shafts journaled at both ends in ABEC class 5 bearings, minimize deflection and backlash, maximize torque load capacity, insure smoother operation and continued reliability of performance beyond normal endurance life requirements. Cage-type construction facilitates inspection and lubrication while gearhead is mounted simply by removing motor.

CPPC motors will stand greater heat than ever before due to the use of new materials. See box at lower right.

Write for our free pamphlet which gives detailed specifications of our entire gearhead motor and motor-tachometer line, sizes 8, 10 and 11.

PERFORMANCE CHARACTERISTICS

SIZE 8 INTEGRAL GEARHEAD MOTOR
SERVO MOTOR TYPE ALC-8-□-1



STANDARD TYPES

RATIOS Size 8	Size 10	No. of Clusters	Dir. of Rotation
12.09	19.98	2 (3 pass)	reverse
20.63	32.19	3 (4 pass)	direct
34.26	58.28	3 (4 pass)	direct
58.44	93.89	4 (5 pass)	reverse
97.07	169.97	4 (5 pass)	reverse
165.58	273.84	5 (6 pass)	direct
275.02	495.74	5 (6 pass)	direct
469.15	798.70	6 (7 pass)	reverse
779.22	1445.92	6 (7 pass)	reverse

Notes: 1. Any ratio (±3%) is available within the limits of the ratio range at additional cost and may require longer delivery time. 2. Max. backlash = 30 minutes at 2 in-oz reverse gauge load in above units. Inquire if special tolerance is required.

MOTORS

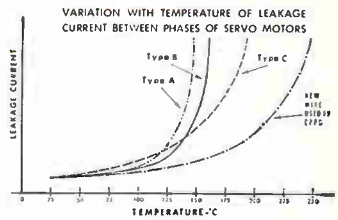
The following CPPC standard motors, electrical characteristics of which can be found in the current CPPC Rotary Components catalog, are offered with our gearheads:

SIZE 8		SIZE 10	
ACH-8-□-1	AMH-8-□-3	ACH-10-□-1	ALH-10-□-1
ACH-8-□-4	ALC-8-□-1	ACH-10-□-4	ALH-10-□-5
AMH-8-□-1	ALC-8-□-4		

CURRENT LEAKAGE

Superiority of insulation in CPPC motors is illustrated by actual comparative curves shown at the right.

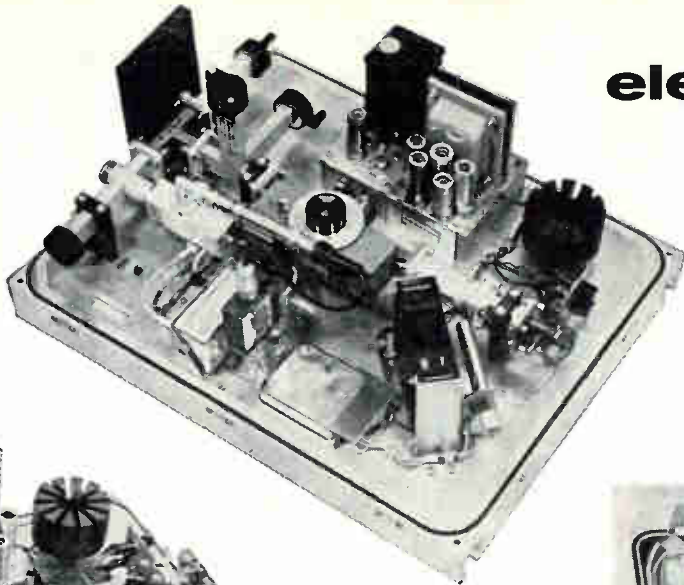
VARIATION WITH TEMPERATURE OF LEAKAGE CURRENT BETWEEN PHASES OF SERVO MOTORS



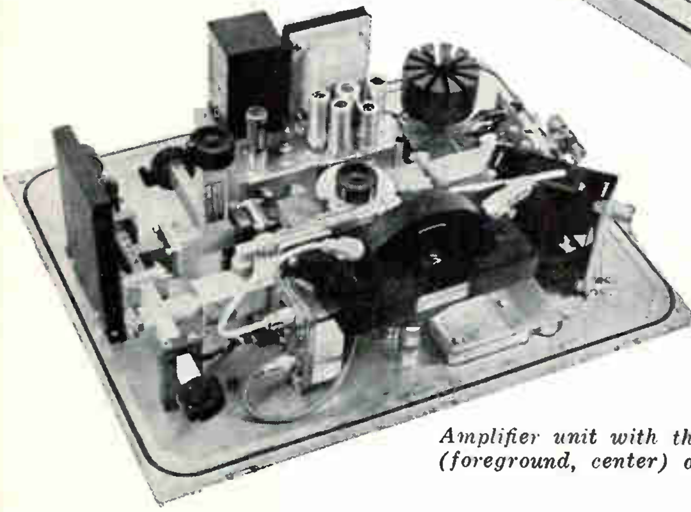
CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS, PENNSYLVANIA

cppc

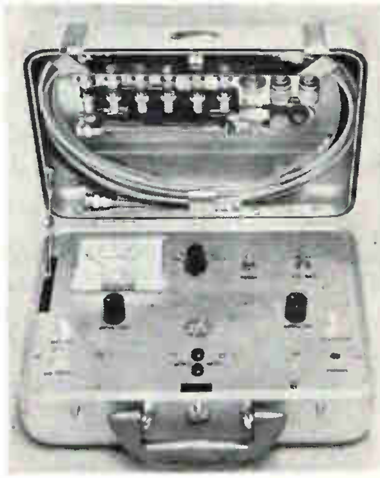
electronics
January 27, 1961



Amplifier unit with cover removed. For stable and reliable operation, unit was sealed



Amplifier unit with the circulator (foreground, center) added



Transistorized parametric amplifier test set is designed to simplify adjusting and field maintenance

Parametric Amplifier For Space Probe Tracking

Phase-locked loop receiver using a parametric amplifier reduces noise figure to 2 db

By CHARLES F. BRETT Space Technology Laboratories, Inc., Los Angeles, California

COMMUNICATION over millions of miles, rather than thousands, has been made necessary by the advent of space exploration. For reliable data telemetering over such distances it is necessary to keep down, as much as possible, the internally generated noise in the receiving system. The parametric amplifier described here was used for tracking the deep-space probe Pioneer V. Tracking was done at the 250-foot parabolic antenna at Jodrell Bank near Manchester, England, successfully to over 22 million statute miles. The amplifier operated at 378 Mc in a one-port, difference-frequency mode and was pumped at 9,100 Mc; an over-all system noise temperature of 167 K resulted, giving a receiver threshold sensitivity of −162 dbm.

To communicate over ten to one hundred million miles with the present weight and space limitations of space vehicles[1, 2, 3], extra-sensitive receivers are needed. The expected power received by the antenna can be calculated as

$$P_r = P_t G_t G_r / (5.25 \times 10^3 f^2 d^2)$$

where P_r = power received in watts, P_t = power transmitted in watts, G_t = transmitting antenna gain, G_r = receiving antenna gain, f = frequency in Mc, and d = dis-

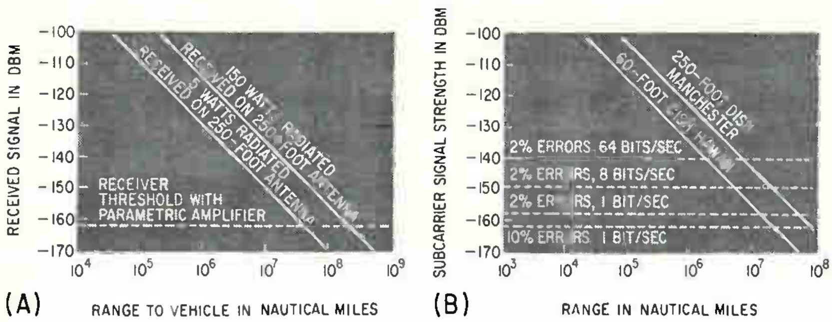


FIG. 1—Signal strength is plotted against range for the Pioneer V telemetry system (A); expected subcarrier signal reception using 150-watt transmitter is shown in (B)

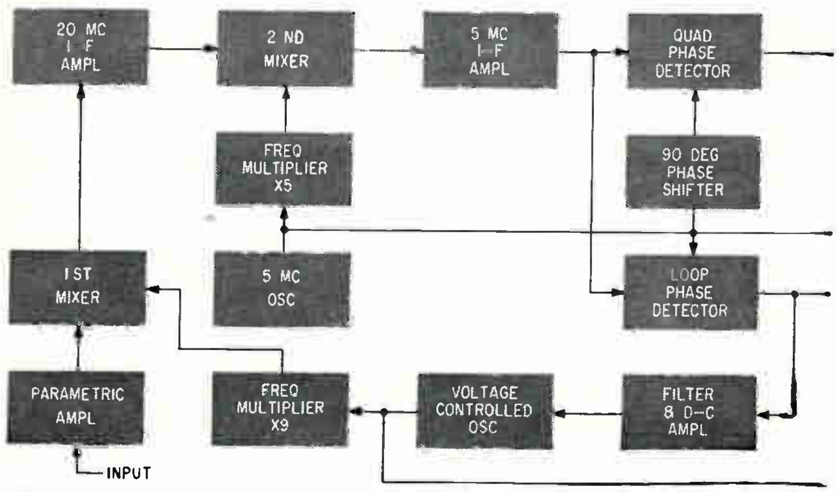


FIG. 2—Block diagram of phase-locked loop receiver

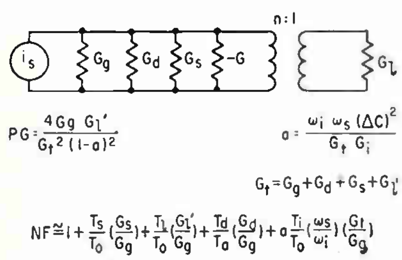


FIG. 3—Simplified diagram shows theoretical sources of noise

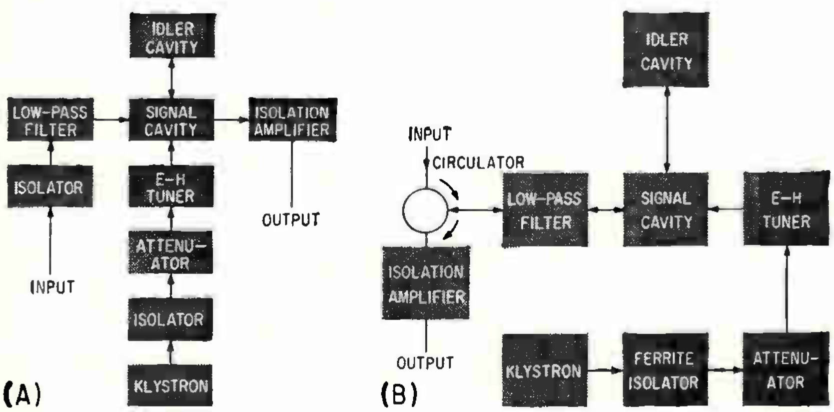


FIG. 4—Block diagram of parametric amplifier circuit used (A); with the addition of a circulator shown in (B)

tance in nautical miles. Figure 1A shows results for Pioneer V. To communicate over the greatest possible range, the receiver threshold sensitivity figure should be as low as possible; therefore, the effective bandwidth and internally generated noise must be very low. Threshold sensitivity is the signal power which will produce a signal-to-noise ratio of unity.

Bandwidth can be reduced to a cycle or two with filter techniques; but because of doppler shift there is an important difference between receiving signals from fast moving objects and normal fixed communications. With very narrow-band receivers the doppler shift is many times the receiver bandwidth; therefore, some sort of tracking receiver is needed. Doppler shift can vary from zero at liftoff to as high as 20 to 30 Kc for most space probe applications.[3,4,5] The doppler shift f_d is given as

$$f_d = [(f_t V)/C] / \sqrt{1 - (V/C)^2}$$

where f_t = frequency of the transmitter, V = relative velocity of transmitter and receiver, and C = velocity of light. For small velocities relative to the velocity of light, this can be written as $f_d = f_t V/C$. For example, at 400 Mc and a V of 20,000 miles an hour the doppler shift is 11.9 Kc.

The development of coherent detecting processes, using narrow-band phase-locked loops as tracking filters, gives an ideal solution to the problem. A phase-locked loop can be made with an adjustable bandwidth to accommodate various information rates with only the change of a few components in the loop filters. Figure 2 shows the block diagram of the ground receiver used with the parametric amplifier.

Neglecting transmission line loss, the total noise power in the receiving system, referred to the input, can be written as

$$N_s = KB\,[t_a + (NF - 1)\,t_o]$$

where N_s = total available noise power referred to the input, B = effective noise bandwidth, t_a = effective temperature of the antenna, t_o = reference temperature 290 K, NF = noise figure power ratio, and K = Boltzmann's constant, 1.38×10^{-23} joule/deg K.

From this it is evident that two sources of noise can be reduced: noise associated with the antenna system, and noise generated within the receiver. The antenna noise can be reduced by using a highly directive antenna with minimum side-lobe pickup, and pointing the antenna toward the cold part of space. With the frequency of 378 Mc the expected sky temperature was 40 K maximum and 30 K minimum for the Pioneer V trajectory, and the side-lobe pickup added another 15 K, giving a maximum antenna temperature of 55 K.

As to the internally generated noise, within the past few years several devices have become available[6, 7, 8, 9] which have very low noise capabilities: masers, parametric amplifiers, special low-noise electron beam devices, and some super-cooled amplifiers.

In tracking Pioneer V it was desired to have a maximum system noise temperature of 169 K (2 db) resulting in a receiver carrier threshold sensitivity of −162 dbm. The expected subcarrier signal reception at the Hawaii and Manchester stations, when the space probe is transmitting with the 150-watt transmitter, is given in Fig. 1B. For the particular requirement at 378 Mc, it was decided to use a parametric preamplifier ahead of the phase-locked receiver. A parametric amplifier can produce a large coherent gain with very low noise figure and is practical for field operation and field maintenance. The amplifier had to work in the unprotected weather conditions of Manchester, Singapore and Hawaii; for this reason it was decided to pressurize the amplifier case with dry air or nitrogen, and also to regulate ambient temperature.

It is well known[10, 11, 12] that parametric amplifiers using the time-varying depletion layer capacitance of a *p-n* junction produce very low noise figures. The objective was to build an amplifier that would maintain phase coherence and have a noise temperature of 75 K (1 db). A one-port difference-frequency mode of operation was chosen and the pump frequency was placed at X-band to ensure negligible noise from the idler. This allows the signal frequency of the parametric to be increased, if desired, by changing only the signal cavity.

The gain and noise figure for a one-port parametric amplifier without a circulator is given as[16, 17]

$$PG = \frac{4G_gG_1'}{G_t^2(1-a)^2} \quad \text{where } a = \frac{\omega_i\omega_s(\Delta c)^2}{G_tG_i}$$

where PG = power gain, G_g = generator conductance, $G_1' = G_1/n^2$ = transformed load conductance, n = effective turns ratio, $G_t = G_s + G_d + G_g + G_1'$, ω_i = idler frequency $(2\pi f_i)$, ω_s = signal frequency $(2\pi f_s)$, and $\Delta c = C_{max} - C_{min}$;

$$NF = 1 + \frac{t_s}{t_o}\left(\frac{G_s}{G_g}\right) + \frac{t_1}{t_o}\left(\frac{G_1'}{G_g}\right) + \frac{t_d}{t_o}\left(\frac{G_d}{G_g}\right) + a\,\frac{t_i}{t_o}\left(\frac{\omega_s}{\omega_i}\right)\left(\frac{G_t}{G_g}\right)$$

where t_s = effective temperature of signal circuit, t_1 = effective temperature of load circuit, t_d = effective temperature of diode, and t_i = effective temperature of idler circuit.

When this amplifier was being developed, no low-loss circulators or isolators were available at 378 Mc. Without a nonreciprocal device, noise feedback from the load could increase the over-all noise temperature of the parametric. To eliminate this problem the load was decoupled (See Fig. 3) by mismatching it from the signal circuit[13, 14, 15] by $1/n^2$ times the effective turns ratio of the output transformer.

This basic design made it possible to build six parametric amplifiers with noise figure of 1 db (75 K). The varactor was a silicon type MA460E operated with contact bias only, that is, short circuited.

After the original amplifiers were built, a circulator became available with an insertion loss of 0.3 to 0.4 db and isolation of 25 db. One of the parametrics was then modified to include this circulator and a noise temperature of 55 K (0.75 db) resulted. The lower noise performance of the amplifier with the circulator was due to better matching and also the load noise could be eliminated. A miniature isolator was also developed for parametrics; it weighed only 7 ounces and had an insertion loss of 0.6 to 0.7 db, and an isolation of 11 to 14 db. This isolator was developed for use within the space vehicle as well as with the ground parametrics.

Figure 4A is a block diagram of the amplifier used. The signal is fed through a uhf isolator and low-pass filter into the signal cavity, and is amplified. From there the signal is lightly coupled out into a grounded-grid triode stage that serves as an isolation amplifier for external loads. Figure 4B shows a typical circulator-type amplifier, where the signal flows from port 1 to port 2 and is amplified in the signal cavity, and then is circulated around to port 3 and out into the isolation amplifier. The photos show the amplifiers and the table lists some of the performance data.

AMPLIFIER PERFORMANCE

Frequency range	370–380 Mc
Bandwidth	1.4 Mc when gain is set to 20 db
Gain	Parametric cavity 20 db Isolation Amplifier 13 db Total over-all 33 db
Linearity	Amplifier is linear up to about −35 dbm
Noise figure	1 db (75.5 K)
Spurious response	No spurious responses on either side of center frequency ± 50Mc
Spurious radiation	Down 60 db or more
Conducted interference	Power line is filtered better than 150 db

Tracking of the Pioneer V was done at the Space Technology Laboratories tracking site, 80 miles southwest of Hilo, Hawaii, with a 60-foot parabolic antenna, and at the Jodrell Bank experimental station in England with their 250-foot parabolic antenna. The tracking stations are so arranged that simultaneous transmission of 8 Kw at about 400 Mc takes place while receiving signals down to −162 dbm at 378 Mc. For this simultaneous operation care has been taken in the diplexer, shielding all leads and spurious signals of the transmitter. With transmitter operating at full power, no increase in voltage was apparent at the output of the receiver. The parametric amplifier was installed just under the antenna dish, to avoid any pickup from the transmitter that might cause cross-modulation or saturation in the parametric. A ⅝-inch low-loss Styroflex line coupled the amplifier to the diplexer.

A light-weight transistorized test

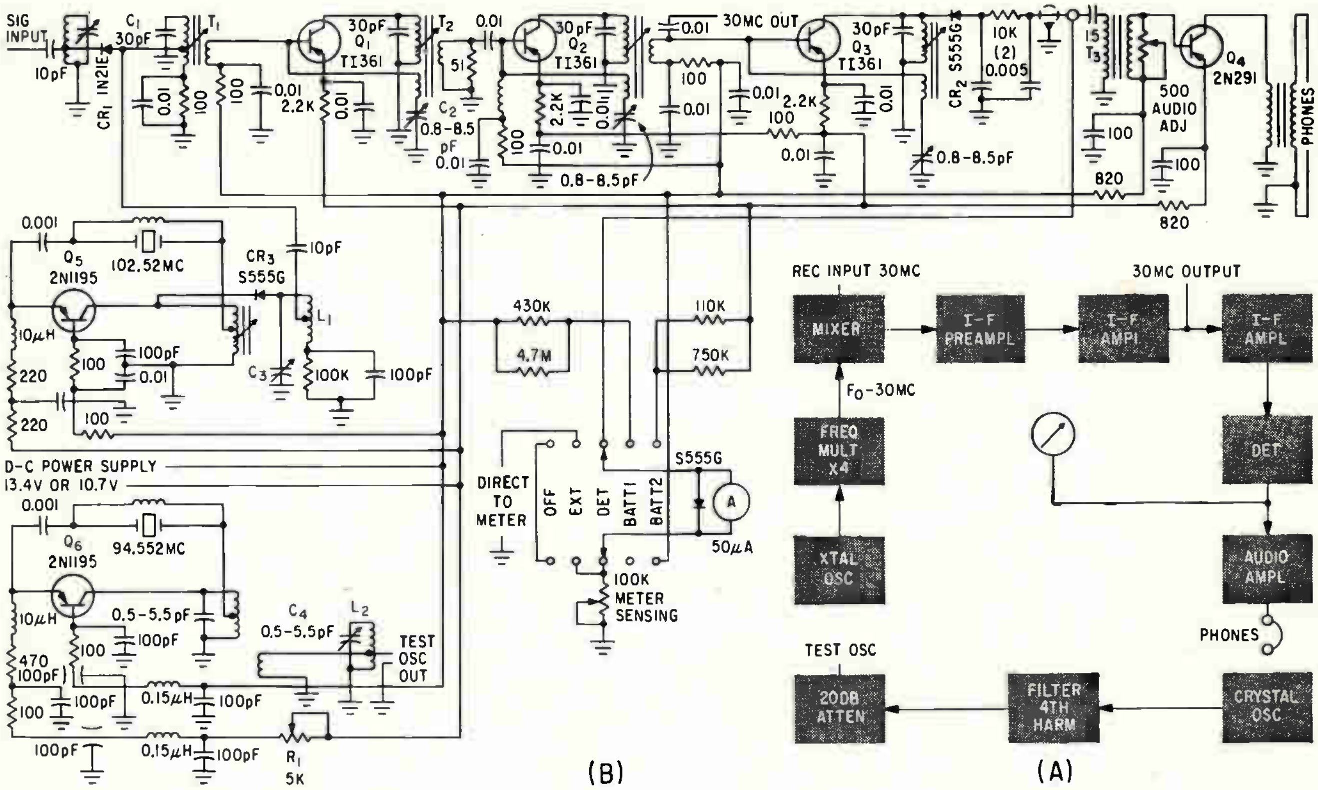


FIG. 5. Block diagram (A) and wiring diagram (B) of amplifier test set. Batteries are not shown

set was developed to simplify field maintenance and tuning of the parametric amplifier (See photo). Its basic function is to supply a c-w signal that can be injected into the parametric amplifier, and to act as a receiver to take the output from the parametric and display relative power on a meter. The test set also has an output at 30 Mc which can be used to feed an automatic noise-figure meter. Some other features are provisions for aural monitoring to check for erratic performance, attenuator pads to measure and set the power gain of the parametric, and provision for monitoring the power output from the klystron pump. Figure 5A is a block diagram of the test set.

Wiring diagram of the test set is shown in Fig. 5B. The mixer (upper left) converts the output signal of the parametric amplifier from 378 Mc down to 30 Mc where it can be amplified and provide output for an automatic noise figure meter or the detector. Crystal diode CR_1 mixes the local oscillator with the receiver input. The difference signal is picked off with the tank circuit C_1-T_1 and coupled to i-f preamplifier Q_1. The over-all noise figure of the mixer and preamplifier is 9 db.

The mixer output is coupled through T_1 to common-emitter stage Q_1, a low-noise i-f preamplifier. The noise figure of this amplifier is less than 3 db at 30 Mc and it produces about 20 db power gain. The stage is neutralized by C_2 and a winding on T_2.

The i-f amplifier consists of Q_2 and Q_3; its overall gain is about 45 db. The output of Q_2 is also coupled out for use with an automatic noise-figure meter. The signal is envelope-detected by CR_2 and the average d-c current, after filtering, is read on the meter. This current serves as relative indication of signal strength.

From the detector, any audio signal is coupled through T_3 to Q_4, an audio amplifier that gives an additional 30 db power gain to drive a head set.

The local oscillator is made up of a series mode crystal-controlled transistor oscillator Q_5, which produces about 20 mw of output power at 102 Mc. This signal is then multiplied by four by the non-linear capacitance of CR_3 diode, to produce 2-3 mw for injection into the mixer. The diode is self-biased and C_3 and L_1 are tuned to the output frequency, 408 Mc.

The test oscillator is the same circuit as the local oscillator, but operating at reduced power output and at a sub-multiple of the signal frequency. The oscillator is operated in a double-shielded container with only a small amount of fourth harmonic coupled out to C_4 and L_2. The tank circuit output then passes through a 20-db attenuator and to the output jack. The level of the local oscillator can be adjusted by the R_1 trimpot, and the output can be set to about 100 microvolts across 50 ohms. This is a strong signal, well out of the noise within the bandwidth of the test set.

The test set has provisions for checking its internal batteries. When the primary battery is below its rating, an auxiliary battery can be switched in. When the lid is closed, a switch disconnects the batteries. A short-test antenna is supplied.

A typical field problem with operating a parametric is the tuning of the amplifier for the lowest noise performance when it is coupled into the antenna. The method found most suitable for our application uses a 20-db directional coupler between the diplexer and the parametric amplifier. With this directional coupler, a small signal was injected into the amplifier from a test generator. With this signal the parametric amplifier can be tuned and its relative gain checked by switching the pump power on and off. To optimize the parametric, the signal generator output is reduced to a level of −155 to −160 dbm so that the carrier energy is well below the noise within the i-f bandpass of 10 Kc. With the receiver phase-locked to the injected signal, the parametric amplifier is then tuned for maximum output at the quadrature phase detector. Because the receiver maintains signal-plus-noise power into the phase detector constant by i-f limiting, it follows that we have the maximum signal-to-noise ratio when the output of the quadrature phase detector, whose noise bandwidth is about 10 cps, is greatest.

To check the over-all noise performance of the antenna, parametric and receiver, a celestial radio source was used.[18] Many such discrete radio sources have been measured.[19, 20] Two of these are of particular interest because of their intensity: Cygnus A located right ascension 19 deg 58 minutes and declination N 40 deg 30 minutes and Cassiopeia located right ascension 23 deg 21 minutes and declination N 58 deg 30 minutes. The flux density received from the celestial sources is given as

Cygnus A: $F = (100/f_{mc})^{1.2} \times 1.2 \times 10^{-22}$ w/ sq m/cps

Cassiopeia A: $F = (100/f_{mc})^{0.8} \times 1.7 \times 10^{-22}$ w/sq m/cps

Using Cassiopeia as a source of radio noise, the power from the antenna is

$$P_c = F\,G_aB$$

where P_c = power from antenna in watts, F = flux density from celestial source in watts/sq m/cps, G_a = effective antenna area in sq m, and B = bandwidth, cps.

This gives 12.3×10^{-21} watts/cycle for the Jodrell Bank antenna when pointed at Cassiopeia. This antenna has a 3-db beamwidth of 0.75 deg and gives a sharp rise in the output when it is swept past a celestial radio source. As the antenna was swept across Cassiopeia there was a rise of noise output of about 12 db, using the parametric amplifier. The celestial noise a few degrees off Cassiopeia is very low and can be considered negligible. Therefore the ratio of noise power referred to the input when the antenna is pointed at the radio source to that when the antenna is pointed into cold space is

$$R = (P_c + N_o)/N_o = [F\,G_aB + (NF - 1)\,kt_oB]/[(NF - 1)\,kt_oB]$$

where N_o = noise power referred to the receiver input from amplifier only, and P_c = noise power available from celestial source.

From this equation the noise figure can be written

$$NF = [FG_a/kt_o(R - 1)] + 1$$

Thus for a 12-db rise off Cassiopeia and using the 250-foot antenna

$$NF = [12.3\times10^{-21}/4\times10^{-21}(15.8-1)] + 1 = 1.2 \text{ (0.82 db)}$$

The parametric amplifier described improved the system noise performance at uhf from 617 K (4.94 db), which was produced with a low-noise vacuum tube preamplifier, down to about 167 K (2 db), effecting a signal-to-noise ratio improvement of 5.7 db. This improvement made possible the tracking of the space probe Pioneer V to a distance of over 22 million miles. The range was limited to this figure because of malfunction of batteries, limiting transmitter power output to about 5 watts.

For future parametric amplifiers, advances in low-loss packaged gallium arsenide and silicon varactors, circulators, isolators, and thermoelectric devices allow construction of stable parametrics from the uhf region through the high microwave. Using cooling techniques, noise temperatures of 20-50 K can be obtained and with thermoelectric devices no liquid coolant is needed.

Using varactor multipliers, solid-state pumps can be built which will produce tens of milliwatts of power up to high X-band, and with the negligible aging associated with semiconductors devices, good long-term gain stability can be achieved. With addition of feedback around the pump circuit, the amplifier gain can be held to better than 0.05 db an hour.

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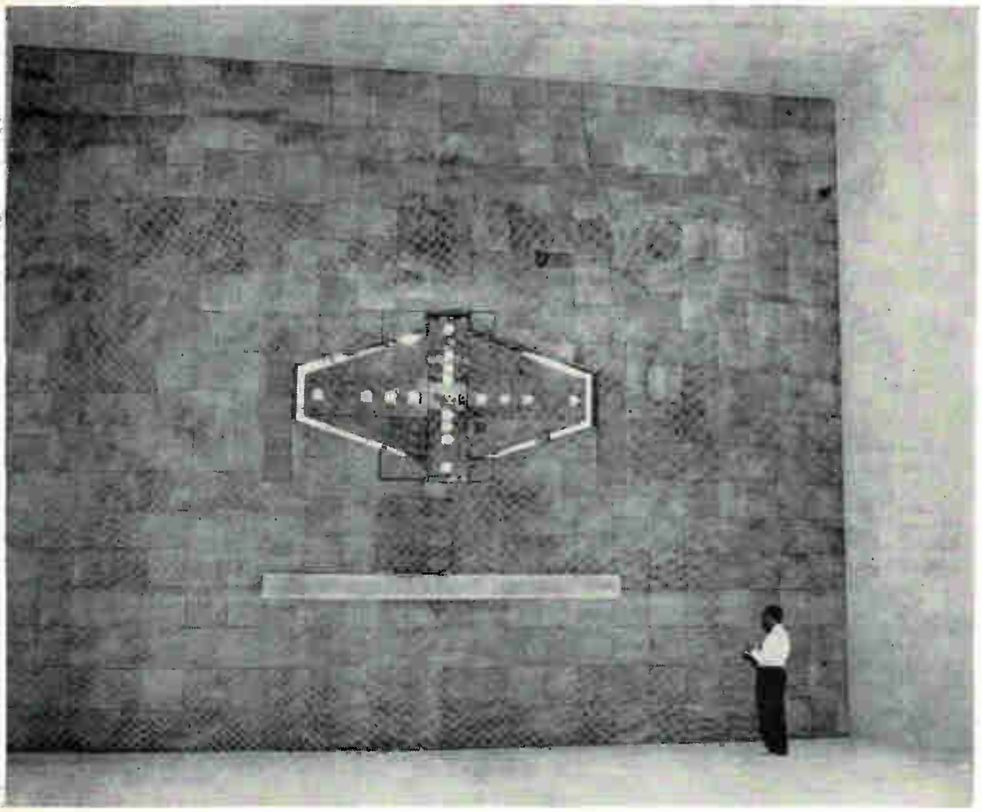
Precisely Aligning Doppler Radar

Doppler radar for the B-58 Hustler bomber determines velocity to within 0.1 percent. To obtain this precision, the plane's radar antennas are aligned to within 0.01 degree in the ground installation described



Anechoic tunnel and receiving horns. Measurements show that this tunnel achieves over 50-db attenuation of reflected energy

ADVANCES IN aircraft design improve range and velocity capabilities, but demands upon electronic equipment become increasingly severe. The high-performance B-58 Hustler bomber is an example of an aircraft with advanced capabilities that required new concepts of electronic equipment performance. For this bomber, a highly accurate doppler radar (the AN/APN-113) has been developed.

Using doppler information from six separate antennas (three transmitting and three receiving), this radar makes three independent measurements of aircraft velocity. From this information, velocity can be determined with respect to the longitudinal, transverse and normal coordinates of the aircraft.

With this radar, velocity must be determined to within 0.1 percent. To achieve such accuracy, it is necessary to maintain a rigid control of all the elements of the equipment that affect accuracy.

Among the most important factors is the precision to which the antenna beams can be aligned (boresighted) to predertermined angles. Velocity information depends upon computations using an assumed antenna alignment; consequently, any deviation from the theoretically correct alignment would result in an error in velocity indication.

After assigning achievable toler-

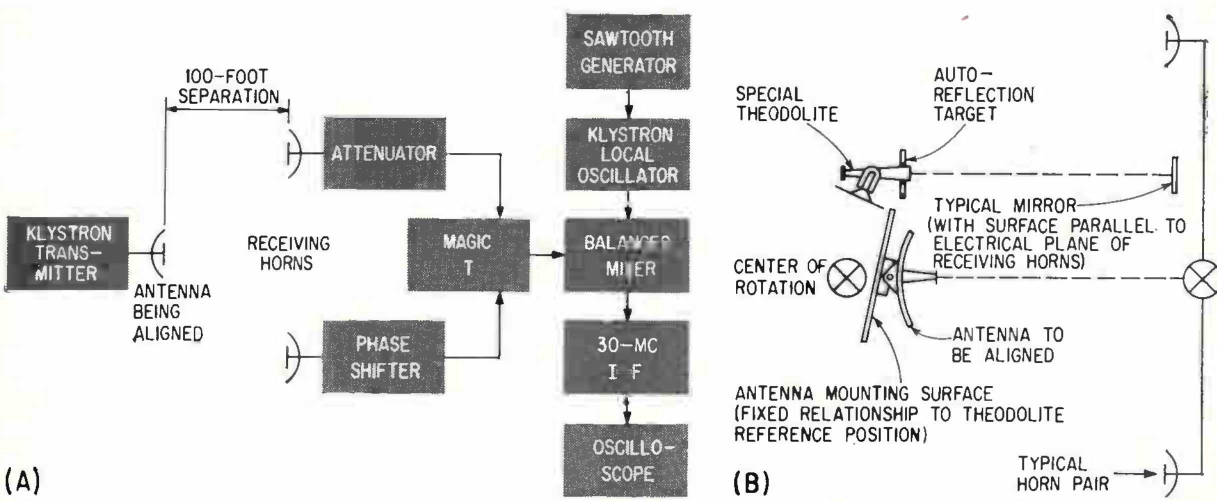


Diagram of electronics for antenna boresighting facility (A), and optical system employing autoreflection (B)

 By J. FRANK LANE, Design Section Manager, Airborne Equipment Operations, Equip. Div., Raytheon Co., Sudbury, Mass.

ances for all other sources of system error, it was established that the antennas must be aligned to an accuracy better than ±0.01 degree (36 seconds) to comply with system requirements.

When this problem was first considered several years ago the standard approach was to make no special effort to align the antennas with precision, but rather to apply compensation derived from flight tests with the complete system over an accurately calibrated course. After a series of test flights, the indicated and actual flight distances are compared and an equivalent calibration adjustment injected into the system to correct for the overall system error. This system of calibration, still in use, is costly and not altogether satisfactory.

Another method of developing calibration constants is to employ photogrammetric techniques. This involves taking photographs at regular intervals over accurately marked terrain. However, considerable data reduction time is involved and the method is not considered applicable to calibration of production systems. Attention was therefore directed to boresighting schemes that would align antennas on the ground with the necessary accuracy.

Although physical measurements can be made to permit mechanical adjustments of the parabolic antenna reflectors to an accuracy better than 0.01 degree, the alignment problem is complicated because we cannot be certain that the mechanical and electrical axes of alignment will coincide. In the ideal case, they will be the same; however, seemingly insignificant asymmetries in the antenna reflector or feed position could cause an excessive distortion of the radar beam. Consequently, a combination electrical-optical rather than a purely mechanical alignment must be made.

As conventional methods of pattern measurement are not sufficiently precise for this application, an interferometer technique was decided upon. In this method, the microwave energy radiated by the antenna is received in spaced pairs of receiving horns mounted in a cruciform configuration. The amplitude and phase of the signals received at each horn pair are compared by null detection.

Figure A shows a block diagram of the electronics for the boresighting operation. The functions shown are duplicated for each of four pairs of horns mounted horizontally and four pairs mounted vertically. The outermost horns are spaced about 13 feet apart. The signals received at each matched pair of horns are applied to magic T's. The difference signals from the T's, together with the output from a klystron local oscillator, are applied to balanced detectors. The local oscillator frequency is varied by a saw-tooth generator so that the output of the 30-Mc i-f amplifier varies in amplitude as the signal is swept through the i-f bandpass. The peak amplitude is proportional to the received signal strength which is related to the signal unbalance from the two receiving horns. The i-f output, then, can be detected and used as a measure of the relative alignment of the antenna under test and the receiving horns. The detected output is presented on an oscilloscope with the sweep synchronized with local oscillator sweep, so operator can adjust for an amplitude null.

Great care must be taken in initial calibration of the boresighting facility to insure that the microwave circuits for each horn pair are balanced with respect to attenuation and phase shift. Attenuation must be balanced within approximately 0.01 db so that measurement of the beam center will not be biased excessively.

The parabolic antennas used in the AN/APN-113 have a symmetrical pattern. Therefore, one horn pair in the vertical axis and one in the horizontal axis theoretically could define the beam power center of gravity. Occasionally, minor asymmetry, due to mechanical imperfections in the antenna, can be detected with additional horn pairs. When a null is observed with one pair of horns, it can be checked on the other pairs. If alignment need not be changed in switching from one pair to another, beam is symmetrical.

Since the antennas being aligned are not mounted concentric with the axis of rotation of the movable test stand on which they are mounted, the receiving as well as the transmitting test stands must be rotated to obtain the proper null. Rotation of the transmitter stand is characterized by a change in amplitude of the received signal, whereas rotation of the receiver stand causes principally a change in phase. Nulls will be observed at multiples of a wavelength as the receiver stand is rotated. These ambiguities can be resolved by the use of the additional horn pairs. When a null is detected on one pair of horns, it may be checked on another. If the stands do not have to be repositioned to obtain a null when using different horn pairs, the correct null has been selected.

One of the inconveniences of antenna boresighting is the large facility required. If it were necessary to define the complete radiation characteristic of the antenna, the antenna being tested and the detection equipment would be separated by an approximate distance of $2D^2/\lambda$ where D is the aperture dimension. In our application this would be roughly 150 feet.

However, the alignment requirements for the AN/APN-113 can be satisfied by determining the power center of the beam. Provided symmetry of the beam is not distorted excessively, we can establish this power center by measurements made much closer than 150 feet. Theoretical and empirical studies indicate that a separation of about 100 feet is acceptable. Physical and optional instrumentation limitations restrict further separation.

In making the necessary microwave measurements to determine the power center of gravity of the beam, it is imperative that reflections from the ground or other objects be attenuated sufficiently so that beam symmetry will not be affected significantly. Reflected energy must be attenuated at least 45 db from the desired signal to insure satisfactory alignment.

This isolation from reflections can be achieved by mounting the two boresight stands on top of towers to remove them from ground effects. Towers, however, suffer from a number of drawbacks (swaying, weather effects, etc.). Another method is to construct an anechoic tunnel to enclose the separation between the two stands.

The new Raytheon antenna boresighting facility at Sudbury, Massachusetts uses a microwave absorbent tunnel. The entire structure is enclosed in a 6,800-square-foot building with close control of temperature. To eliminate build-up of air layers, the forced convection heating system encircles the outside of the anechoic tunnel in rotating currents of air.

The anechoic tunnel (photo) was designed especially for this application and uses Eccosorb CV-6 and FR-330 as microwave absorbers. These are made from light-weight, artificial dielectric loaded foam. The tunnel length is 100 feet and has a maximum cross section of 45 feet by 35 feet. A recent series of measurements show that the tunnel achieves over 50-db attenuation of reflected energy.

To achieve the extreme precision of alignment required, the pedestal upon which the antenna to be aligned is mounted must be capable of precisely controlled, fine increments of rotation in both azimuth and elevation. To insure freedom from vibration, the stand is mounted on reinforced concrete mats supported by pilings extending down to refusal (50 feet).

The main drive for the pedestal is almost completely devoid of gears to minimize wear and backlash. A separate vernier drive can move the stand at a rate as slow as 0.05 degree per minute. The pedestal can be positioned in increments less than 0.001 degree with essentially no backlash. The receiver stand is similarly equipped.

The first step in boresighting is to mount the antenna to the transmitter stand with a known relationship between the antenna mounting points and the optical reading system. The transmitter and receiver stands are then positioned to the theoretically correct angles at which a null should be observed. Since the initial reflector position is established by a mechanical measurement, it is unlikely that a null will be observed at this point. However, the settings will probably be correct within 0.1 degree. This establishes the initial position of the stands within reasonable limits, so that precise vernier adjustments can be made thereafter.

Next, the transmitter and receiver stands are adjusted alternately until a null is observed. These readings are compared with the theoretically correct angles, and and adjustment is made to the reflector in a direction to reduce the error. This process is repeated as many times as necessary in a converging series until the null occurs within an acceptable tolerance of the correct alignment. The parabolic reflector is then locked in position, after which the readings are rechecked to insure that alignment has not been disturbed. This process is only as accurate as the precision with which we can establish the relative angular relationships. Two different methods of optical instrumentation are employed at Raytheon's two B-58 doppler radar boresighting facilities. The first method has been in use for about four years. A slightly more accurate yet simplified system is used at the recently completed facility at Sudbury, Massachusetts.

In the original optical system, the theory of operation in determining the relative position of the antenna test fixtures involves an initial set-up to establish a zero position and position reading from fixed datum lines in space. The initial set-up involves positioning the antenna mounting fixtures and the receiving horns on the test stands in planes swept by penta prisms fastened to alignment telescopes mounted on each stand. This locates the fixture elements in planes at right angles to the lines-of-sight of the telescopes. Next the telescopes are aligned by moving the transmitter and receiver stands until a common line-of-sight exists between the telescopes. This places the transmitter and receiver fixture faces parallel to each other. Under these conditions, true azimuth and elevation angles are read for both the transmitter and the receiver. These readings are recorded as the zero positions.

After the zero position of the stands has been determined, the transmitter and receiver stands are adjusted alternately until a null is detected. The angular alignment is then read and compared with the theoretically correct angles.

The optical system in use at the new boresighting facility (Fig. B) not only eliminates some sources of error, but is simpler to operate as well. The original method requires four zero readings and four position readings obtained on four separate instruments. The new method requires only two zero and two position readings, all obtained on a single instrument.

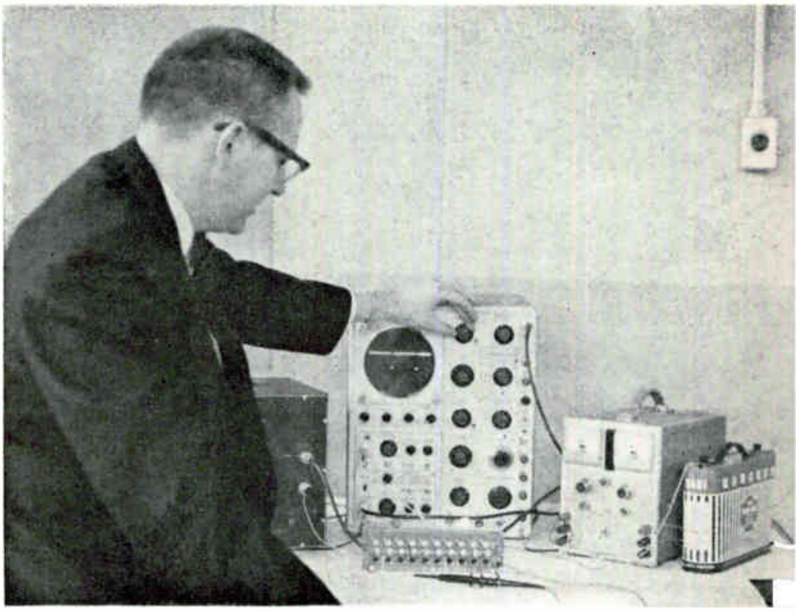
The principal of autoreflection is used. Mirrors are positioned on the receiver cruciform and aligned to the plane of the horns. A direct-reading theodolite is fastened to the main frame of the transmitter stand so that a constant known relationship is maintained between the theodolite axes and the mounting surface for the antenna. Zero position is established initially by autoreflection between the transmitter and receiver stands. This zero position does not have to be determined for each antenna to be aligned. A null is obtained in the same manner as with the system previously described and the angles are read directly on the theodolite after autoreflection.

With the new optical system, perfect vertical and horizontal traverse of the stands is no longer necessary. Also, references to ground for azimuth readings and to gravity for elevation readings have been eliminated.

The B-58 doppler radar boresighting facility has been evaluated through carefully controlled flight tests of the AN/APN-113 over photogrammetric ranges. Results indicate that the doppler radar is meeting its accuracy requirements. We can conclude that the boresighting method results in antenna alignment to the high degree of precision required.

Raytheon is producing navigational and search radars under subcontract to Sperry Gyroscope Co. which is producing the doppler inertial navigation system for the Convair B-58.

Ring Counter Uses Transistors



Oscilloscope is adjusted in test of ten-stage ring counter

Current response curve of the bistable circuit resembles the current response of a thyratron. Each stage of the counter uses three transistors, four resistors, two diodes and no capacitors

By JOSEPH A. PECAR,
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THE BISTABLE circuit in a transistorized thyratron ring counter (TTRC) is a refined configuration. Figure 1A shows the schematic of one of the bistable circuits in the TTRC. Each circuit consists of two opposite-symmetry germanium transistors, two diodes and four resistors. A single description, applicable to all the operating conditions of any switching circuit, is difficult. Therefore, the explanation of the operation of the bistable circuit used in the TTRC is given in three parts corresponding to the following conditions: (1) the non-conducting or cutoff conditions, (2) the transient condition and (3) the fully conducting or ON condition.

In the non-conducting condition, by assuming e_{IN} is zero, no current can flow anywhere in the circuit. The +6 and −6 v supply voltages, in addition to being collector supplies, also hold in cutoff, the *pnp* and the *npn* transistors, Q_1 and Q_2. This reverse-biasing technique employed in transistor switching circuits is necessary if the resulting design is to possess temperature stability.

As indicated in Fig. 1A, I_{co}, the reverse thermal current that flows in the base circuit, always tends to turn the transistor on. The actual amount of thermal current flowing at a given time is directly proportional to the ambient temperature. Therefore, if the cutoff condition is to be insured at elevated temperatures, a reverse-biasing technique must be used. With the bias voltages and impedance values given in Fig. 1A, the elements are theoretically stabilized for temperatures in excess of the crystallizing temperature of germanium.

In the cutoff condition, the base of Q_1 and the collector of Q_2 are at +6 v. Similarly, the base of Q_2 and the collector of Q_1 are at −0.2 v. Under these conditions the diode joining the collectors is reverse-biased and, for the purposes of analysis, can be considered as not in the circuit.

In analysis of the transient condition, for a current to flow in the element, e_{IN} must be increased from zero to slightly more than 6 v. At this point the base-to-emitter junction of Q_1 becomes forward-biased and collector current will flow. Transistor Q_2 will not begin conduction, however, until e_{IN} is increased to a value that causes the reverse-bias current flowing in R_3 to be balanced by the collector current in Q_1. When e_{IN} has reached this value, Q_2 begins conduction and both base and collector current flow. The collector current in Q_2 reduces the base voltage of Q_1 to about 2 v, causing it to conduct an increased amount of current. Under these conditions, the collector current of one transistor is effectively the base current of the other. This results in a very high loop gain and allows the transition from the cutoff condition to the fully ON condition to occur in an extremely short time.

It is apparent that both transistors are driving each other to the conducting state. This action is made possible by opposite-symmetry transistors. It is impossible to arrange two vacuum tubes with positive feedback so that each drives the other into conduction simultaneously. This is one inherent advantage in transistor circuits that results in more rapid switching characteristics.

In an analysis of the conducting

condition, if the collector-to-collector diode were removed from the circuit, once conduction was started, the transistors would drive each other into saturation, with saturation defined as that condition whereby the base-to-collector junction of a transistor is forward-biased.

Transistors in saturation can be considered practically as circuit nodes. Therefore, under these postulated conditions, the current I_e is proportional to e_{IN} and limited practically only by the parallel combination of R_1 and R_2, and the source impedance of e_{IN}.

Without the diode, the circuit would be bistable; however, the rate at which the circuit could be switched from conducting to non-conducting conditions would necessarily be slow. This follows from the fact that transistors in saturation exhibit storage-time effects. In other words, once a transistor saturates, it acts as a charged capacitor and must be given time to discharge through the associated circuits. The diode in the bistable circuit acts as an anti-saturation device, which simultaneously prevents both transistors from saturating. To understand how this is accomplished, refer to Fig. 1A. Assuming that potential e_{IN} is high enough to cause the circuit to conduct, there will be a voltage drop across R_1 in the direction indicated. When the circuit is conducting, the diode is forward-biased and therefore can be considered a low impedance between collectors. If the forward voltage drop across the diode is small in comparison with the drop across R_1, then the base-to-collector junction of Q_2 must be reverse-biased. A similar analysis can be made regarding Q_1, showing that it is simultaneously prevented from saturating as the circuit is caused to conduct current.

As a result of including this anti-saturation device, the turn-off time of the bistable circuits can be greatly reduced. This effectively increases the frequency response of the circuits, making them suitable choices for use in a high-speed ring counter.

Figure 1B is a plot of e_{IN} against I_e for the three conditions discussed. There is a similarity between this curve and the current response of a gas-filled thyratron.

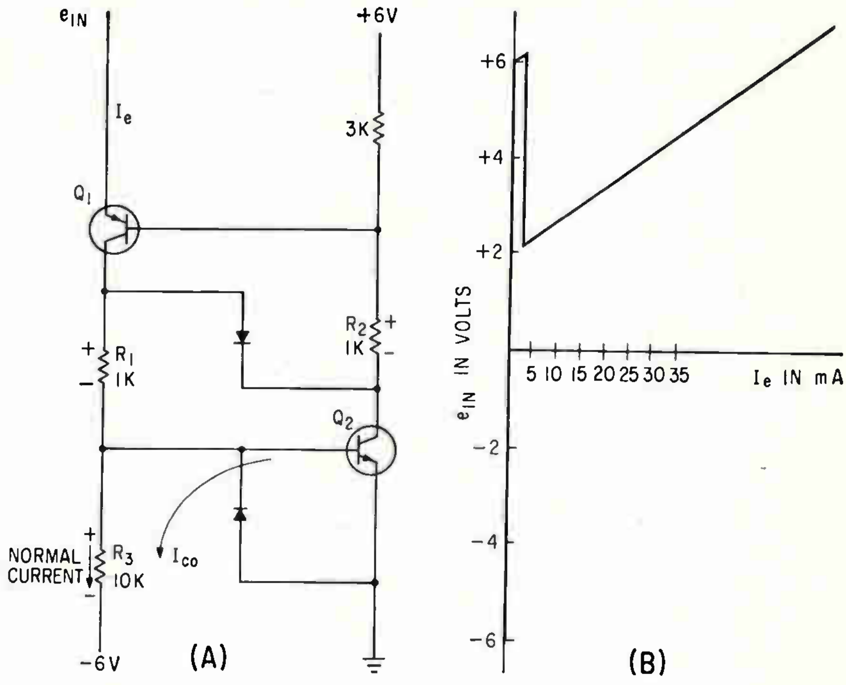

Fig. 1—Basic bistable circuit (A) and its current response curve (B)

This similarity is responsible for the description of the resulting ring counter as a transistorized thyratron ring counter.

The circuit diagram of the complete TTRC is presented in Fig. 2. The supply voltage and ground connections are common for all the bistable circuits. Likewise, the terminals to which e_{IN} has been applied are also connected to a common bus and returned through a 5,100-ohm resistor to a potential of 12 v.

Each stage in the TTRC consists of a bistable circuit and an additional transistor. This transistor transfers the conducting stage from one position to the next succeeding position. However, in the absence of a transfer pulse, these transistors are ineffective.

The base of the additional transistor Q_3 of stage 1 is either at +2 or +6 v, depending on whether the stage is conducting or non-conducting. In the absence of a transfer pulse, the emitter of this transistor is at some minus potential E. The collector voltage is bi-valued and can be either −0.2 v, if stage 2 is cutoff; or +0.2 v if stage 2 is conducting. Therefore, in the absence of a transfer pulse both the base-to-emitter and the base-to-collector junctions of the transfer transistor are reverse-biased. Therefore, the operation of the bistable circuits is not affected by the addition of the extra transistor except during the transition of an ON stage from position to position.

The following is a discussion of the TTRC in the energized state, but in the absence of any transfer pulses. As the supply voltages are switched on, normally one of the bistable circuits will begin conduction and the others will remain cut off. That one of the stages must begin conduction can be seen from Fig. 2. When the potential between ground and the emitter of the Q_1 of the bistable circuit exceeds 6 v, the circuit instantly assumes a fully-conducting condition. Therefore, when 12 v is applied through resistor R_1, at least one stage must become conducting. Figure 1B shows that the minimum voltage to sustain conduction is about 2 v. Under this minimum voltage condition, each bistable circuit draws about 2 ma. Since it is impossible, under any circumstances, for the current through resistor R_1 to be greater than 2.35 ma, only one bistable circuit can conduct at a given time. If no special preset circuit is employed with the TTRC, the stage that becomes conducting when the power supplies are turned on is strictly a random process depend-

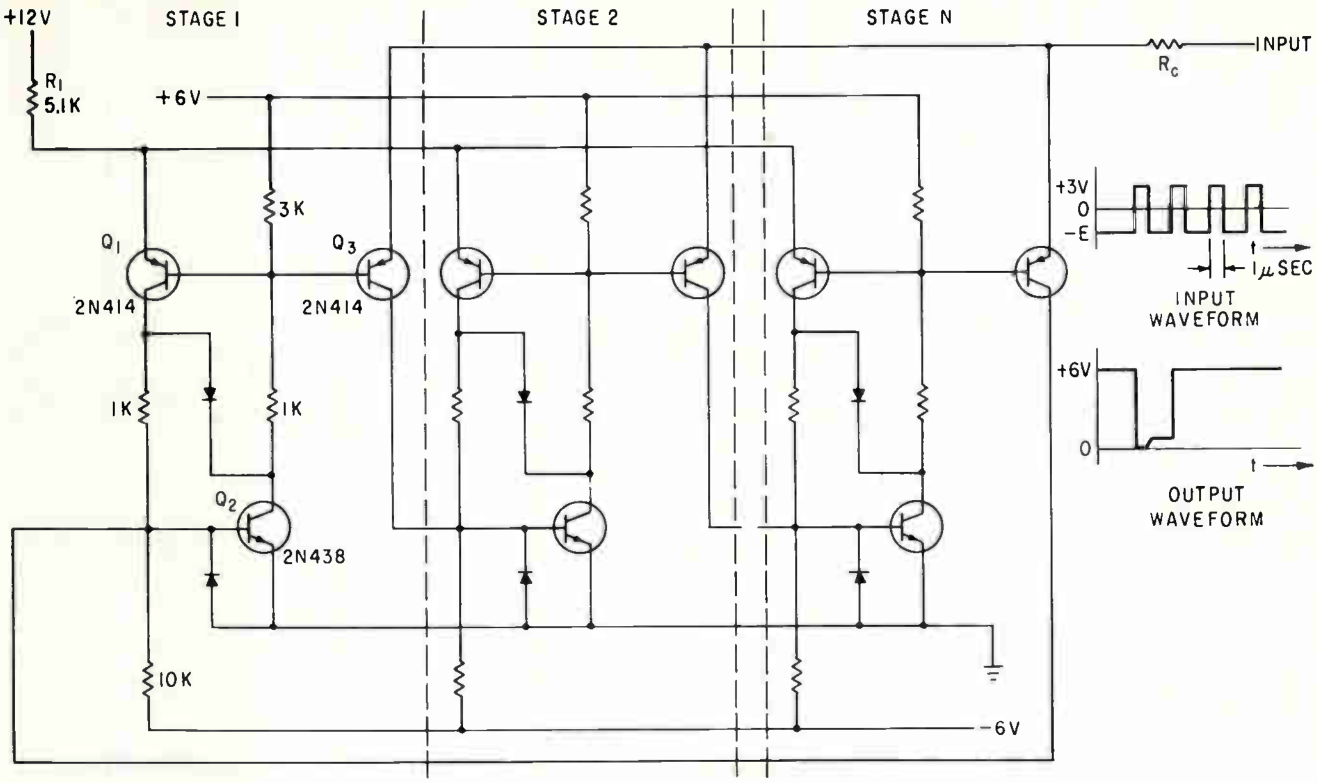

Fig. 2—Schematic shows three stages of the ring counter with input and output waveforms

ent upon the individual characteristics of the bistable elements involved.

Once energized, one stage of the TTRC must be conducting while all the remaining stages must be non-conducting. This complies with one of the prerequisites of any ring counter: only one stage can be conducting at a time.

The final part of the theory regarding the TTRC involves a description of the method in which the conducting stage is switched from position to position. Referring to Fig. 2, assume that the circuit is energized and that the bistable circuit of stage 1 is conducting. Under these conditions the base regions of both Q_1 and Q_3 in stage 1 will be at about +2 v. These same terminals on the remaining stages are at +6 v. As a consequence of this difference in voltage levels, a transfer pulse with a maximum amplitude of 3 v will cause current to flow only in the transfer transistor of stage 1. The amount of current flowing in the transfer transistor of stage 1 when a transfer pulse occurs is essentially limited only by the internal impedance of the pulse generator and the current limiting resistor R_c.

The collector of the transfer transistor is connected directly to the base of transistor Q_2 of stage 2. The anti-saturation circuit of stage 2 is bypassed by this connection. As a result, practically all the emitter current of the transfer transistor is available as base current for Q_2 of stage 2. It is possible, therefore, by proper selection of the current limiting resistor R_c, to drive Q_2 of stage 2 into saturation with the application of a transfer pulse. This is true only if the bistable circuit of stage 1 is conducting previous to the application of the transfer pulse.

The application of the transfer or shift pulse to the TTRC instantaneously causes a second bistable circuit to become conducting. This added current that flows through R_1 reduces the input voltage to all the bistable elements below the minimum level required for conduction. Therefore, all of the stages attempt to be non-conducting. The stage in which Q_2 was driven into saturation cannot become non-conducting as fast as the remaining stages, and remains ON.

In essence, the shift pulse turns on a succeeding stage which in turn causes the preceding stage to be non-conducting. Thus, the switching of the ON position from stage to stage is accomplished by taking advantage of the storage time of a transistor, a characteristic normally thought of as a disadvantage.

Since this transition occurs in a short interval of time, a discrete shift pulse is required. If the pulse width of the transfer pulse exceeds 1 μsec, multiple stage switching will take place.

As the transfer pulse diminishes, the anti-saturation circuit of the stage that had been in saturation, again becomes effective. The resulting output waveform, which is available at the collector of any of the Q_2 transistors, is shown in Fig. 2. The extension at the bottom of the waveform is due to the particular bistable circuit saturating under the influence of the transfer pulse. As the transfer pulse passes, the bistable circuit pulls out of saturation.

The advantages of the TTRC are: high-speed operation (no capacitors); high current driving capacity (output taken from a saturating transistor); theoretically unlimited number of stages because no bias current is required from the ON stage to keep the remaining stages cut off; backward-forward type of operation where desired; and either symmetry configuration may be used, producing either a negative or a positive-going output waveform.

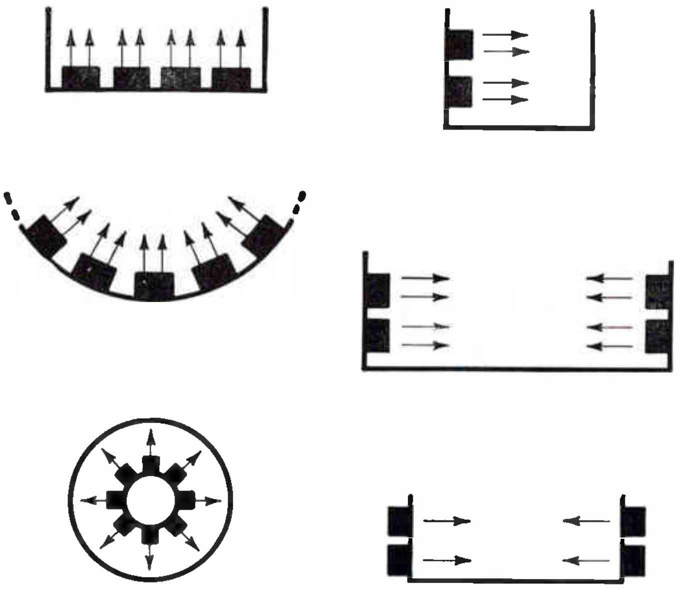

FIG. 1—*Transducer tank configurations (upper four—Branson; lower left—Turco; lower right—Gulton)*

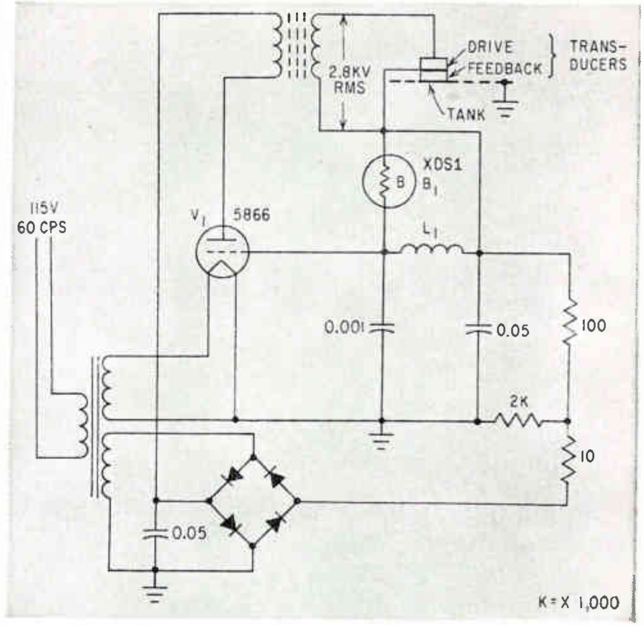

FIG. 2—*Self-tuned ultrasonic generator powers bank of drive transducers in cleaning tank (Powertron)*

Ultrasonic Equipment in Industry

Lists data on characteristics and performance of equipment used in high-power and low-power applications of ultrasonics

By SY VOGEL, Associate Editor

THIS ARTICLE describes complete equipments that use ultrasonic energy for industrial purposes. Table I lists typical equipments that develop high-power ultrasonic energy. The limited space available precludes the listing of all ultrasonic equipment currently being manufactured.

The sketches in Fig. 1 show some typical transducer configurations in cleaning tanks.

Figure 2 shows a self-tuned generator that powers a drive transducer. Current from the feedback transducer goes through ballast lamp B_1, keeping oscillator V_1 tuned despite changes in load, temperature and liquid level.

The output waveshapes typical of ultrasonic generators are shown in Fig. 3A. Figure 3B compares the cleaning actions of these waveshapes, each waveshape having an average power of 3 watts per sq in. At low power levels, pulsed wave-

TABLE I—HIGH-POWER ULTRASONIC EQUIPMENT

Application	Typical Freq in Kc	Transducers	Tuning	Range of Available Power in Watts [a]	Miscellaneous Information
Cleaning	20, 21, 25, 28, 30, 38, 40, 90	M, BaTi, PbZrTi, P [b]	manual, automatic	35 (¼ gal) to 3,000 (75 gal) (average)	Most units give pulsed, rather than unmodulated power; pulsed units give 2 or 4 × the peak power; most generators are tube-type, some are semiconductor; percent of bottom covered by transducers differs greatly from unit to unit
Drilling	20, 25	M, PbZrTi	manual, automatic	50 to 2,400 [c]	Can machine to about 0.0005-in. tolerance, finish to 10-μin, in roughing operation; special tooling cuts to 5-in. depth; possible to set up drill as limited-area cleaner
Welding	18, 20, 38, 40	M, PbZrTi	manual, automatic	10 to 4,000 (average)	Typical 2-Kw unit welds up to ¼-in. diam, has welding efficiency of 90 percent; afc units have no significant freq shift when clamping force is applied to weldments; welding freq have been 100 Kc or higher
Soldering	20, 38, 60	M, PbZrTi	manual	10 to 100 (average)	Most portable soldering irons have line-powered heaters; transducers generally Ni or Ni alloy; CoFe [d] also used

(*a*) Powers listed are for units which are among the smallest and largest of available standard units; (*b*) magnetostrictive, barium titanate, lead zirconate titanate, piezoelectric; (*c*) probably average watts; (*d*) cobalt iron

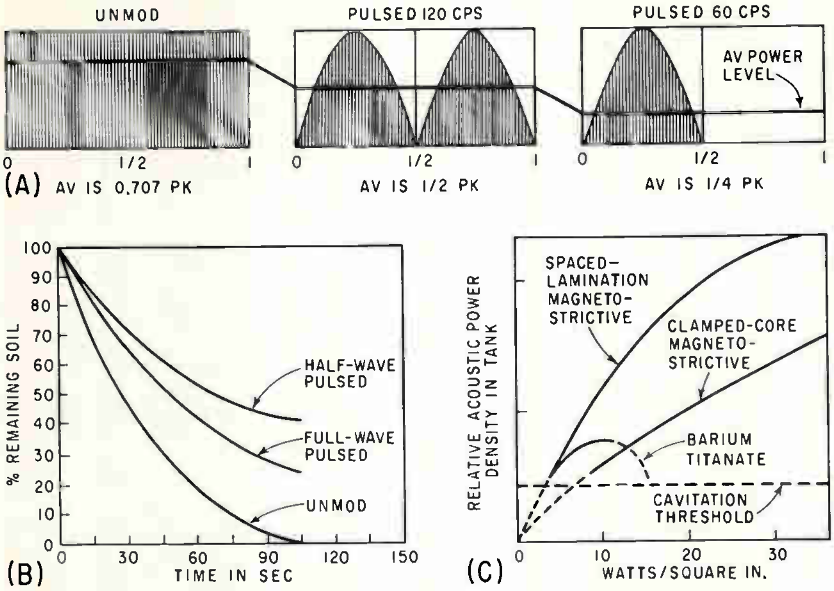

FIG. 3—Waveshapes in (A) compare unmodulated and pulsed generators for same peak power; cleaning is compared in (B) for these waveshapes. Curves of (C) compare transducer efficiencies (Westinghouse)

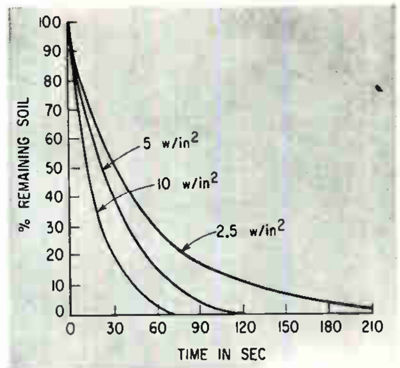

FIG. 4—Effect of increased intensity on cleaning (Westinghouse)

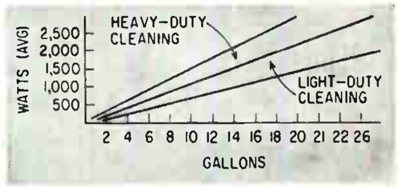

FIG. 5—Guide to required cleaning power (Powertron)

shapes clean faster than the unmodulated waveshapes; this is not shown in the curves.

There is no universally accepted standard of evaluating transducer conversion efficiencies; the Ultrasonic Manufacturers Association has a committee working on this problem. Figure 3C gives transducer acoustical output curves plotted against frequency.

Increased power density improves cleaning (Fig. 4); however, some experiments have indicated that power greater than 200 watts per gallon is wasted energy except in special cases.[1]

Most, if not all, manufacturer's ratings of ultrasonic cleaners fall in the ranges shown in Fig. 5. Although there is general agreement as to what constitutes adequate power into the transducer for heavy, moderate and light cleaning, there is as yet no universally accepted standard for evaluating over-all cleaning performance. Table II lists methods used to evaluate cleaning performance.

Figure 6 shows two setups for ultrasonic drilling. Multiple ultrasonic-transmission lines deliver energy to several cutting tools in Fig. 6A; in Fig. 6B, the drilling tool is mounted on an antinodal point of the tool holder and the workpiece, made of a hard material such as tungsten carbide, is rotated to drill a thread in the workpiece.[2]

Ultrasonic-welding techniques are

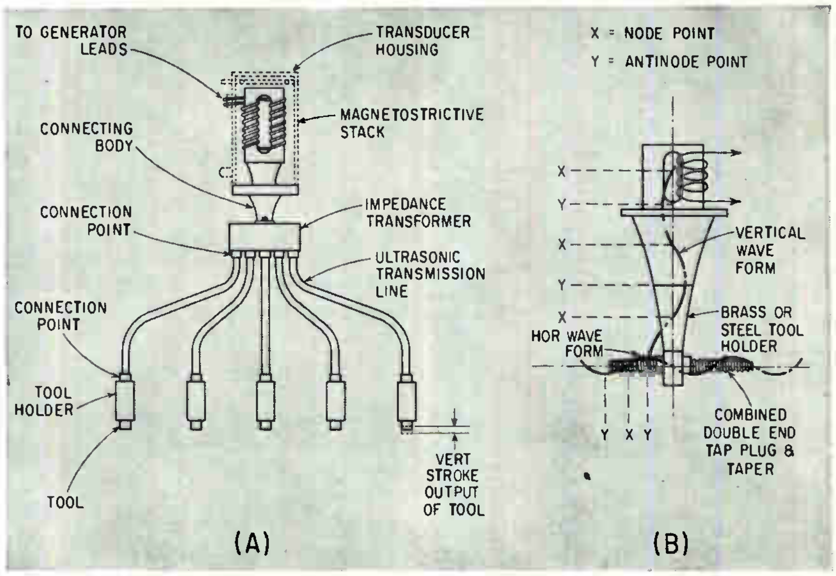

FIG. 6—Multiple-drilling (Sheffield-A) and tap-drilling (Mullard-B) arrangements

TABLE II—METHODS OF EVALUATING SONIC CLEANING

By DR. T. J. BULAT, Bendix Corp., Davenport, Iowa

Method	Relative Accuracy	Advantages and Disadvantages	Relative Equipment Expenditure
Visual	Good to 100 μ	Cannot inspect hidden areas.	None
Microscopic	Good to 1 μ	Cannot inspect hidden areas. Field of examination is limited.	Moderate
Ultraviolet Light	Limited	Cannot inspect hidden areas. Limited to substances which fluoresce.	Low
Gravimetric	Good to 1/100 of a mg	Only good for relatively small parts. Difficult to control.	High
Water Break	Good	Surfaces to be tested must be flat. Effective only on organic contaminants.	None
Water Spray	Good	Same as for Water Break.	None
Chemical Tests	Excellent	Limited to contaminants of a specific chemical nature.	Moderate
Radioactive Tracers	Excellent	Probably best artificial test; requires highly-specialized personnel and equipment	High
Light Reflectance	Poor	Varying distribution of contamination is easily misinterpreted.	Moderate
Graphite on glass (Ceramic)	Good	Strict standardization of the contaminant and its environment must be maintained.	Low
X-ray	Good when applicable	Limited in scope, only solid contamination can be determined. Specially-trained personnel necessary.	High
Lead Erosion	Poor	Not directly related to cleaning	Low
Functional Tests (Electrical-Mechanical)	Excellent	Only applicable where assembly or part can undergo sufficient number of functional tests.	Moderate
Surface Conductivity	Excellent	Good only on small parts. Environmental conditions are critical. Not effective on gross contamination.	Moderate

TABLE III—WELD COMBINATIONS

	AL	BE	CU	FE	MG	MO	NI	TA	TI	W	ZR
ALUMINUM & ALLOYS	●	●	●	●	●	●	●	●	●		●
BERYLLIUM & ALLOYS		●							●		
COPPER & BRASS			●	●		●	●		●		●
IRON & STEEL				●		●	●		●	●	●
MAGNESIUM & ALLOYS					●						
MOLYEDENUM & ALLOYS						●	●	●	●	●	●
NICKEL & ALLOYS							●		●		
TANTALUM & ALLOYS								●			
TITANIUM & ALLOYS									●		
TUNGSTEN & ALLOYS										●	
ZIRCONIUM & ALLOYS											●

being used to bond many materials. Table III shows some of the many combinations which have been made.[3] Blank spaces in this table do not necessarily mean that these combinations could not be made. Typical strengths of welds are shown in Table IV.[4] The 90-percent confidence intervals are the ranges of weld strengths in which 90-percent of the welds fall. Figure 7 shows how ultrasonic welding compares with resistance welding.

Larger powers are required for welding increased thicknesses, as indicated in Fig. 8.[5]

Figure 9 shows the block diagram of an afc ultrasonic welder. The capacitance pickup, which is mounted at the end of the welding horn, senses the horn's vibrations and feeds back an afc signal that shifts the oscillator frequency to the horn's resonant frequency.[6]

Figure 10 shows some of the many welding arrangements that are possible.

The same limitations discussed above for Table I apply to Table V, which lists equipments that use relatively little ultrasonic power. Flaw-detection units can detect thickness and thickness gages can detect flaws, but generally, each unit performs best in one of these functions.

Ultrasonic therapy has been helpful in treating a great many ailments; among these are asthma, arthritis, bursitis and muscular sprains. Since there are no cumulative effects and since a person would feel considerable pain before receiving a dangerous dose, it is perfectly safe to work around ultrasound and to receive ultrasonic therapy (see *Notes on Dosages*).[7]

The author greatly appreciates the help of S. Bagno of Walter Kidde and Co., Dr. Claus Kleesautel, Dr. T. J. Bulat, and other workers in ultrasonics.

TABLE IV—TYPICAL STRENGTHS OF SINGLE-SPOT WELDS

Material	Type	Sheet Gage (in.)	Tensile-Shear Strength [a] (lb)
Aluminum	2024-T3 Bare	0.063	1,290 ± 60
Aluminum	2014-T6	0.063	1,310 ± 120
Aluminum	2020-T6	0.040	1,240 ± 50
Aluminum	7075-T6 Alclad	0.050	1,540 ± 90
Mild Steel	1020	0.020	500 ± 20
Stainless Steel	Type 301	0.025	1,040 ± 70
Stainless Steel	17-7 PH	0.020	668 ± 110
Molybdenum	Powder Metallurgy	0.025	430 ± 50
Molybdenum	Arc Cast	0.025	360 ± 40
Inconel		0.010	170 ± 70
Inconel		0.020	220 ± 105
Titanium	A-110AT (5 Al-2.5 Sn)	0.028	1,950 ± 120
Titanium	C-120AV (6 Al-4 V)	0.025	1,230 ± 60
Titanium	C-110M (8Mn)	0.032	1,730 ± 200
Zircaloy-2		0.020	615 ± 20

((*a*) Average value with 90 percent confidence intervals.

NOTES ON ULTRASONIC THERAPEUTIC DOSAGES

Ultrasonic energy over 3 w per sq cm may be hazardous; below this level it is nearly always safe.

Studies on animals show more than 5 w per sq cm can achieve destructive effects.

Therapy stems from heat, mechanical and chemical effects of ultrasonics on the body.

Most clinical dosages are less than 2 w per sq cm.

Typical clinical dose has between 0.3 and 1.5 w per sq cm.

Patient would almost always feel (and complain) of considerable pain before dangerous dosage level would be reached.

Guide to intensity for a frequency of 1 Mc and a radiation area of about 5 cm: weak intensity—0.1 to 0.6 w per sq cm; moderate—0.6 to 1.0 w per sq cm; strong—1.0 to 1.5 w per sq cm. Weak stimuli increase physiological activity and very strong stimuli inhibit or abolish activity. Weak intensity used for extremely acute condition and treatment about the face. Moderate intensity used for subacute condition; moderate intensities used in large majority of therapy cases. Strong intensity used for extremely chronic or deep-seated conditions.

Time of dosage: 4 to 8 min is average; hospitalized patients—daily, outpatients—2 or 3 times a week. Total number of treatments: 10 to 12 as required. If further treatment is necessary, wait 2 weeks and start another series (of 10 to 12 doses).

Precautions: avoid eyes and areas of malignancies or areas where skin suffers from sensory impairment, undertreat heart cases, avoid heart areas and pregnant uteruses

COMMENTS ON NOTES ON ULTRASONIC THERAPEUTIC DOSAGES

Ultrasonic intensities below 3 w per sq cm are not always safe; they are only safe if the treatment head is moved sufficiently fast over the skin. Thus, 2 w per sq cm and 5 w per sq cm can be perfectly safe if the treatment head is moved slowly for 2 w per sq cm and moved fast for 5 w per sq cm.

All therapeutic effects of ultrasound are complex—even the thermal effects. Ultrasonics produces selective heating; hence, under normal conditions, bone tissue is heated much more than the soft tissue. This fact is important in treating ailments that are related to the bones.

A patient would feel pain when a dangerous level is reached, and not before. According to the pathological condition of the patient, pain sometimes may not be felt, even if the exposure is excessive, because the pain-indicating mechanism of the body is impaired. On the other hand, pain may be felt for limited exposures if the patient has a painful condition.

Ultrasonic specialists do not completely agree on dosages. What some consider strong, other consider as weak. Since there are no cumulative effects caused by ultrasonic treatment, it is difficult to prove what constitutes a strong dose

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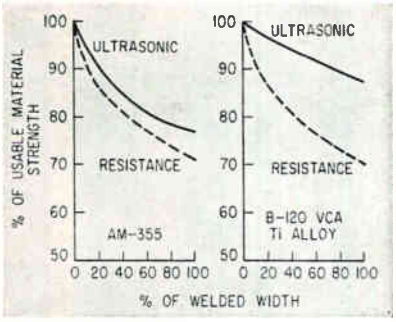

FIG. 7—Comparison of ultrasonic and resistance welds (Aeroprojects)

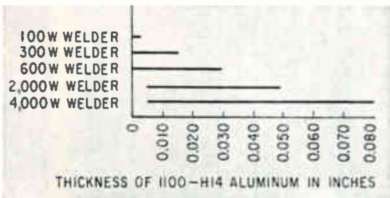

FIG. 8—Comparison of welder capabilities; weld strengths meet MIL R 6858A (Aeroprojects)

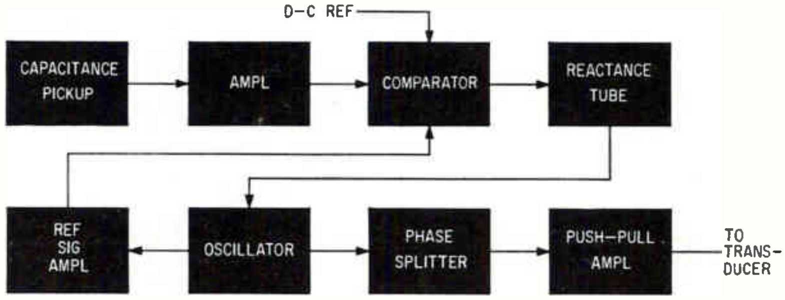

FIG. 9—Self-tuning welder (Gulton)

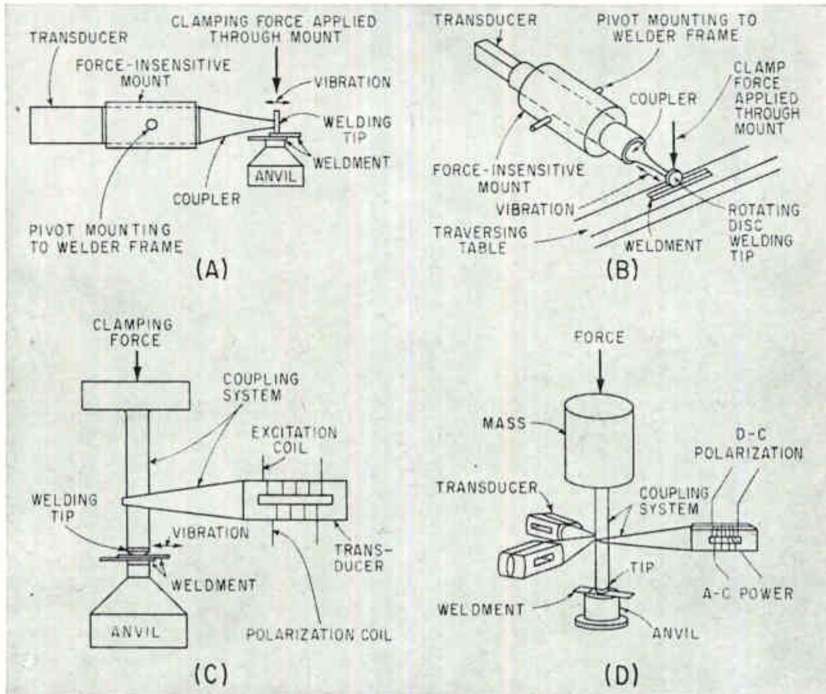

FIG. 10—Lateral-drive (A), continuous-seam (B), wedge-reed (C), and ring welding systems (Aeroprojects)

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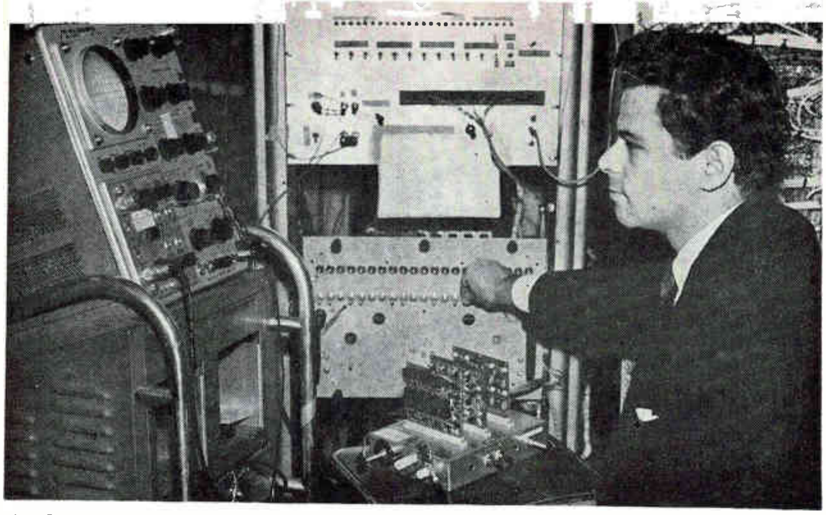
TABLE V—LOW-POWER ULTRASONIC EQUIPMENT

Application	Typical Frequencies	Transducers	Characteristics of Equipment
Flaw detection	0.1 to 10 Mc	Quartz, BaTi [a]	Generally are pulse-echo type: typically, can find between 2 in. to 40 ft in steel; some have fixed freq; some have continuously variable freq
Thickness gages	0.4 to 35 Mc	Quartz, BaTi	Generally are pulse-echo type; typical accuracy is 1% of thickness; most units measure between few hundreths in. to tenths of in.; some to several in.
Depth and fish finding	12, 30, 37.5, 40, 75, 200 Kc	M [b], crystal, ceramic [c]	Some units measure depths, find fish, to 1 or 2-thousand ft with accuracies of about 5% at greatest depth; 12-Kc unit finds depths to 36,000 ft.
Level sensing	0.4, 1 Mc	BaTi	Some units measure to 100 ft with accuracy of ±0.01 ft for homogeneous liquids
Signaling	40 Kc	BaTi	Transmitter-rec combinations used for paging; bandwidths up to 8 Kc obtainable; see ELECTRONICS, May 27, 1960, p 128
Control	38 Kc	M	Sensors detect objects between 0.25 in. to 20 ft; can use as counter
Tv revr control	40 Kc	M, BaTi, E [d], mechanical gongs	Trans/revr combinations for tv revr control; see ELECTRONICS, Mar. 1, 1957, p 156, and Jun 6, 1958, p 68
Alarm	19.2 Kc	M	Trans/revr combinations to detect intruders and fires; uses c-w which is contained by enclosures; see ELECTRONICS, Feb. 14, 1958, p 102
Flow metering	1 Mc	PbZrTi [e], quartz	Some schemes have transducers inside pipe containing liquid, others outside; accuracies about 1%
Medical therapy	0.45 to 5 Mc	Quartz, BaTi	Usual therapeutic frequency is 1 Mc; typical unit delivers 3 or 4 w/cm^2; see ELECTRONICS, May 1959, p 53
Dental drilling	30 Kc	M	Requires abrasive; linear motion of tool is about 0.0012 in.
Dental prophylaxis	25 Kc	M	For treatment of gums; uses water or chemical lubricant, rather than abrasive; to help cutting action, tool motion describes ellipse whose major axis is 0.0015 in.

(*a*) barium titanate; (*b*) magnetostrictive; (*c*) most ceramics generally BaTi; (*d*) electrostatic; (*e*) lead zirconate titanate



Author tests 26-bit converter that consists of conventional logic blocks

Summary of various conversion methods includes a technique in which conversion circuits deliver the least significant bit first, rather than last. Advantage of this technique is that reversal of word-bit order is not required

Gray-to-Binary Converter Handles

By GILBERT DAVID BEINHOCKER, Associate Director Of Engineering, Epsco Inc., Cambridge, Mass.

TABLE I — GRAY-TO-BINARY CONVERSION WITH MOST SIGNIFICANT BIT DEALT WITH FIRST

Conversion Stages	Gray Code	Binary
Original word	MSB ↓ 1 1 1 0 1	
Number of ONES in 1st digit is odd.	MSB ↓ 1	MSB ↓ 1
Number of ONES in 1st 2 digits is even.	MSB ↓ 1 1	MSB ↓ 1 0
Number of ONES in 1st 3 digits is odd.	MSB ↓ 1 1 1	MSB ↓ 1 0 1
Number of ONES in 1st 4 digits is odd.	MSB ↓ 1 1 1 0	MSB ↓ 1 0 1 1
Number of ONES in 1st 5 digits is even.	MSB ↓ 1 1 1 0 1	MSB ↓ 1 0 1 1 0

TABLE II — GRAY-TO-BINARY CONVERSION BY MULTIPLICATION OF ALL THE ONES

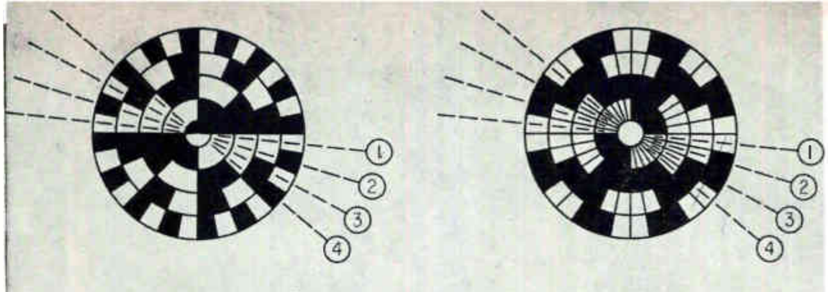
Gray Code					MSB 1	1	1	0	1	
Multiply by					1	1	1	1	1	
					1	1	1	0	1	Suppress the carries in adding up columns.
				1	1	1	0	1		
			1	1	1	0	1			
		1	1	1	0	1				
	1	1	1	0	1					
MSB →	1	0	1	1	0	1	0	1	1	
	Converted binary word					Discard				

GRAY, or cyclic, coding is a method of counting in which only one bit changes at a time. For devices which measure angular displacements such as shaft encoders, this is an important property. If only one bit changes from count to count it precludes the possibility of a catastrophic reading through many bits changing simultaneously even if the difference between two readings is only one unit such as they change from 01111 to 10000. Hence, for an ambiguous reading of the shaft encoder the error in resolution will not exceed the value of the least significant bit. Figure 1A illustrates how reading errors can arise and Fig. 1B shows the Gray coded disk whose readout changes by only one digit in each step.

The dark areas of both discs represent conducting portions while the light areas are insulation portions. Brushes are arranged in a straight line at different distances from the center. If the light portions are considered ZEROES and the dark portions ONES, the code readout will be that tabulated in Fig. 1, with binary and Gray codes contrasted to show how the Gray code reading changes by only one digit for each step.

When counting in the Gray code the binary bits for which the next most significant bit is ZERO remain unchanged; the others are converted 1 into 0 and 0 into 1.

The rule for serial Gray code to



POSITION	VALUE	BINARY WORD	GRAY WORD
1	0	00000	0000
2	1	00001	0001
3	2	00010	0011
4	3	00011	0010

FIG. 1—Contrasting binary (A) shaft encoder with Gray (B) encoder shows how the latter changes its word by one digit at a time. The table lists readings for the first four decoder positions

Least Significant Bit First

binary code conversion, MSB first, is: starting with the MSB (most significant bit) of the Gray code word, count the number of ones one bit at a time, two bits at a time, three bits at a time, and so on, until the whole word has been dealt with, and write down the corresponding straight binary bit according to the rule:

{ if the number of ones is odd, write down a 1; }
{ if the number of ones is even, write down a 0. }

If the Gray code word is presented MSB first to the input of the complementing flip-flop shown in Fig. 2, its output will be translated to straight binary code according to the above rule (Table I).

A problem that invariably arises in Gray code conversion is bit order. Gray-to-binary code conversion requires a bit transmission of MSB first. However, in serial arithmetic processes, bit transmission is always LSB (least significant bit) first, because carries must always be propagated to bits of ascending weights. Therefore, after Gray-to-binary code conversion is accomplished, some operation for reversing bit order is always performed. This operation most often takes the form of a parallel transfer between a parallel read-out register to a parallel read-in register with the wires being reversed. A parallel transfer scheme is shown in Fig. 2.

If the time to perform the operation is critical, multiplication may be done by a high-speed parallel arithmetic unit. A comprehensive design is not set forth here because except under very unusual circumstances the amount of equipment would be prohibitive.

Gray-to-binary code conversion may proceed LSB first if the parity of the word is known beforehand. The parity of the word is defined as the number of ONES in the Gray code word. An odd number of ONES gives an odd parity, an even number of ONES an even parity.

A rule for serial Gray code to binary code conversion, LSB first is shown in Table III and operates as follows. Determine the parity of the Gray code word, and if it is odd write a ONE down to form the LSB of the new binary word. If the parity is even, write a ZERO down instead. If it is a ONE, the LSB of the straight binary word is a ONE; if it is a ZERO, the LSB of the straight binary word is a ZERO. The B_{n-1} bit of the binary word is then determined by the following operation:

G_n (Gray Code bit) + B_n (Binary Code bit) = B_{n+1} with a suppression of the carry bit.

Table IV illustrates this principle by converting Gray-code 11101 to its binary equivalent of 10110.

Since Gray-code words are usually taken as input information from shaft encoders, the words will normally be read-in in parallel form. This makes determination of parity relatively expensive to mechanize, unless the equipment has an input buffer register with a serial output. Figure 3 overleaf is the schematic of a five-bit Gray-to-binary conversion arrangement, while the photograph facing this page shows a converter capable of handling a 26-bit word. The 5-bit Gray code word comes in LSB first and goes to both the complementing flip-flop and the shift register (Fig. 3).

Initially, the complementing flip-flop is reset by the P_0 pulse via OR gate 4. Pulses P_1 through P_5 will transfer the 5-bit Gray code word into the shift register and into the complementing flip-flop. The AND gate 1 preceding the complementing flip-flop is permissive on pulses P_1 through P_5. The purpose of the complementing flip-flop is to determine the parity of the Gray code word. If the flip-flop is left in a set state after the Gray code word has been presented to it, the Gray code word has an odd parity; if it is left in

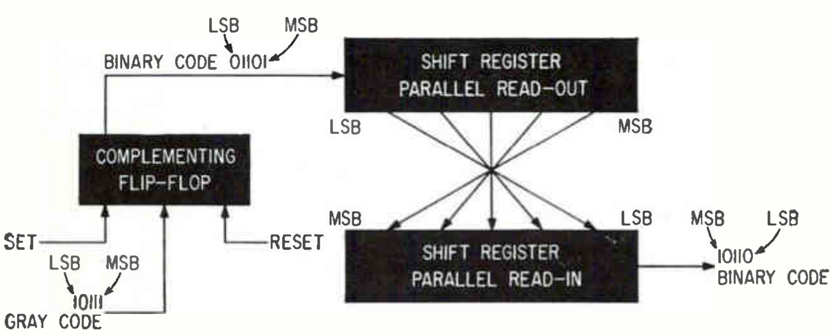


FIG. 2—Conversion technique used when Gray code word is fed in with most significant bit first. The ensuing registers reverse the word order giving a LSB output

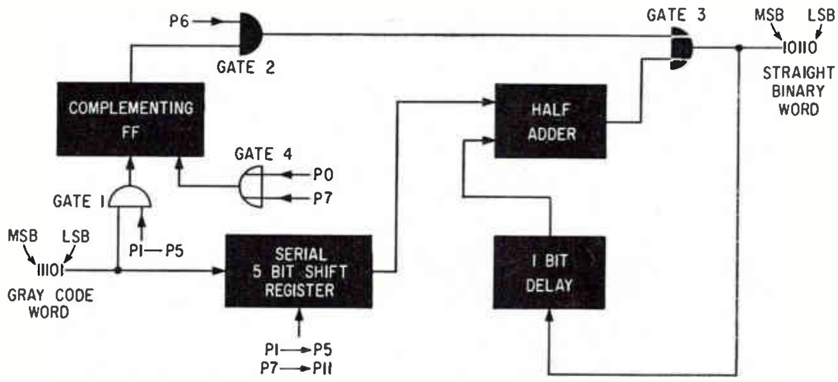


FIG. 3—Gray-to-binary converter accepts the least significant bit first, avoiding subsequent reversal of word order required in Fig. 2

TABLE III — PRINCIPLE OF GRAY-TO-BINARY CONVERSION WITH LSB FIRST

Bit Position	#5	#4	#3	#2	#1	#P. B.
Gray Code	MSB 1	1	1	0	LSB 1	0 {Parity bit is determined by counting up the ONES in a Gray code word.
Binary Code	MSB 1	0	1	1	LSB 0	0 {Always write down ZERO in this place.

Bit addition proceeds as follows

Gray Code Bit G_n	Binary Code Bit B_n	Binary Code Bit B_{n+1}
0	0	0
0	1	1
1	0	1
1	1	0 (Carry is suppressed)

TABLE IV — CONVERTING GRAY CODE 11101 TO BINARY CODE 10110 WITH LSB FIRST

Steps		MSB				LSB	P. B.
	Gray Code	1	1	1	0	1	0
Step 1	Binary Code					0	+0 — ←0
	Gray Code	1	1	1	0	1	0
Step 2	Binary Code				1	+0 — ←1	0
	Gray Code	1	1	1	0	1	0
Step 3	Binary Code			1	+1 — ←1	0	0
	Gray Code	1	1	1	0	1	0
Step 4	Binary Code		0	+1 — ←0	1	0	0
	Gray Code	1	1	1	0	1	0
Step 5	Binary Code	1	+0 — ←1	1	1	0	0

the reset state, the Gray code word has an even parity. On pulse P_6 AND gate 2 will be permissive and if the complementing flip-flop is in the set state, indicating an odd parity for the Gray code word, gate 2 will give an output of a ONE.

Since the Gray code word 11101 used in Fig. 3 has an even number of ONES, it has an even parity. Therefore, the complementing flip-flop will be in the reset state at the end of pulse P_5, and there will be no output from gate 2; hence at the output of OR gate 3, the first bit, according to the rule, will be a ZERO.

Since only the parity of the Gray code word determines the LSB of the binary word, the complementing flip-flop must now be deactivated. This is done by automatically resetting it by way of OR gate 4 with the P_7 pulse.

Simultaneously, on pulse P_7 the Gray code word is shifted (LSB first) out of the 5-bit serial shift register into the half adder. As the Gray code word is presented to the half adder, starting with pulse P_7, the previously generated straight binary bit from P_6 time (the LSB) is also presented to the half adder. This is accomplished by putting a one-bit delay in the loop. The output of the half adder is then the sum $B_{n+1} = G_n + B_n$ to yield a ONE for the next bit in the straight binary word. Since the truth table by which we do our addition calls for a suppression of any carries, a half adder is used instead of a full adder so that carries are dropped.

On pulse P_8 the next Gray code bit G_n will be presented to the half adder along with the previously generated binary bit B_n, which in this example is a ONE. Half adder output will be ONE, and this is the second bit in the straight binary word.

The process thus continues. At the end of P_{10}, the desired straight binary word, LSB first, will be available at the output of OR gate 3.

Pulse P_{11} is irrelevant for the conversion process, being fed into the shift register to clear out the last Gray code bit, leaving the register clear for an ensuing operation.

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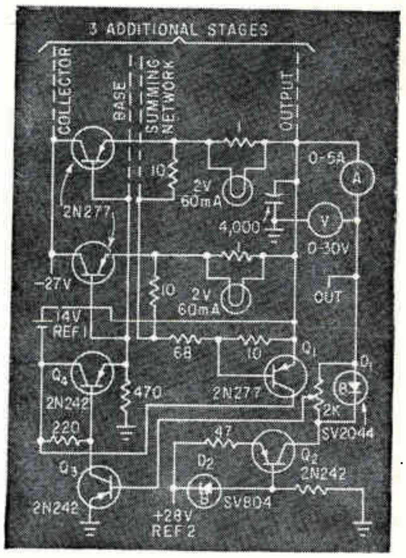
Fault-Indicating Series Regulator

Five regulator transistors in a 5-amp power supply have indicator lamps at their emitters. By being evenly lit, out, or too bright, the lamps indicate normal conditions, an open transistor or a collector-to-emitter short

By JAY A. WHEELER* and EVAN J. CURRENCE*,
Maico Electronics, Inc., Minneapolis, Minn.



Two of the five series regulating transistors are shown. Transistor Q_1 provides overcurrent protection

DESIGN OF transistorized regulated power supplies, like design of vacuum-tube regulated power supplies, is well established. There is a consistently increasing demand for high-current variable-voltage transistorized supplies for the laboratory and for bench testing.

This article describes an economical transistor regulated supply with good performance characteristics. The input is 120 v 60 cps, the output is 5 amp at 0 to 20 v. The regulation is better than 0.1 percent at 20 v, and the ripple does not exceed 1 mv rms. The supply includes short-circuit protection and indicators for the series regulating transistors.

The design requirements were met using the series regulating circuits, shown in the figure. Transistor, Q_1 provides overcurrent protection. The d-c amplifier consists of transistors, Q_2, Q_3 and Q_4, referenced by Zener diodes D_1 and D_2. Two transistor types were used to simplify the design. The one-ohm resistors in the emitters of the series regulating transistors equalize the load current between the units.

To check the operating condition of each of the series regulating transistors, a 2-v lightbulb is connected across the one-ohm resistor in the emitter of each transistor. Under normal operating conditions all bulbs will have the same voltage across them and therefore be lit equally. If one of the series regulating transistors is open, its light will go out. If the transistor has a collector-to-emitter short, its light will glow more brightly than normal.

The one-ohm emitter resistors of the series regulating transistors are also current-sensing elements for overload protection. The average of all the emitter resistor drops is summed with the five 10-ohm resistors. When an overload occurs, the voltage across the emitter resistors increases until transistor Q_1 is turned on. When transistor Q_1 conducts, the output voltage from refernce supply 1 is reduced. Since reference supply 1 provides the base drive to the series regulating transistors, lowering its voltage causes the base drive to decrease and prevents the output current from exceeding about 6 amp.

Transistor Q_2 supplies constant current to main Zener regulator D_1. This current remains constant regardless of the setting of output voltage or changes in input voltage, because the Zener diode D_2 holds the supply-to-base voltage constant.

The full incremental change in output voltage is reflected to the base of transistor Q_3, the first stage of the d-c amplifier. The second stage of the d-c amplifier is an emitter follower for current amplification.

For a decrease in the output voltage, that is, when it goes more positive from −20 v, the base drive of transistor Q_3 will decrease, resulting in the collector going more negative. As the collector voltage of transistor Q_3 becomes more negative, the drive to the emitter follower transistor Q_4 increases. This increases the base drive to the series regulating transistors, bringing the output voltage back to −20 v.

From no load to a 4-amp load the output voltage variation does not exceed 25 mv. At a 6-amp load the output voltage has dropped to zero, showing the effectiveness of the overload protection circuit. Measured ripple was less than 1 mv rms. Without the overload protection, a zero to 5-amp load change results in less than a 15-mv change in the output voltage. With a 2-amp step change in output current, the voltage change of 75 mv recovered in 100 μsec.

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* Now with Northern Electronics, Inc., Minneapolis, Minn.

LITTON INDUSTRIES MICROWAVE TUBES P, L, S, C, X, K BANDS

KLYSTRONS

Type Number	Frequency Range Megacycles	Peak Power (Minimum) Megawatts	Cathode Pulse Length Microseconds	RF Duty Ratio	Remarks
L-3270	1250 to 1350	2	8	0.0025	Broadband (100 megacycles between 2 megawatt points)
LT-7504 (L-3035)	1240 to 1360	2.2	8	0.0025	Long range search radar
L-3257	1280 to 1330	4	30	0.0003	For linear accelerator
L-3227	1280 to 1330	5	8	0.002	For linear accelerator
L-3250	1250 to 1350	10	7.2	0.0015	Long range search radar and linear accelerator
L-3387	1250 to 1350	30	7.2	0.0033	Long range search radar
L-3302	2855	10	7.2	0.0015	For linear accelerator and radar
L-3355	1250 to 1350	20	7.2	0.0015	Long range search radar

TRAVELING WAVE TUBES

Type Number	Frequency Range Megacycles	Power Output	Focusing	Duty Factor
L-3266	7000 to 11,000	20 mw	PPM	CW
L-3236	7000 to 11,000	2 W	PPM	CW
L-3470	4000 to 8000	20 mw	PPM	CW
L-3471	4000 to 8000	2 W	PPM	CW
L-3472*	8500 to 9600 7000 to 11,000	10 W 5 W	PPM	CW
L-3264*	100 to 300	100 W	Solenoid	CW

* *In development*

M-TYPE BACKWARD WAVE OSCILLATORS

Type Number	Frequency Range Megacycles	Power Output	Focusing	Factor	Remarks
L-3148	8500 to 11,000	150 watts minimum	Permanent magnet	CW	No holes in a 1.5/1VSWR

A complete line of M-BWO's is available but classified

PULSE MAGNETRONS

Type Number	Frequency Range Megacycles	Peak Power (Min.) KW	Duty Ratio	Remarks
L-3204	8800±25	0.04	0.25	Extremely high duty
L-3105	9300±40	0.10	0.027	Highly ruggedized; frequency stable
L-3028	9280 to 9320	0.12	0.027	Frequency stable; pulse train capability
L-3379	8800 to 9500*	1.0	0.003	Highly ruggedized; frequency stable
L-3058	9330 to 9350*	1.0	0.003	Frequency stable
L-3358	16,000 to 16,500*	1.0	0.001	Highly ruggedized; frequency stable
L-3380	8800 to 9500*	2.0	0.002	Highly ruggedized; frequency stable
L-3359	16,000 to 16,500*	2.0	0.001	Highly ruggedized; frequency stable
L-3381	8800 to 9500*	3.0	0.001	Highly ruggedized; frequency stable
L-3382	8800 to 9500*	4.0	0.001	Highly ruggedized; frequency stable
LT-6233	9280 to 9345	7.0	0.003	High duty beacon magnetron
L-3103	8500 to 9600*	30.0	0.002	High duty version of LT-6543
L-3168	9375±30	30.0	0.002	High duty version of LT-4J52A
L-3306	16,000 to 17,000*	30.0	0.002	High duty version of L-3083A
L-3083A	16,000 to 17,000*	60.0	0.001	Recommended for new systems
LT-6543A	8500 to 9600*	65.0	0.001	Recommended for MTI systems
L-3305	8600 to 9500*	65.0	0.001	Recommended for frequency diversity
LT-6510	9375±30	65.0	0.001	Recommended for MTI systems
LT-4J52A	9375±30	70.0	0.001	Recommended for new systems
L-3312	8500 to 9600*	200.0	0.001	In development
L-3313	8600 to 9500*	200.0	0.001	Hydraulically tunable for frequency diversity
LT-4J50A	9375±30	225.0	0.001	Recommended for new systems

**Fixed frequency versions available generally throughout tunable range.*

CW MAGNETRONS

Type Number	Frequency Range Megacycles	Minimum Power Watts	Remarks
L-3456	350-590	500	These CW Magnetrons may be pulsed to approximately 2 kilowatts peak power and are recommended for component testing.
L-3459	590-975	500	
L-3465	975-1500	400	
L-3464	1500-2350	400	
L-3460	2350-3575	500	
L-3461	3575-4975	400	
L-3467	4975-6175	400	
L-3468	6175-7275	300	
L-3462	7275-8775	300	
L-3463	8775-10,475	250	

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Controlling Attitude of Manned Satellites

MANNED satellites will require that the human operator monitor and control many vehicle functions including the fundamental one of attitude control. Although tasks will vary with mission, information about the vehicle and the performance of the attitude control system must be presented to the operator.[1,2] Also, provisions must be made for him to enter the attitude control loop.

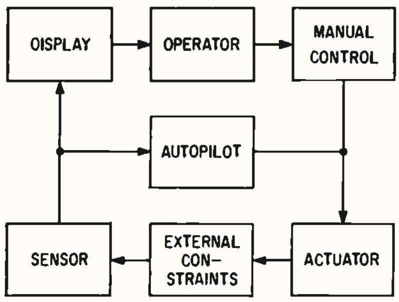
An analysis of required attitude displays and controls was described by D. K. Bauerschmidt, Hughes Aircraft Co., at the 15th annual American Rocket Society meeting. The research had USAF support and was monitored by Aerospace Medical Laboratory, Wright Air Development Center.

The study included establishing system functions, operator tasks, control and display requirements, as well as preliminary design of controls and displays. The mission was assumed to involve initiation of powered flight, attaining a nearly circular orbit, rendezvous with another satellite, attaining aerodynamic flight, navigation to landing base and controlled landing. Vehicle attitude would have to be controlled throughout within predetermined limits.

Generally attitude will be controlled automatically. Operator participation will be limited by factors such as required speed, accuracy and fuel economy. In addition, human ability will be limited at times, such as during high trust conditions. Weight and space for required control and display equipment will further limit operator functioning.

Operator functions may include that of decision maker. He might select an attitude-correcting program from alternates, the source of attitude information or whether to continue a mission. The human as a data sensor may supplement satellite sensing devices by performing functions like sensing vehicle orientation relative to the earth. As a data processor, the operator may compute or interpret tabular data such as fuel expenditure or the attitude program required for a specific maneuver. The operator as a controller may control attitude rates or operate devices like star trackers or horizon scanners.

When attitude is controlled by the autopilot in the basic single-axis control system in the figure, the operator provides redundancy.



During manual attitude control autopilot may provide stabilization and during automatic control operator provides redundancy

He would make decisions and possibly process data. When the manual loop controls attitude, the human functions as controller and possibly as data sensor. The autopilot may provide stabilization during manual control. However, the operator can obtain a particular vehicle orientation directly rather than through control of angular rates.

Major dynamic considerations are imposed by the external constraints common to both loops. External constraints are the relationships that describe vehicle rotation about a particular axis in response to actuator outputs about one or more rotational axes.

Controls and displays must enable the operator to initiate orbital maneuvers or operate sensing devices. Orientation accuracies of $\frac{1}{10}$ degree have been assumed necessary. Control of attitude rates must permit vehicle rotation to be neutralized at the end of the main thrust or a desired orientation to be maintained. Required accuracy of angular rates is assumed to be 0.01 deg/sec near zero and 0.005 deg/sec at about 0.05 deg/sec.

Most controls and displays related to attitude are grouped together. The attitude display is a vehicle model in a 4-inch sphere. It can rotate about all three axes with its rotation analogous to vehicle rotation, displaying vehicle orientation continuously relative to a set of reference axes. Attitude is shown by model orientation relative to the plane of a fixed mounting surface that is normal to the local vertical. Direction of the vehicle velocity vector projected on the plane is represented by a fixed index.

Attitude vernier scales present precise pitch, roll and yaw angular deviation from that commanded and absolute attitude angles. The operator or computer can enter command attitude angles, which are indicated to the nearest one-tenth degree on counters. An arrow-shaped index against the fixed scales indicates actual attitude angular deviation. Scale division marks represent one-tenth degree of attitude angle so that absolute attitude angle can be obtained from index position.

Vehicle roll, pitch and yaw angular rates are indicated by wheels on axes parallel to the corresponding vehicle axes. A ratio of 500:1 between wheel and vehicle rotations aids detection and control of rates near zero. The wheels are divided into alternate black and white sectors. If angular rate exceeds critical fusion frequency of the sectors, a light indicates direction of rotation.

A pitch bias signal can be entered against which a precise desired pitch angular rate can be nulled. Thus pitch rate that keeps the vehicle longitudinal axis aligned with the velocity vector in a nearly circular orbit exists with the wheel stopped.

Pitch, roll and yaw controls mounted coaxially with the corresponding body rate indicators permit manual attitude control. A

VOLTAGE REGULATED DC POWER SUPPLIES KEPCO

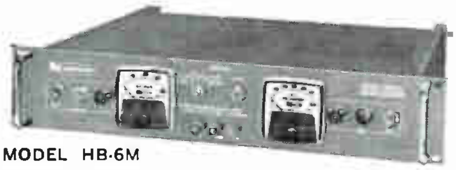
TRANSISTORIZED DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SC 32-0.5	0-32	0-0.5	
SC 32-1	0-32	0-1	
SC 32-1.5	0-32	0-1.5	
2SC 32-1.5	0-32	0-1.5	
Dual Output	0-32	0-1.5	
SC 32-2.5	0-32	0-2.5	
SC 32-5	0-32	0-5	
SC 32-10A	0-32	0-10	0.01%
SC 32-15A	0-32	0-15	
SC 60-2	0-60	0-2	
SC 60-5	0-60	0-5	
2SC 100-0.2	0-100	0-0.2	
Dual Output	0-100	0-0.2	
SC 150-1	0-150	0-1	
SC 300-1	0-300	0-1	
SC 18-0.5	0-18	0-0.5	
SC 18-1	0-18	0-1	
SC 18-2	0-18	0-2	
SC 18-4	0-18	0-4	
SC 36-0.5	0-36	0-0.5	0.1%
SC 36-1	0-36	0-1	
SC 36-2	0-36	0-2	
SC 3672-0.5	36-72	0-0.5	
SC 3672-1	36-72	0-1	
PSC 5-2	0-7.5	0-2	
PSC 10-2	7.5-12.5	0-2	
PSC 15-2	12.5-17.5	0-2	0.02%
PSC 20-2	17.5-22.5	0-2	
PSC 28-1	22.5-32.5	0-1	
PSC 38-1	32.5-42.5	0-1	
HB-2	0-325	0-200 ma.	
HB-4	0-325	0-400 ma.	0.1%*
HB-6	0-325	0-600 ma.	
HB-8	0-325	0-800 ma.	
SR 12-50	5-13	0-50	
SR 28-50	24-32	0-50	0.1%
SR 48-30	44-52	0-30	
SM 14-30	0-14	0-30	
SM 36-15	0-36	0-15	
SM 75-8	0-75	0-8	
SM 160-4	0-160	0-4	
SM 325-2	0-325	0-2	
SM 14-15	0-14	0-15	
SM 36-10	0-36	0-10	
SM 75-5	0-75	0-5	0.1%*
SM 160-2	0-160	0-2	
SM 325-1	0-325	0-1	
SM 14-7	0-14	0-7	
SM 36-5	0-36	0-5	
SM 75-2	0-75	0-2	
SM 160-1	0-160	0-1	
SM 325-0.5	0-325	0-0.5	

*0.01% REGULATION AVAILABLE

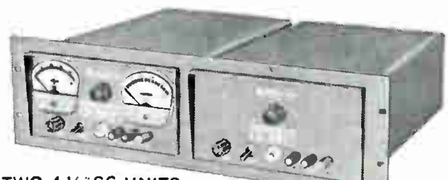
MAGNETIC DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KM236-15A	0.1-36	0-15	
KM236-30	0.1-36	0-30	0.5%
KM236-50	0.1-36	0-50	
KM 251	2-14	30A or 240 W.	
KM 252	5-35	12A or 240 W.	
KM 253	20-60	6A or 240 W.	±1%
KM 254	30-90	4A or 240 W.	
KM 255	60-180	2A or 240 W.	



MODEL HB-6M

COMPACTNESS



TWO 4 ¼" SC UNITS MOUNTED IN RACK ADAPTER RA-2

WIDE VARIETY

MODEL 2SC32-1.5

VERSATILITY

MODEL 400B

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VACUUM TUBE DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
800B	#1 0-600 #2 0-600 Parallel 1 & 2 0-600 Series 1 & 2 0-1200	0-200 ma. 0-200 ma. 0-400 ma. 0-200 ma.	
430D	#1 0-450 #2 0-450 Parallel 1 & 2 0-450 Series 1 & 2 0-900	0-300 ma. 0-300 ma. 0-600 ma. 0-300 ma.	TO 0.01%
2400B	#1 0-400 #2 0-400 #3 0-150 Bias Parallel 1 & 2 0-400 Series 1 & 2 0-800	0-150 ma. 0-150 ma. 0-5 ma. 0-300 ma. 0-150 ma.	
103	#1 0-300 #2 0-300 #3 −50 to +50 Parallel 1 & 2 0-300	0-75 ma. 0-75 ma. 0-5 ma. 0-150 ma.	unregulated
400B	0-400 0-150 Bias	0-150 ma. 0-5 ma.	
730B	0-350	0-3 Amp.	
720B	0-350	0-2.25 Amp.	TO 0.02%
710B	0-350	0-1.5 Amp.	
700B	0-350	0-750 ma.	
780B	0-600	0-3 Amp.	
770B	0-600	0-2.25 Amp.	
760B	0-600	0-1.5 Amp.	
750B	0-600	0-750 ma.	TO 0.01%
605	0-600 0-150 Bias	0-500 ma. 0-5 ma.	
615B	0-600 0-150 Bias	0-300 ma. 0-5 ma.	
2500	0-2500	0-50 ma.	
1520B	0-1500	0-200 ma.	TO 0.004%
1220C	0-1200	0-50 ma.	
1250B	0-1000	0-500 ma.	
KR16	0-150	1.5 Amp.	
KR17	100-200	1.5 Amp.	
KR18	195-325	1.5 Amp.	
KR19	295-450	1.5 Amp.	
KR8	0-150	600 ma.	
KR5	100-200	600 ma.	
KR6	195-325	600 ma.	
KR7	295-450	600 ma.	0.1%
KR12	0-150	300 ma.	
KR3	100-200	300 ma.	
KR4	195-325	300 ma.	
KR10	295-450	300 ma.	
KR11	0-150	125 ma.	
KR1	100-200	125 ma.	
KR2	195-325	125 ma.	
KR9	295-450	125 ma.	

CIRCLE 63 ON READER SERVICE CARD

switch permits the wheels to function as continuous rate controls to modify attitude rates manually. Another switch position enables manual change from one stable attitude to another using the wheels.

An attitude fuel remaining indicator and an attitude fuel mode selector are mounted separately. The selector enables minimum fuel or minimum time attitude maneuvers as well as a normal mode.

REFERENCES

(1) T. B. Garber, Orientation and Control, The Rand Corp., Report No. P-1430, Feb. 24, 1958.

(2) C. O. Hopkins, D. K. Bauerschmidt and M. J. Anderson, Display and Control Requirements for Manned Space Flight, WADD Tech. Report 60-197, Aerospace Medical Division, Air Research and Development Command, April 1960.

Unit Measures Printed Circuit Resistances

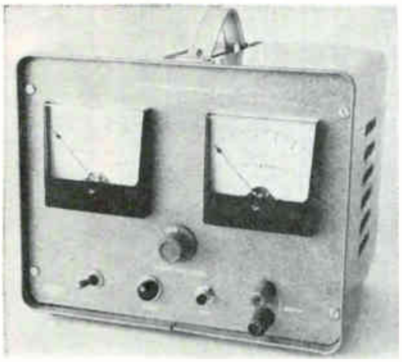
By F. W. KEAR,
Supervisor, R&D Lab., Lytle Corp., Albuquerque, N. M.

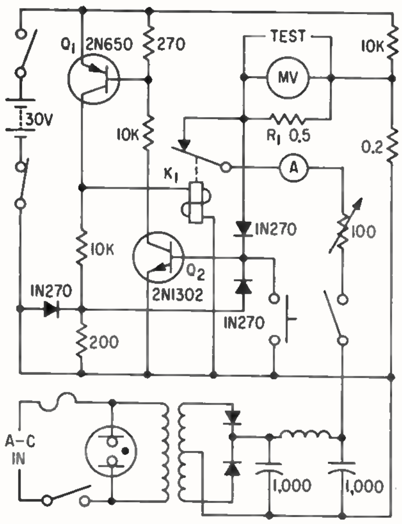
RAPID measurements of low resistances can be made with a simple-to-operate instrument. The tester, developed primarily for quality control, can provide up to 5 amperes through a test circuit. It operates over a resistance range from 0 to 50 milliohms with less than 10 percent error.

The unit was developed primarily for nondestructive testing of commercial-grade printed-circuit board and through-hole plating. However, it has also been found effective for inspecting soldered joints, testing inductors and identifying transformer windings. Mechanical holding devices for printed circuits and transformer leads free the operators hands, and only a single control is required to adjust current through the test circuit.

The circuit shown in the figure includes an ammeter and a millivoltmeter. Current-voltage relationship in the test circuit indicates resistance. Thus if test current is 1 amp, resistance in milliohms is indicated directly on the millivoltmeter.

A key portion of the circuit is designed to protect the millivoltmeter from voltage overloads, which could result from accidental opening of the test circuit. Tran-



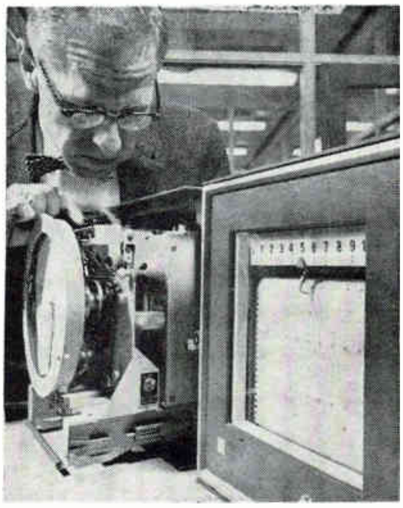


Single adjustment simplifies operation of resistance tester, which includes circuits to protect millivoltmeter from voltage overloads

sistors Q_1 and Q_2 with appropriate biasing and clamping provide the overload protection by energizing relay K_1. The normally closed relay contact is opened, interrupting rectified output from the a-c power supply.

The overload protection circuit is adjusted to operate at 25 percent overload of the millivoltmeter or 0.075 volt between the output terminals. Voltage exceeding this level is sensed by Q_2. The resulting rise in collector voltage on Q_2 maintains the base voltage of Q_1 at saturation level. Relay K_1 remains energized as long as Q_1 is saturated or until continuity has been restored through the test circuit.

Shunting resistor R_1 limits the rate of voltage increase across the millivoltmeter resulting from accidental opening of the test circuit. Thus the meter is protected during the time required for the relay to operate. If resistances greater than 50 milliohms are to be measured, the shunt resistor may be omitted.



Free-wire strain-gage component (left) is heart of new line of instruments developed by Brown Instruments Division of Minneapolis-Honeywell Regulator. Idea of John McGee (left) was incorporated into strip-chart and circular-chart recorders and circular-scale indicators by John Leyenberger (center). Vice-President J. S. Locke, and divisional sales manager J. A. Robinson (right) discuss first production models, off the line next week

Electronic Recorders End Slidewire Problems

ATTEMPTS HAVE BEEN made to eliminate the sliding-contact type of voltage divider used in potentiometer circuits. Few have been completely successful for thermocouple measurements. Some have short life; others, available for some time, have not received universal acceptance in industrial applications.

At Minneapolis-Honeywell, a specially-designed strain gage, called a Stranducer, is now incorporated in a new line of low-cost precision measurement and recording instruments: the ElectroniK 17 Series. The Stranducer has an unusually long life and will operate when the instruments are subjected to ambient temperatures from 0 to 130 F. And all slide-wire problems are eliminated. Among these are mechanical wear, limited resolution, and bounce which occurs in instruments operating at high speeds.

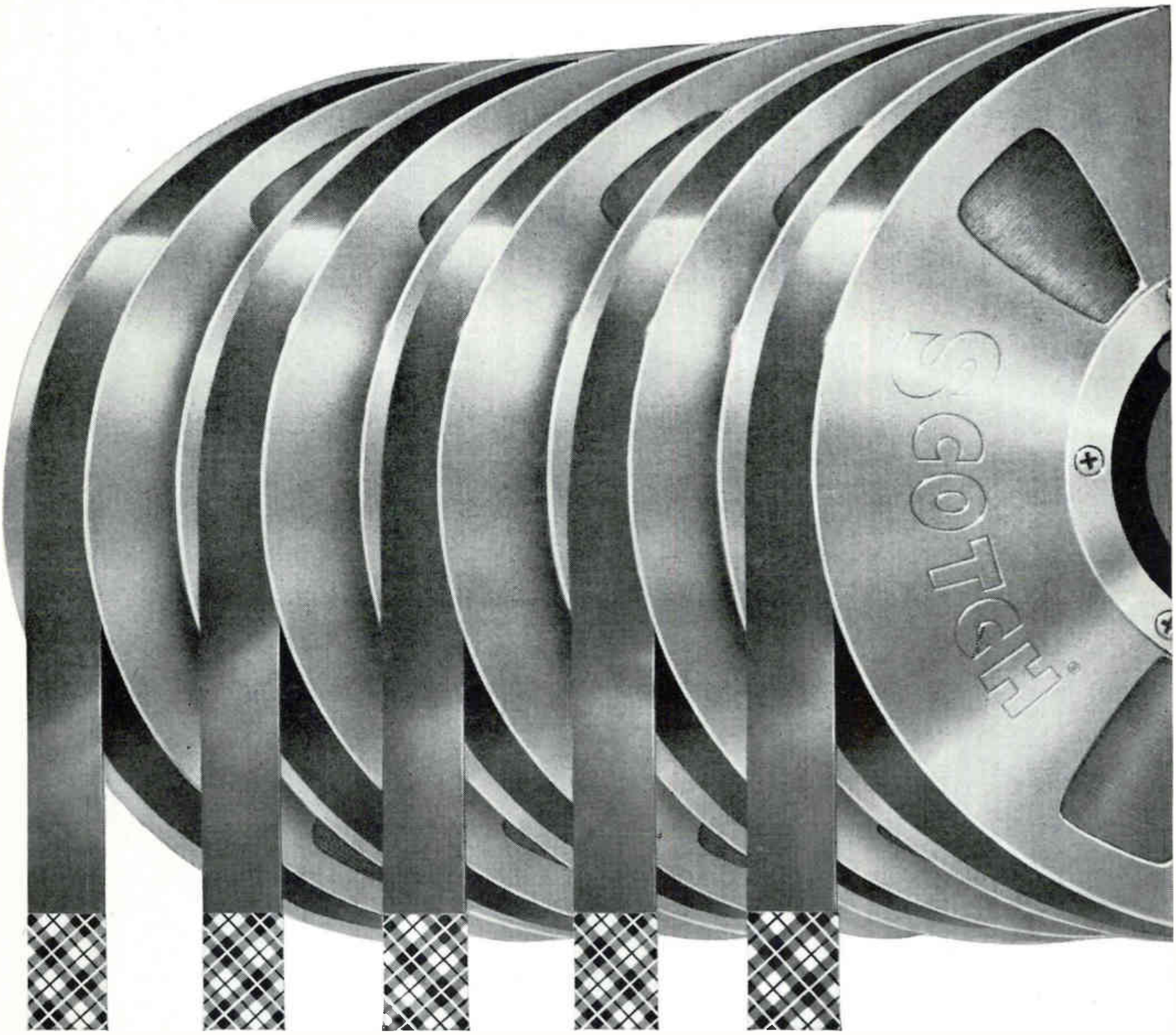
This voltage divider works on the principle that a stretched wire changes its resistance in proportion to its mechanical elongation. But a free wire not only changes its resistance with length, but also with temperature. And a successful design for a voltage divider has to eliminate the temperature effect. Also, since wire-length changes are extremely small, elongation must never approach the point where the elastic limit is exceeded.

Instability problems were solved by the mechanical construction of the strain gage shown in the photos above. This unit is enclosed in an I-shaped frame. Four looped wire strands are electrically arranged to form variable resistance legs of a Wheatstone bridge and vary in proportion to applied tension. The Stranducer controls magnitude and polarity of feedback voltage of measuring circuit and is linked mechanically through sector and strap reduction stages and drive cable to balancing motor. Electrical connections are made through the unit's terminal board.

The wire strands are prestressed and placed so that in the dead zero position all wires are in equal tension and are of equal resistance. The pivot arm, as it rocks back and forth, increases the tension on the other two wires. The small motions of the pivot arm are carried through a drive strap to the drive sector which is connected to the drive shaft with a strap connection. A take-up spring keeps the mechanical strap connections always in tension. Thus, a friction-free, precise 40-to-1 reduction is accomplished between the angular motion of the drive shaft and the hub to which the wire strands are fastened.

The principle advantage of this strain gage in a self-balancing potentiometer is the infinite resolution it provides in recording input signals. This comes about by the elimination of a voltage divider having a fixed number of stopping places, or convolutions. The absence of convolutions also provides another important advantage. A moving contact on the voltage divider has a much higher resistance when it is moving, then when it is static. This higher resistance, which is randomly higher in value, contributes to unstable dynamic operation. The infinite resolution of this strain gage design gives superior and consistent dynamic action. In microvolt measurement, and where extraneous electrical effects exist, the unit is considered a major contribution to the precision operation of Minneapolis-Honeywell's new ElectroniK 17 strip-chart recorders, circular-chart recorders and circular-scale indicators.

Other features of the new gage reviewed by Walter P. Wills, Brown Instrument Division Technical Adviser are: an amplifying system providing critical damping and optimum response for high-impedance



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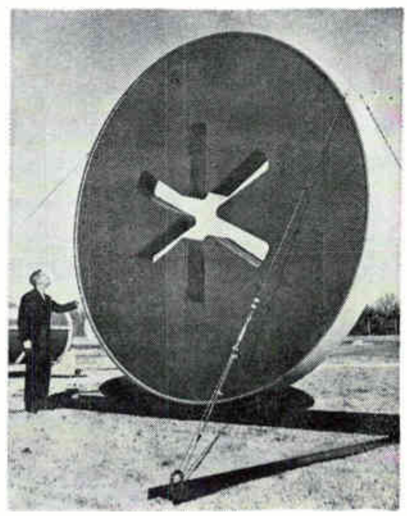
actions; thermally-compensated electrical networks to minimize zero shift due to temperature change; cascaded zener diode network providing a constant current to the measuring circuit and eliminating the need for periodic standardization; a new plug-in converter; and modular construction.

The input impedance of the ElectroniK 17 input circuit and voltage amplifier is in excess of 100,000 ohms. It thus can handle source impedances of 50,000 ohms and do this under rate accuracy and speed of response. The units have two amplifiers, one solid state and the other with vacuum tubes and transistors to take advantage of both. Both are interchangeable with plug-in connections.

Modular construction gives the new units flexibility and versatility.

Solid Rocket Power Propels Space Ships



FULL SCALE cross section of a solid propellant rocket motor under study by the Redstone Division of Thiokol Chemical Corporation for the National Aeronautics and Space Administration. This 14-ft diam motor, envisioned by Redstone Division engineers for NASA would total 63-ft in length, and produce an average thrust of 2.4 million pounds during a burning time of 82 seconds. Seven of these motors represented by this cross section would be clustered together to power the first stage of future space research vehicles. Currently, as part of the large solid propellant rocket motor design study being conducted for NASA, Thiokol's Redstone Division has under construction motors ranging in size from ten to twenty-eight feet in diameter

Each module is a complete interchangeable assembly or subassembly. The measuring circuit can be changed for different ranges or actuations by substitution of range cards and actuation boards. The drawer-type chassis, with its wiring drawbridge, can be pulled out for instrument adjustment or service without disrupting operation.

The drive module, which contains the measuring circuit, the Strandcer, constant-current unit, input filter, converter, amplifier and balancing motor, is common and identical on all ElectroniK 17 models.

A second recording-pen system is easily added to the strip-chart model. By using a deeper case, the second drive module is added directly behind the first drive module and a second pen carriage is added to the display module. The two pens can travel full scale and pass each other with complete freedom.

Calibrated accuracy of the ElectroniK 17 is ¼ percent. Strip-chart instruments have pen speeds of 1, 5 and 15 seconds. Those for circular-chart instruments are 5 and 15 seconds.

Materials Available For Laser Studies

ONE OF THE BEST laser materials found to date, samarium-doped calcium fluoride, is now being produced by Semi-Elements, Inc., Saxonburg, Pennsylvania.

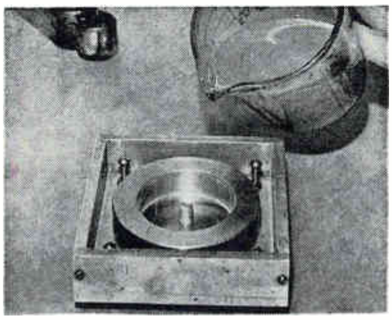
This material requires only 1/500 the pumping power in comparison to ruby. The appearance of samarium-doped calcium fluoride is a transparent green material, and currently it is being grown in the desirable laser size of ¾-in diam by one-in or more in length. Larger sizes are grown on request.

In addition to samarium-doped calcium flouride, Semi-Elements is also producing gadolinium-doped calcium flouride, available in the same size crystal ingot.

Besides the laser uses of calcium fluoride, this material is also good for fluorescence studies, as well as maser applications.

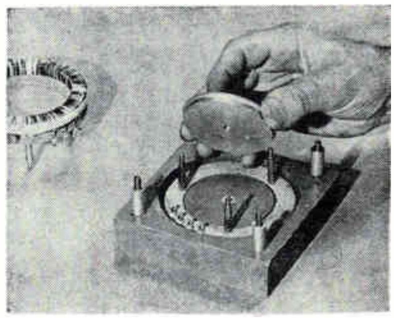
Single crystal ingots are priced at $225 each, deliveries range from one to two weeks.

Calcium fluoride will be available in the other rare earths.



Pouring around pattern and studs

Mold is released from pattern



Coil, spacers and disk are placed

Molded Molding Jig Speeds Encapsulation

MOLD COSTS can represent a considerable part of the expense of producing encapsulated parts in short and medium production runs. If a long, room temperature cure is desired, a number of molds are needed to obtain adequate daily output. Molds which are molded from a master pattern are frequently used to solve the cost and time problem.

This technique was recently used by Torwico Electronics, Inc., Union, N. J., to encapsulate alignment coils for RCA color television cameras. Both the molds and the encapsulant are epoxy.

A feature of the molds is a built-in jig which permits rapid, accurate positioning of the coil within the mold for complete, even encapsulation.

The aluminum master pattern was made by Torwico at a cost of $200. Twenty molds were made at an estimated cost of $10 each. Each mold can be used up to 100 times and any number of molds can be made from the pattern.

Steps in preparing and using the mold-jig are illustrated in the photos. The pattern has unthreaded holes at the four corners and center, for studs and a bushing which become embedded in the mold.

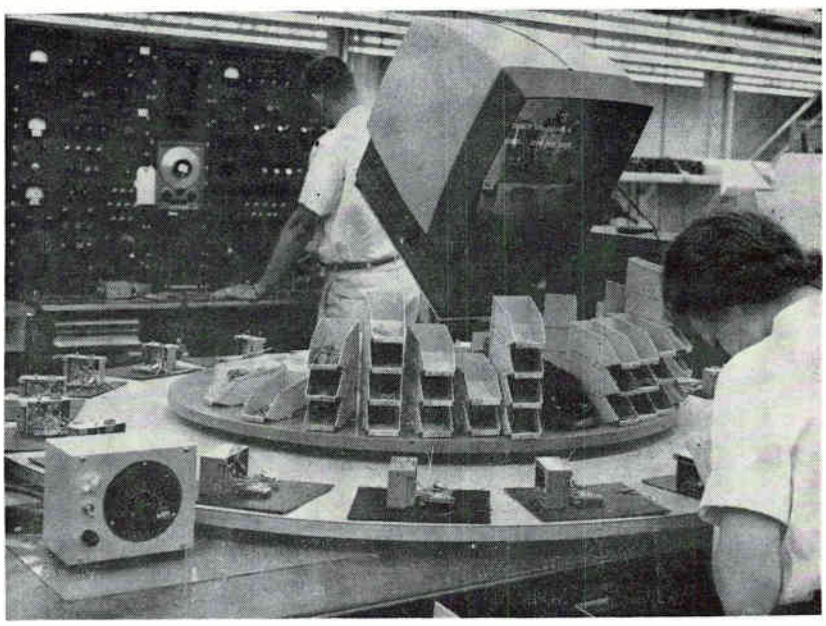
The mold is made of an aluminum-filled casting resin with an aromatic amine hardener. The resin is vacuum deaerated for about a minute before the hardener is added and the mold is deaerated after pouring to prevent blow holes. After room temperature gel and a post-cure for two hours at 100 C, the pattern is rapped with a mallet to loosen the mold.

The alignment coil, also made by the firm, is placed within the mold and four spacers are slipped over the mold studs. An aluminum disk is secured in the bushing with a screw, as a guide to resin pouring level. An X-frame is attached to the mold with four thumb screws. Three studs which are part of the coil fit through holes in the X-frame. Nuts are screwed down on these studs until the coil is lifted a predetermined distance from the bottom of the mold. The frame also positions the coil so circumference is clear of the mold.

The coil is encapsulated with a low-viscosity, silicate-filled epoxy compound with an aliphatic amine hardener. Again, the resin is deaerated before mixing with the hardener and after being poured. The mold assembly is preheated to 50 C before pouring, to remove moisture. After 16 hours cure at room temperature, the mold is rapped to release the part.

The mold and encapsulation com-

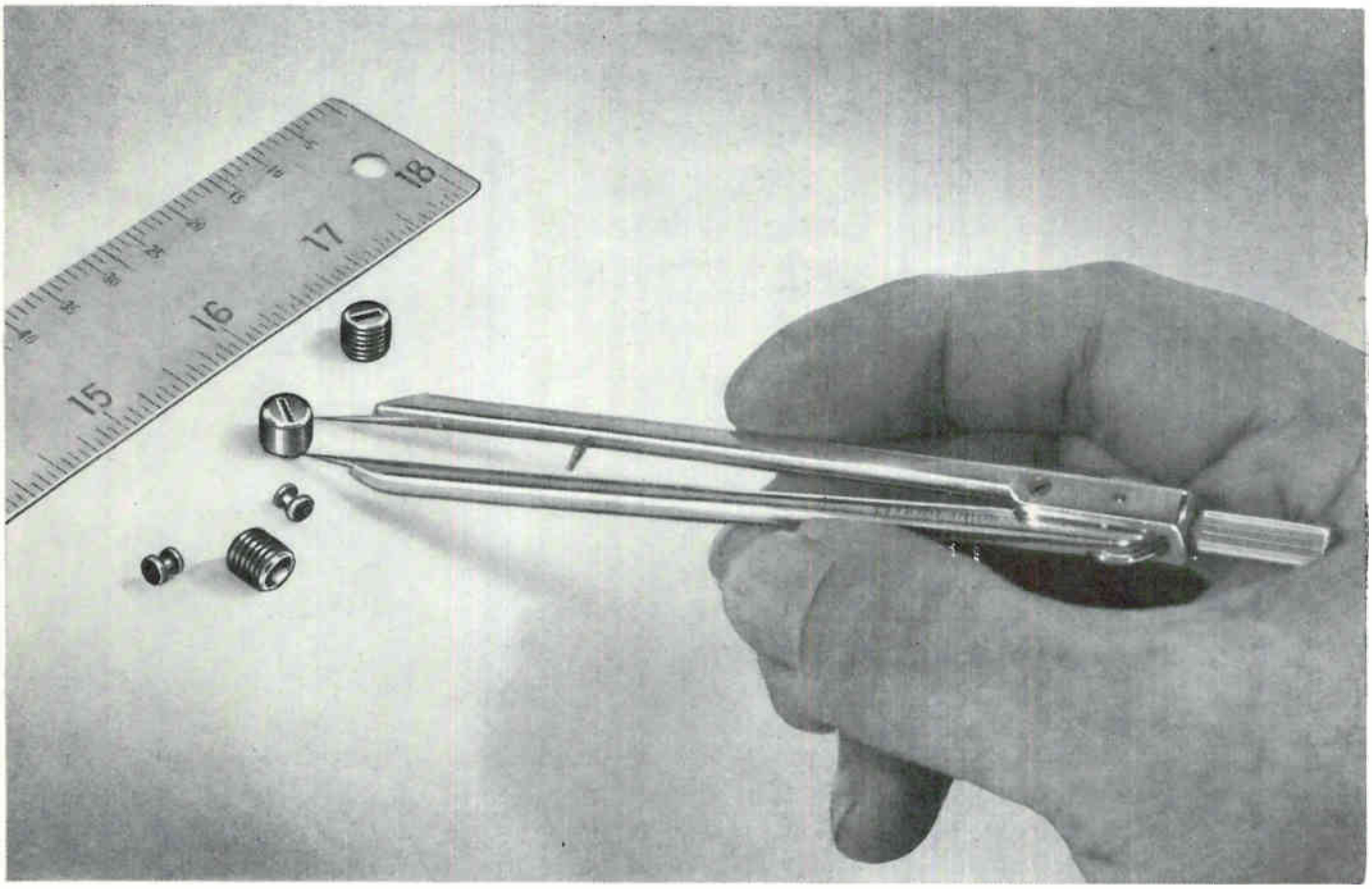
Stereo Viewer Guides Assembler



Collins Radio Co., Cedar Rapids, Iowa, is evaluating the effectiveness of a stereo type slide viewer as a production aid. Instead of using tape-recorded instructions (as other recently-reported visual aids do), the instructions are overprinted on the assembly step photo in the viewer

ANOTHER G-C SPACE SAVER!

Threaded Cup Core and Bobbin for Miniaturized IF Transformer and Coil Applications



Now you can design miniaturized IF transformers and coils for AM-FM radio and television applications, and maintain high "Q" and effective permeability factors.

This new G-C threaded cup core and ferrite bobbin assembly has closely held mechanical tolerances for precision screw adjustment, and allows close coupling factor between the coil and core.

For RF coil applications, G-C offers a complete line of threaded cores operating in frequency ranges up to 65 mcs. G-C threaded cores are available from stock in Q-1 and Q-2 material; pitch sizes from ¼–28, 10–32 and 8–32; lengths from ¼" to 1⅛" with hex, square or screw-driver holes.

Write for additional information on the miniaturized threaded cup core F1266 and bobbin F1270 and data on G-C stock cores. Please address inquiries to Section A-1.

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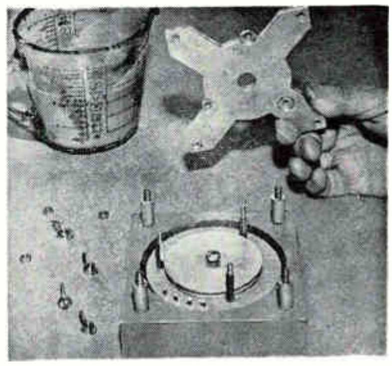
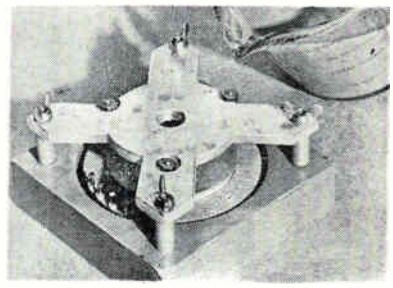
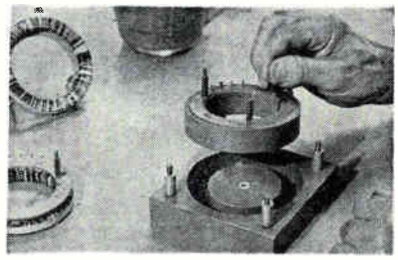


X-frame fits on mold and coil studs



Resin is poured around suspended coil



Encapsulated coil is removed from mold

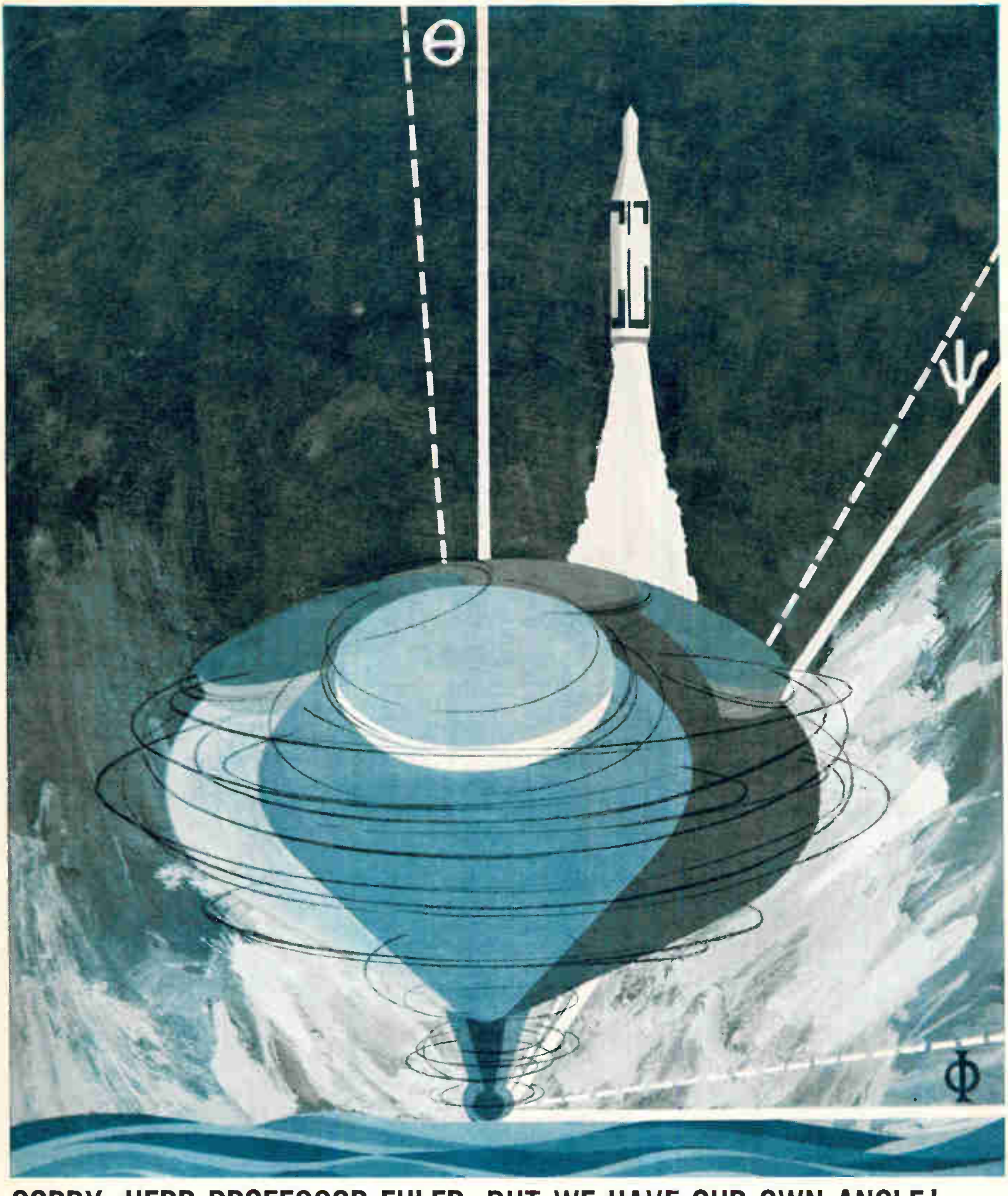
pounds were obtained from Smooth-On Manufacturing Co., Jersey City, N. J. Base epoxies of the compounds are made by Union Carbide Plastics Co., Division of Union Carbide Corp., New York, which reported this technique.

Demand Dehydrator Is Small, Portable

AIR OR GAS dehydrator that is small enough for rack mounting or shop use on a wheeled cart has been designed by Lear-Romec Division, Lear, Inc., Elyria, Ohio. It operates on the demand-regenerative heatless principle.

A small amount of expanded, dried air or gas flows back through the desiccant as needed. rather than on a preset schedule. This method prevents breakdown of the desiccant and does not require attachment to a heating power line.

The switch and valving system is



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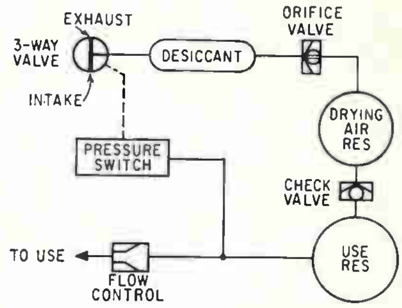
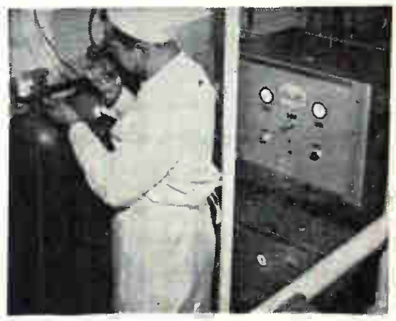
arranged (see flow diagram) to reactivate the desiccant only when the output pressure falls to a predetermined level. For example, at 120 psi, the drying air reservoir is vented to the atmosphere exhaust, expanding through the orifice valve.



Flow diagram of dehydrator

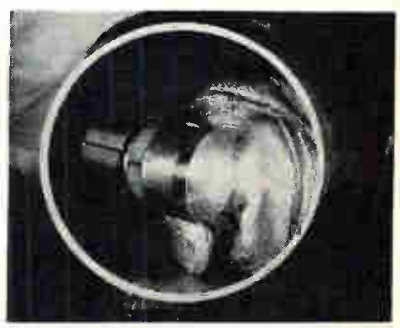


Units can be rack-mounted

When the pressure falls to 80 psi, the valving switches to the air or gas inlet. The wet gas is dried by the desiccant and recharges the use reservoir, which has supplied demand during the regeneration cycle.

As demand fluctuates, regeneration adjusts accordingly. About 1 part of gas in 10 is used in purging. The equipment will dry to −180 F dewpoint. The desiccant used is made by Linde Air Products under the trade name Molecular Sieve.

Miniature Plasma Gun



Tiny one-pound 25 Kw arc-plasma spray gun is small enough for use in confined areas. Gun, used to spray refractory coatings, is made by Plasmadyne Corp., Santa Ana, Calif.

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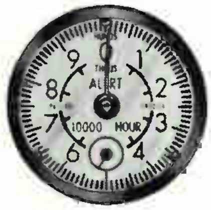

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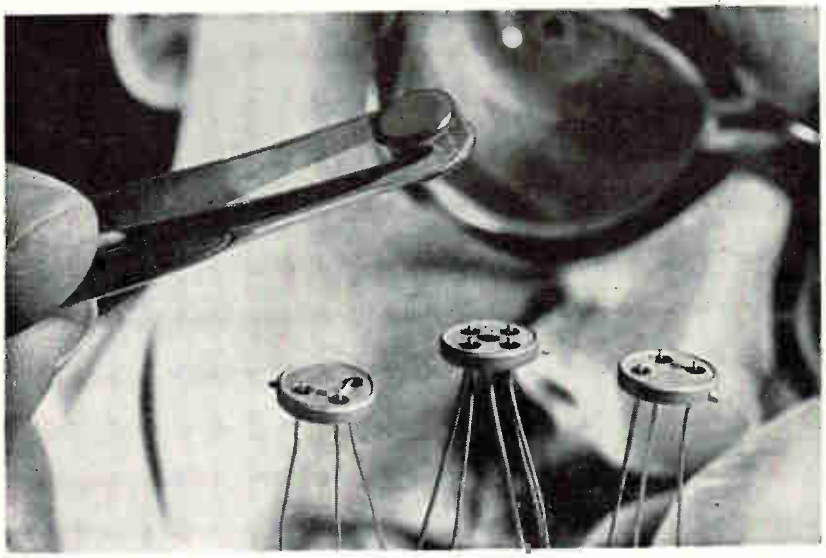
11801 West Olympic Blvd., Los Angeles 64, California

New On The Market



Siamese-Twin Transistor

TWIN-PLANAR CONSTRUCTION

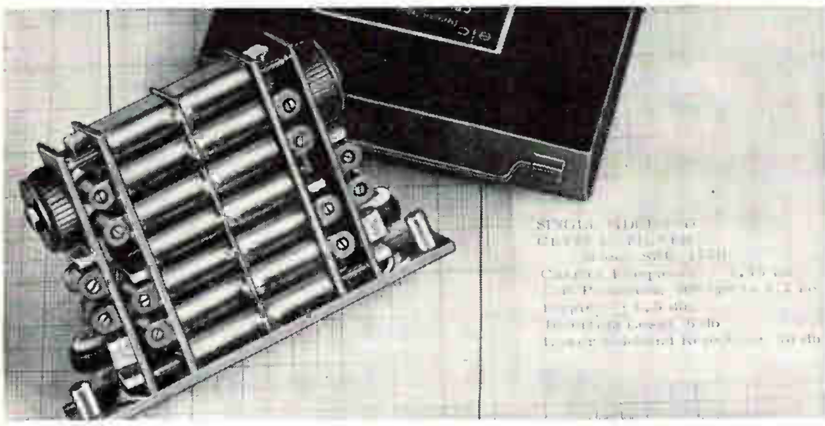
A DOUBLE TRANSISTOR incorporating planar design and construction, and called "the Siamese Twin" because it combines two identical transistors, is announced by RCA Semiconductor and Materials Div., Somerville, N. J.

The solid-state device will be offered initially as a d-c converter, with a price under $25 per unit in lots of a thousand or more.

The device consists of a two-in-one combination; two silicon transistors share a common collector. The twins are united in production and undergo almost identical stress, temperature, environment and other conditions critical to their manufacture. When completed, they demonstrate close similarity in electrical and thermal properties and are packaged as a single unit. The twin-planar can take the place of two individual transistors, and thus cut down size and cost of circuits.

A planar transistor is constructed with all electrically active areas inside the semiconductor crystal. Thus, these areas are constantly protected by the skin of the crystal, even during the manufacturing process.

CIRCLE 301 ON READER SERVICE CARD



Single-Sideband Filter

14 PIEZOELECTRIC CRYSTALS

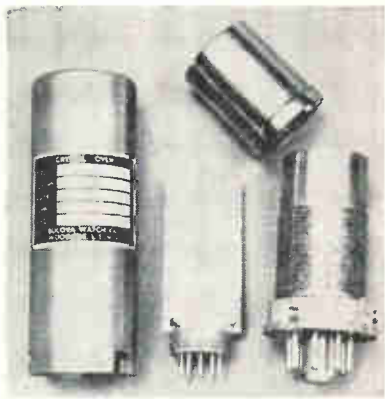
A SINGLE-SIDEBAND crystal filter using fourteen piezoelectric crystals has been developed by Electronic Laboratories Corp., 4221 Spencer St., Torrance, Calif.

The crystal filter is applicable to a world-wide communications system, and has such sharp selectivity on both sides of the bandpass that one unit may be used for alternate transmission and reception.

SBU-175B fourteen-crystal filter has the following specifications: passband from 300 cps to 3.2 Kc at a carrier frequency of 1.75 Mc; lower sideband and carrier frequency rejection of 70 db with insertion loss of 5 db and passband ripple of ± 0.5 db; operating temperature from –55 C to 85 C. The filter is housed in a 1 × 2.625 × 4.187 inch case with subminiature coaxial connectors. Performance is in accordance with applicable military environmental specifications.

Sample quantities will be available within six to ten weeks after receipt of order.

CIRCLE 302 ON READER SERVICE CARD



Variable Oven

CONSTANT TEMPERATURE

AN OVEN for temperature compensation of diodes, crystals and other electronic circuits and components that require stable temperature has been developed by Bulova Watch Co. Electronics Div., 40-01 61st Street, Woodside 77, New York.

The unit was designed to meet precision control specifications. The variable oven is less than 4 inches high and about 1¼ inches in diameter, and is regulated by a hermetically sealed snap-action thermostat.

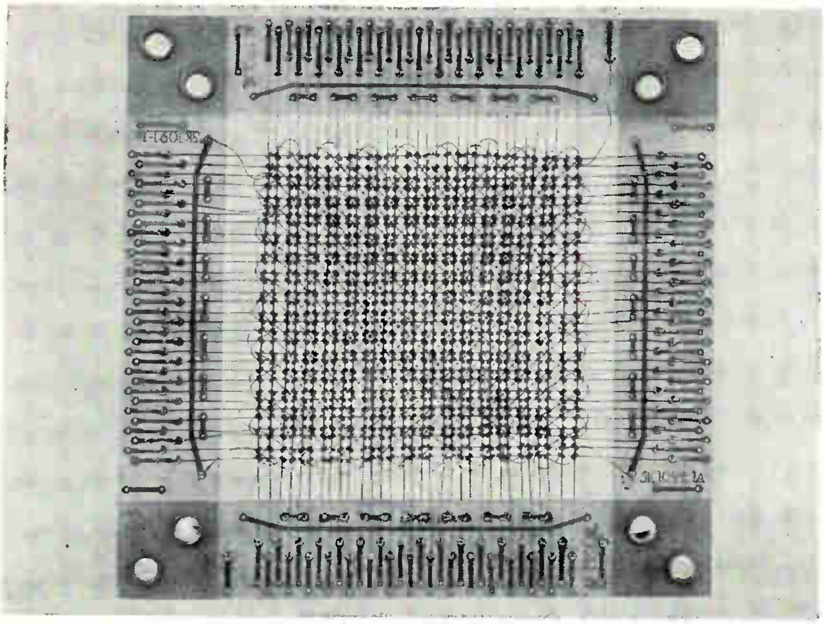
The model BG-200-4N has a removable plug-in epoxy terminal board for individual prototype engineering or production packaging. It will accept a string of Zener diodes, oscillator circuit, reference source or other components.

Among the variables available

are: temperature settings from 25 to 100 degrees C ± 3 C; voltages from 6 to 117 (a-c or d-c, 60 or 400 cps); and heater power requirements from 5 to 20 watts, depending on warmup-time required and ambient temperature.

The oven's ambient temperature range is –55 to 95 C; nonoperating ambient temperature range is from –70 to 100 C.

CIRCLE 303 ON READER SERVICE CARD



Memory Frames

PRINTED CIRCUIT STRIPS

MEMORY FRAMES tailored to meet requirements of low-cost memory systems for business computers are announced by Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles, Calif. Low cost is achieved through prefabricated printed circuit strips that minimize the assembly time of custom memory frames.

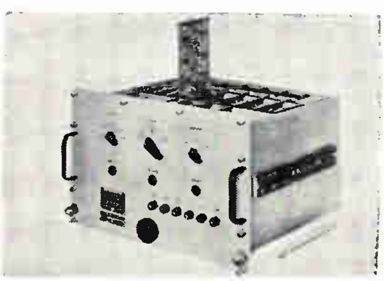
Four sizes of printed circuit strips are manufactured, allowing ten different frame configurations. The four standard sizes are 32-wire, 48-wire, 64-wire and 96-wire strips. Any of several types of 50-mil and 80-mil ferrite cores may be used in the frames. Base material can be glass epoxy, paper phenolic, or other suitable material. Solder-plated circuits are incorporated in all the standard strips. Other types of plating material are available. Price and delivery information on completed memory arrays is available on request.

CIRCLE 304 ON READER SERVICE CARD

Digital Multimeter

MEASURES FREQUENCY

MILITARIZED analog-to-digital converter for measuring a-c and d-c voltages, and resistance, frequency, and period has been announced by Packard Bell Computer Corp., 1905 Armacost Ave., Los Angeles, Calif. Designated model M7 multimeter, the digital instrument was developed for automatic checkout applications including tests of missiles, space vehicles, radar, computers, and other complex electronic equipment.



Frequency measurements from one cps to 100 Kc can be made to an accuracy of 0.01 percent ± 1 count. A measurement is completed in 0.1 second. Periods from 0.001 to 0.1 second can be measured to an accuracy of 0.01 percent. Voltage and resistance ranges extend to 1,000 volts a-c or d-c and one megohm. The multimeter fulfills the requirements of MIL-E-16400 for temperature, shock, vibration, corrosion and tilt; delivery can be made within 120 days after order.

CIRCLE 305 ON READER SERVICE CARD

Varactor Diodes

TO 150 GC CUTOFF

A SERIES of six Varactor diodes ranging in cut-off frequencies from 60 to 150 Gc minimum are announced by Tyco Semiconductor Corp., Waltham, Mass.

The AP-1 series of gallium arsenide Varactors are packaged in a conventional double ended metal/ceramic microwave diode cartridge; smaller pill-type packages are under development.

Power dissipation is 150 mw at 25 C, measured at 10 Gc; breakdown rating is 6 volts for a reverse current of 10 μa at this temperature. Devices in the series are available for immediate shipment at prices competitive with silicon Varactor diode types. The diodes are subjected to electrical tests and temperature cycling prior to shipment.

CIRCLE 306 ON READER SERVICE CARD

Power Supply Filters

REDUCE DISTORTION

MODEL PF400 power filters, products of Polyphase Instrument Company, E. Fourth St., Bridgeport, Pa., are available in 4 stock sizes: 12½, 25, 50 and 100 watts. The filters reduce harmonic distortion from 115 v, 400 cps voltage sources in laboratory installations. They can also be used with transistorized d-c to a-c 400 cps converters for changing square wave output to sine wave output. When so used the output voltage contains less than 1 percent harmonic distortion.

The filters are available either in metal cases, or uncased, or epoxy molded.

CIRCLE 307 ON READER SERVICE CARD

A NEW SERVICE

NOTICE TO READERS

FREE REPRINT OF THE MONTH

Each month the editors of *electronics* are selecting a significant article and offering it in reprint form —FREE—to readers.

For January, *RECENT PROGRESS IN MAGNETICS*, prepared by Nilo Lindgren, Assistant Editor, has been chosen. This article, in the issue of the 13th, reports on advances in all magnetic logic, comparisons of ferrite cores and thin film submicrosecond memory elements, preparation of thin films, ferromagnetic devices and studies of spiral walls in permalloy films.

Order your free copy now by checking the appropriate box on the Reader Service Card in this issue.

electronics

Literature of

GLASS-BONDED MICA Electronic Mechanics, Inc., 101 Clifton Blvd., Clifton, N. J. An applications folder outlines the advantages of Mykroy glass-bonded mica in crucial insulator applications.

CIRCLE 316 ON READER SERVICE CARD

ULTRASONIC CLEANERS L&R Mfg. Co., 577 Elm St., Kearny, N. J. A two-color sheet illustrates and describes the Ultra-Cleen 320 series of ultrasonic cleaners.

CIRCLE 317 ON READER SERVICE CARD

PROGRAMMING PANEL AMP Inc., Harrisburg, Pa. Product information bulletin No. 600 describes the AMP pinboard for matrix and other programming applications.

CIRCLE 318 ON READER SERVICE CARD

A-C VOLTMETER General Electric Co., Schenectady 5, N.Y. GEZ-3254, two pages, contains description and application of the type DB-18 high accuracy, expanded-scale a-c voltmeter.

CIRCLE 319 ON READER SERVICE CARD

SNAP-ACTING SWITCHES Unimax Switch, Division The W. L. Maxson Corp., Ives Road, Wallingford, Conn. Metal-cased snap-acting switches with sealed-plunger, roller-plunger, sealed-roller-plunger, and adjustable roller-lever or hand actuators are described in bulletin B-30.

CIRCLE 320 ON READER SERVICE CARD

FREQUENCY METERS Airpax Electronics Inc., Fort Lauderdale, Fla. Illustrated bulletin F-06 describes a new series of expanded-scale frequency meters developed to provide better than 0.1 percent accuracy in the measurement of 400 cps and 60 cps power frequencies.

CIRCLE 321 ON READER SERVICE CARD

ALUMINUM CONTAINERS The Champion Co., Springfield, Ohio, has available a brochure and a bulletin on modular deep drawn aluminum containers developed for and approved by the Naval Ordnance Laboratory for packaging repairable assembles, components and

the Week

modules of the Polaris and Sub-Roc weapon systems.

CIRCLE 322 ON READER SERVICE CARD

FACILITIES BROCHURE Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y., has available a 3-color, 20-page facilities brochure that describes the company's operations, personnel and capabilities.

CIRCLE 323 ON READER SERVICE CARD

DECADE COUNTER Burroughs Corp., Box 1226, Plainfield, N. J. A fully illustrated data sheet contains complete mechanical and electrical specifications for the DC-114 transistorized decade counter module.

CIRCLE 324 ON READER SERVICE CARD

WAVEGUIDE PRESSURE WINDOWS Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass. Bulletin WD-60 contains full electrical and mechanical specifications, as well as complete dimensions, for both solderable and flange-mounted waveguide pressure windows.

CIRCLE 325 ON READER SERVICE CARD

VACUUM FURNACES Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill., has published an 8-page bulletin describing and illustrating vacuum-type furnaces.

CIRCLE 326 ON READER SERVICE CARD

MAGNETIC COMPONENTS Tenco Electronics, Inc., 108 Cummington St., Boston 15, Mass., has available a technical product catalog of precision magnetic components.

CIRCLE 327 ON READER SERVICE CARD

SWITCHING TRANSISTORS Sprague Electric Co., North Adams, Mass. Three additional types of germanium Micro-Alloy high-speed switching transistors are described in recent engineering data sheets.

CIRCLE 328 ON READER SERVICE CARD

TRIODE OSCILLATOR John Gombos Co., Webro Road, Clifton, N. J., has published data sheet C-3 describing its 1 Kw "C" band pulsed triode oscillator.

CIRCLE 329 ON READER SERVICE CARD

Accurate Specialties Co. Expands

ACCURATE SPECIALTIES CO., INC., recently opened a 15,000-sq-ft plant in Hackensack, N. J., in an expansion move to meet the demand for its semiconductor materials. The firm now has two plants in the city.

The new facility is a modern one-floor plant specially designed for the production of these materials. It is air-conditioned to maintain the high standards of purity essential to the manufacture of semiconductor components.

Under one roof, Accurate now has been able to consolidate all its semiconductor materials production, including raw materials as well as finished subcomponents.

The plant includes production lines for manufacture of semiconductor preform disks and washers, clad metal base tab stampings, and spheres.

In this same plant, there are facilities to produce the raw materials, including rolling mills for manufacture of precision strip and clad metals.

This new, integrated facility has permitted a 30-percent increase in Accurate's semiconductor materials production.

The move also permits expansion of the company's other divisions by freeing more production areas in the other Hackensack plant.

Eisler Book Recalls Industry's Early Days

THE SIMULTANEOUS development of Dr. Charles Eisler, a noted engineer, and today's tube and lamp industry combine to form exciting reading in Eisler's autobiography entitled "The Million-Dollar Bend" (The William-Frederick Press, N.Y.C.).

Board chairman of the Eisler Engineering Co., Inc., Newark, N. J., Eisler, now in his late seventies, has more than 50 patents registered to him. The book's title comes from the patent covering his original tube exhaust method for mass producing tipless stem incandescent lamps. Photographs and drawings of many early electronics industry machines appear in the appendix.

General Electric Promotes Elias

H. J. ELIAS has been named manager of signal diode manufacturing in General Electric's newly-formed signal diode project in its semiconductor products department.

Immediately prior to his promotion, Elias was manager of quality control for the department's Syracuse plant. He will also continue in that post until a successor has been appointed.

Columbus Electronics Settles in New Plant

COLUMBUS ELECTRONICS CORP., manufacturer of double-diffused silicon rectifiers, recently moved into its newly equipped 30,000 sq ft production facility in Yonkers, N. Y., and is now in full production.

Company reports that the new plant has greatly increased its manufacturing and research facilities which include new standard production equipment supplemented by proprietary process machinery, developed and built by the firm. The new facilities also include increased mechanization in junction formation, etching and cleaning for protection from contamination.

Perkin Appoints Peter Schnipper

PETER SCHNIPPER was recently named quality control manager of Perkin Electronics Corp., El Segundo, Calif.

Before joining the power supply firm, Schnipper was in quality control management with Fairchild Controls and Triad Transformer Co.

Space Electronics Elevates Sanders

RAY W. SANDERS has been advanced to the newly created position of director of satellite and space labora-

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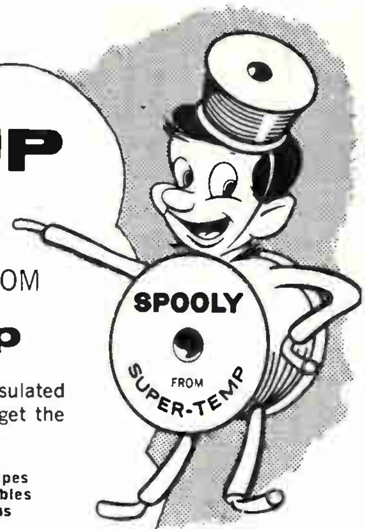
NEED

HOOK-UP WIRE?

YOU GET IT FASTER FROM

Super-Temp



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A	.001—20MF	100—30KV	—55°C +85°C	.02% 1KC	—100 PPM/C	10^7 MEG	0.1—	0.01%
B	.001—20MF	600—20KV	—55°C +70°C	.02% 1KC	+800 PPM	10^6 MEG	1.0%	3.00%
C	.001—20MF	100—30KV	—55°C +200°C	.02% 1KC	—50 PPM/C	10^7 MEG	0.1—	0.01%
D	.0001—20MF	100—60KV	—55°C +125°C	.5% 1KC	+500 PPM	10^6 MEG	1.0%	0.10%

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0.015% TOTAL HARMONIC DISTORTION

0-511.11 VOLTS MILLIVOLT RESOLUTION SIX DECADES

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- FIELD CALIBRATION
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Please write for Bulletin 146

Other Rotek instruments:
AC/DC to DC Comparators
Electronic Standard Cells
DC References

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KIrkland 7-0175

CIRCLE 85 ON READER SERVICE CARD

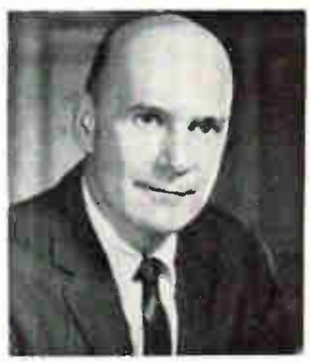
tories, Space Electronics Corp., Glendale, Calif.

Previously manager of the satellite and space systems department, Sanders has been with Space Electronics since 1958. Before that, he served with Gilfillan Brothers for seven years, including positions as the director of the missile section and of the analysis section.

Himmelstein Forms Consulting Company

A NEWLY ESTABLISHED consulting engineering firm, S. Himmelstein & Co., specializing in magnetic recording systems and computer peripheral equipments, has opened offices in Chicago, Ill.

Himmelstein, the firm's founder, has had 15 years of engineering and management experience. Most recently, he was technical director of the Data-Stor division of Cook Electric Co., where he was in charge of industrial and military recording systems and peripheral equipment developments.



Oak Manufacturing Elects Pfannstiehl

OAK MFG. CO., Crystal Lake, Ill., components manufacturer for the electronic and electrical industries, has elected Stewart Pfannstiehl as vice-president, marketing. For the past 14 years he has been associated with Cinch Mfg. Co.

Stromberg-Carlson Hires Bulkley

APPOINTMENT of David D. Bulkley as product manager for intercommunication systems in Stromberg-Carlson's commercial products division, Rochester, N. Y., has been announced.

Bulkley comes to S-C from the ITT Corp. in New York City, where he spent six years in research and development administration for the company's network of research laboratories in the U. S. and Europe.

Snyder Joins Eimac In Marketing Post

ROSS H. SNYDER has been appointed staff assistant to the director of the marketing division of Eitel-McCullough, Inc., San Carlos, Calif., manufacturer of electron-power tubes.

Before coming to Eimac, Snyder was manager of the Video Products Department of the Ampex Professional Products Co.

Schaevitz Names Production V-P

HERMAN SCHAEVITZ, president of Schaevitz Engineering, Pennsauken, N. J., announces the appointment of Russell C. Spera as vice president in charge of production.

According to Schaevitz, Spera was the company's second employee, having joined the firm shortly after its organization in 1946. The company now employs more than 250 people.

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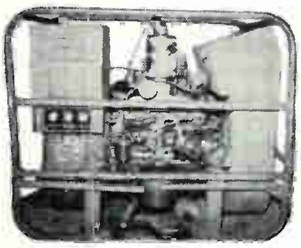

6.3 KVA, 5 KW, Model PU-104/U, single or three phase, 120/208 volts, 400 cycles. Permanent magnet alternator, made by Motoresearch Co. Hercules model ZXB, four cylinder liquid cooled engine. Direct coupled to generator. Operating speed 1714 RPM. Crank start, magneto ignition. Noise suppressed. Instrument panel equipped with A.C. voltmeter, ammeter, frequency meter, switches and controls. Dimensions: 22" wide, 37" long, 31" high. Shipping weight 560 lbs. FOB Chicago. GOVT. SURPLUS —New Condition. No. AS910 Our Price $345.00

12.5 KW, single phase or three phase, 400 cycle, 28 pole, 1714 RPM. Delta Connection: 120 volts, 3 wire, 3 phase, 12.5 KW, 75 amps., or 120 volts, 2 wire, 10 KW, 104 amps. per leg, 1 phase. Wye connection: 120/208 volts, 4 wire, 3 phase, 43 amps. per leg. Gasoline driven, Willys Jeep Engine, O'Keefe Merritt type PM-15 Alternator. Shipping weight 1220 lbs. FOB Chicago. Used — serviceable condition. No. AS911 Our price. $645.00

37.5 KVA, 30 KW @0.8 PF, 120/208 or 240/416 volts, 3 phase, 400 cycle, 4 wire, 1714 RPM. Hercules Electric Machine & Equipment Co., Model 30-W-400. Delco Alternator direct coupled to Continental gasoline engine, type M 330. Radiator cooled, skid mounted, 24 volt battery start, housed, with pre-heater for cold weather starting. Complete control panel has full engine and generator instruments, circuit breaker, voltage regulator, etc. Dimensions: 95" long, 32" wide, 60" high. Shipping weight 3500 lbs. FOB Chicago. Used — serviceable condition. No. AS912 Our price $1845.00

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For details write, Forde Motion Picture Lab, 306 Fairview Avenue North, Seattle 9, Wash.

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EMPLOYMENT OPPORTUNITIES

POSITION VACANT

Teaching and Research. Opening for Electrical Engineer with Ph.D. to supervise graduate research and do some teaching. Research experience in microwave or semi-conductors desirable. Private research or consultation encouraged. Excellent salary and rank arrangements. Department offers work leading to Ph.D. Position available September 1961 or sooner. Apply to Chairman, Electrical Engineering Department, Vanderbilt University, Nashville 5, Tennessee.

SELLING OPPORTUNITY AVAILABLE

Wanted: Territorial Representatives to sell special electronic dielectric data instruments non competitive high quality introductory sales made to leading university and research laboratories. Write stating areas visited and qualifications. Kahl Scientific Instrument Corp., Box 1166, El Cajon, Calif.—12 E 12 St. NYC 3.

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Searchlight Equipment Locating Service
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F. J. Eberle, Business Mgr.

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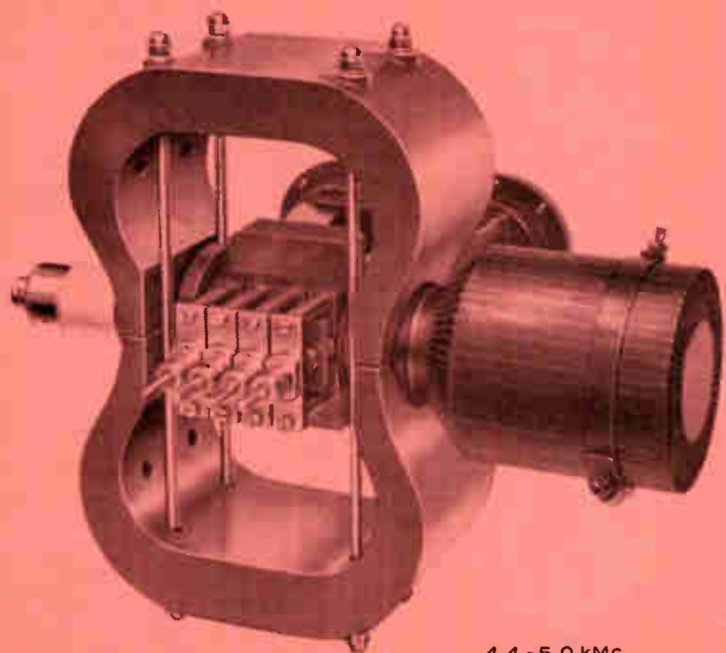
Varian presents the
VA-834B amplifier klystron
—1 kW CW—rugged
—lightweight—for

tactical mobility

In Forward
Scatter Transmitters



4.4 - 5.0 kMc
1 kW CW

Need a rugged power amplifier tube for transportable microwave field equipment? Varian's VA-834B klystron is air-cooled and permanent-magnet focused. Simplifies operation and minimizes prime power requirements. Quick and easy to install. Only adjustment necessary — just tune to desired frequency. Tunable 4.4 to 5.0 kMc with 1 kW CW output. Lightweight — only 60 lb. including magnet.

Specifically developed for tactical and transportable equipment. Suited to commercial forward-scatter communications and radar transmitters.

FEATURES ■ 1 kW CW ■ 4.4 to 5.0 kMc ■ Efficiency up to 40% ■ 45 db Gain ■ 7.5 Mc Bandwidth

Sound interesting? We'll be pleased to send you full technical data. Just write Tube Division.

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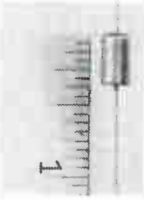
VARIAN A. G. (SWITZERLAND)



Here's RCA's brand-new idea in rectifier case design—four new silicon rectifiers in hermetically sealed flangeless metal packages. These four new types now make silicon rectifiers as easy to handle and mount as other standard tubular components. They are designed to outperform plastic-packaged rectifiers and meet the stringent heat and humidity requirements of today's industrial and commercial applications.

Using a unique combination of a silicon diffused-junction and a new case, these units can be operated at temperatures up to 75°C without derating. They are designed and priced to bring you economy and performance plus easy handling and assembly.

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RCA "TO-1" SILICON RECTIFIERS

Type	Max Ratings PIV	Max Ratings Forward Current * @ 75°C	Max Ratings Recurrent Peak Current @ 75°C	Max. Instantaneous Forward Voltage Drop @ 0.5 DC amp. @ 25°C	Max. Reverse Current @ 25°C and rated PIV
1N3193	200 v	750 ma	6 amp.	1.2 v	10 μa
1N3194	400 v	750 ma	6 amp.	1.2 v	10 μa
1N3195	600 v	750 ma	6 amp.	1.2 v	10 μa
1N3196	800 v	500 ma	5 amp.	1.2 v	10 μa

*Resistive or inductive load

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