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electronics

Circuits of adapters for f-m stereo multiplex reception, p 45

Designing wideband omnidirectional antennas for K-band, p 54

How to use the Kerr cell in nanosecond photography. See p 56

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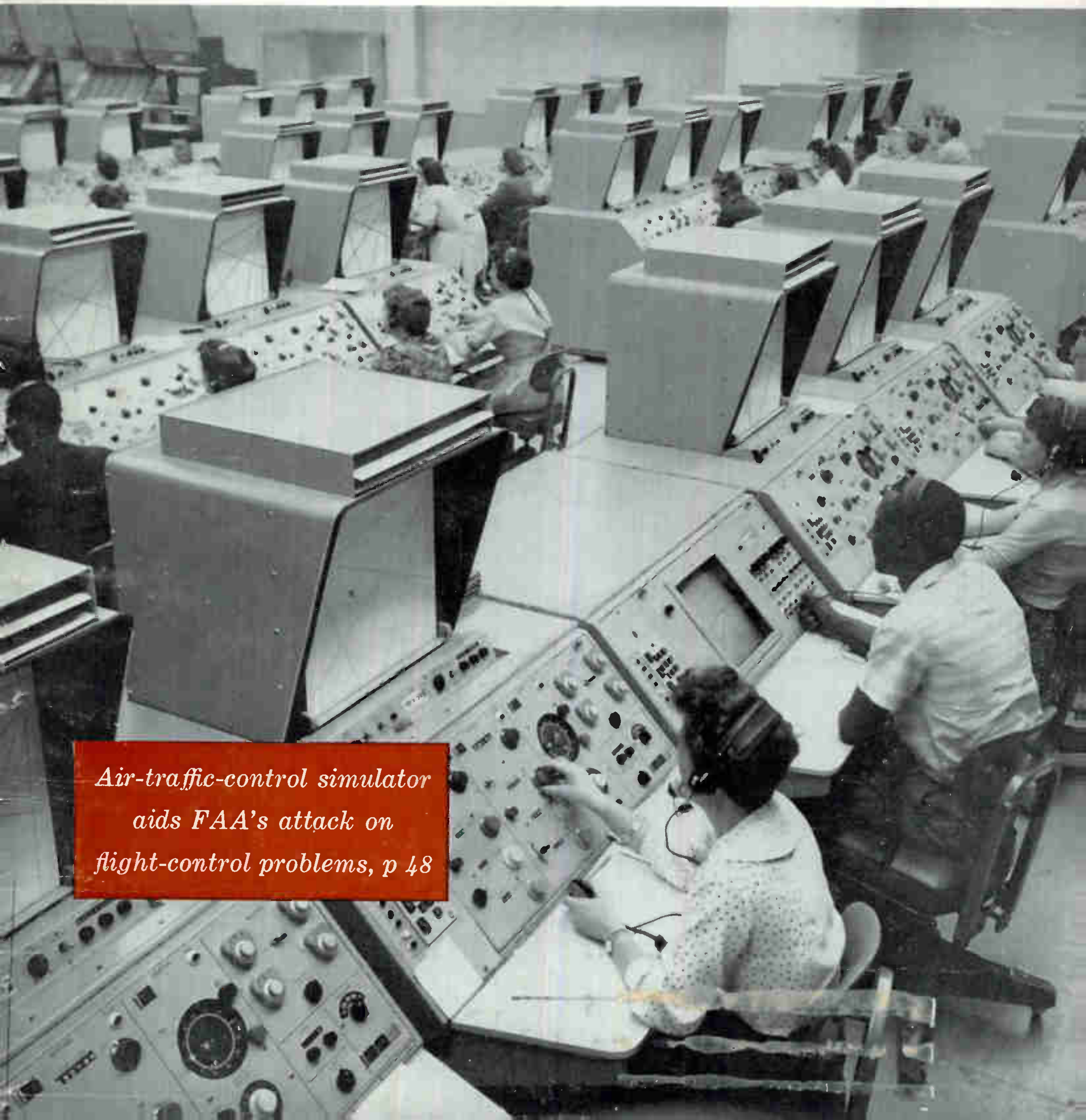
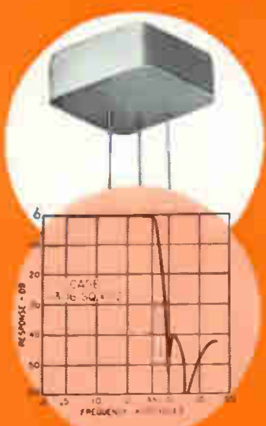


Air-traffic-control simulator aids FAA's attack on flight-control problems, p 48

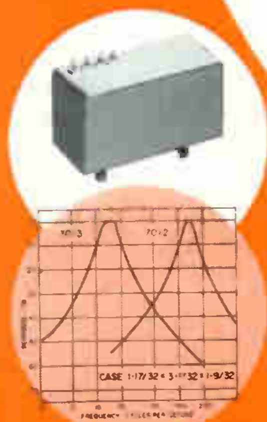
SPECIAL FILTERS

TO YOUR REQUIREMENTS

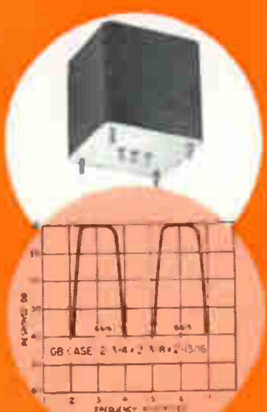
Almost thirty years of experience in the design and production of special filters have resulted in UTC being a first source for difficult units. Present designs incorporate a wide variety of core structures, winding methods, and capacitors to provide maximum performance, stability, and reliability. The units illustrated show a few of the thousands of specials produced by UTC, to customers' requirements, and only slightly indicate the possibilities in present special filter design. Range of frequencies on special units is from .1 cycles to 400 MC.



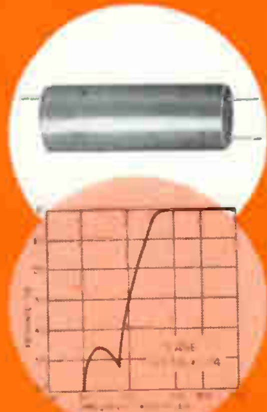
Miniaturized 3.5 KC low pass filter 10K ohms to 10K ohms. Within 1 db up to 3500 cycles. Greater than 40 db beyond 4800 cycles.



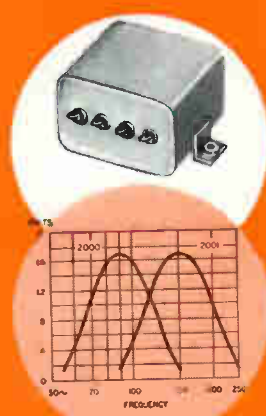
Fifteen cycle and 135 cycle filters for Tacan. 600 ohms to high impedance. Extreme stability —55°C. to +100°C.



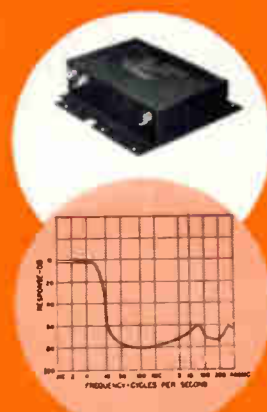
Three KC and 6 KC flat top band pass filters 400 ohms to 20K ohms MIL-T-27A each filter 1.7 lbs.



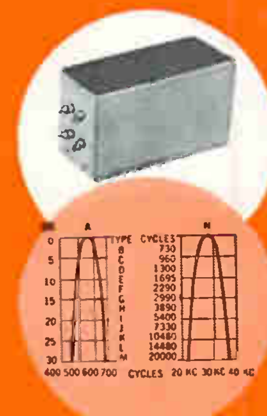
High frequency Mini filters .33 oz. MIL-T-27A Grade 5. 150 KC High Pass 3 db to 150 KC, down 45 db below 85 KC. 7500 ohms.



Curves of our miniaturized 90 and 150 cycle filters for glide path systems 1¼" x 1¾" x 1⅝".



Power line filter from sources of 50 to 400 cycles . . . attentuation from 14 KC to 400 MC . . . 29 cubic inches.



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August 18, 1961

electronics

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W. W. MacDONALD, Editor

One problem in air traffic control studies is duplicating actual conditions realistically. Air traffic simulation is used by FAA to solve complex problems. See p 48 — COVER

Metallic Vapor Plasma: Future propellant? — 20

Successful Midwest Program Will Mean 'Sky's the Limit' for Educational Tv — 26

DEFENSE BUYING: NEEDS NEW EVALUATION FACTORS? Hazeltine's board chairman, W. A. MacDonald, presents his views — 28

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Air Traffic Control Simulator Generates Data for Computers. Aids solution of complex control problems. By E. Boyle, Jr., R. Edwards, Jr. and R. Nicht — 48

OMNIDIRECTIONAL K-BAND ANTENNA Uses Slots, Probes and Horns. Has 1.5 to 1 bandwidth, with less than 3:1 voltage swr. By G. J. Monser and E. D. Botkin — 54

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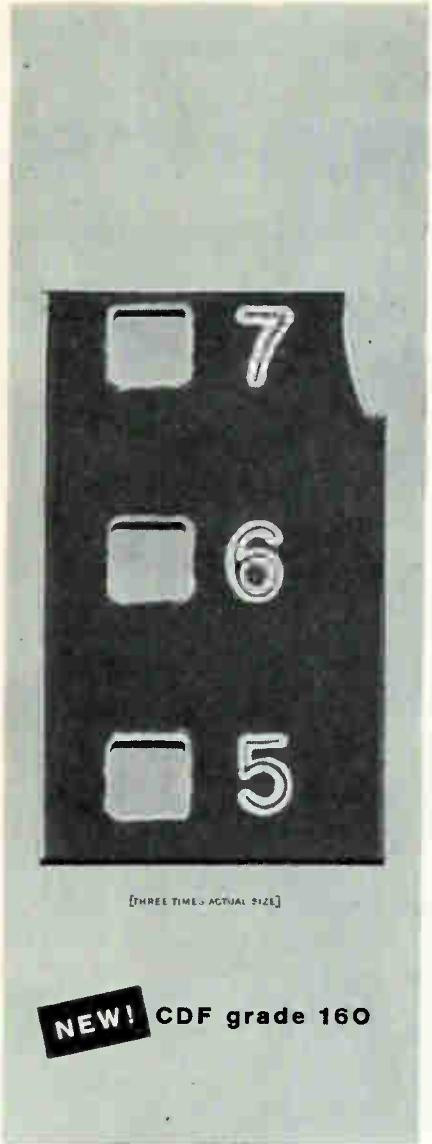

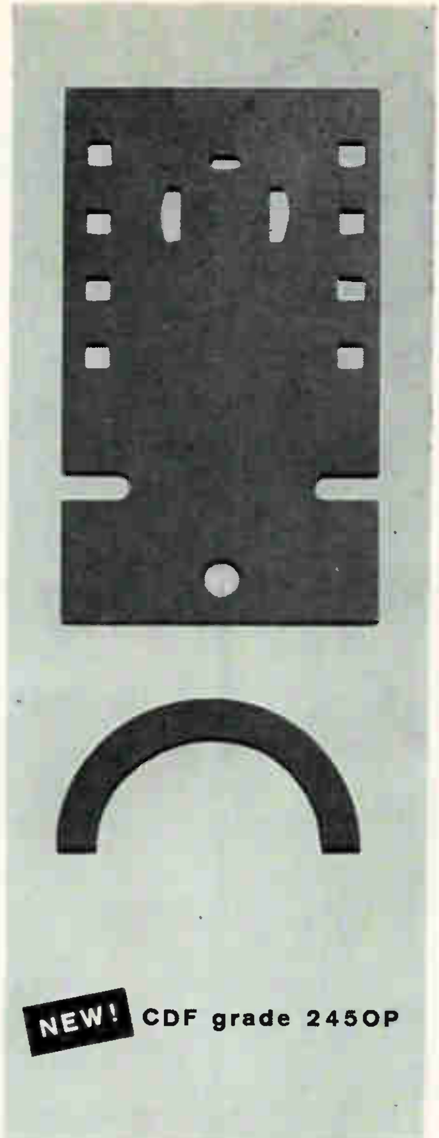

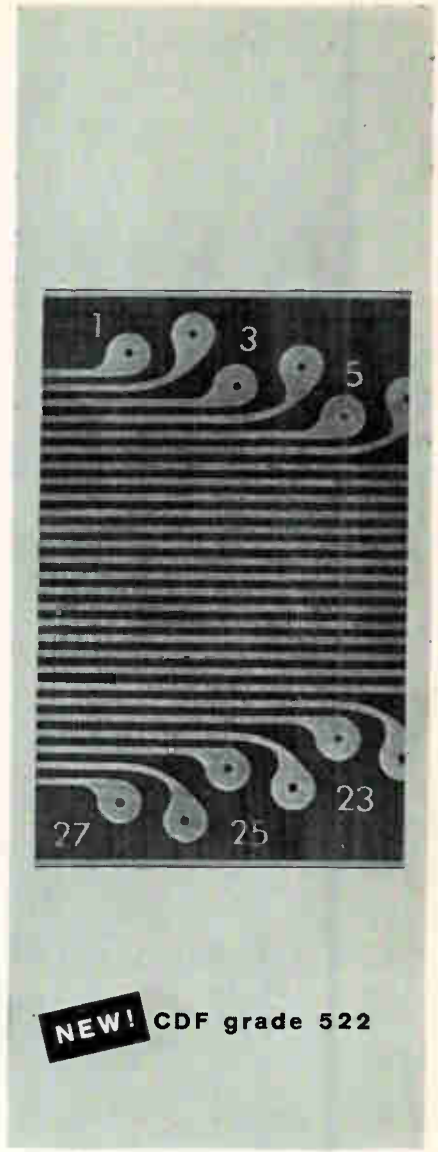

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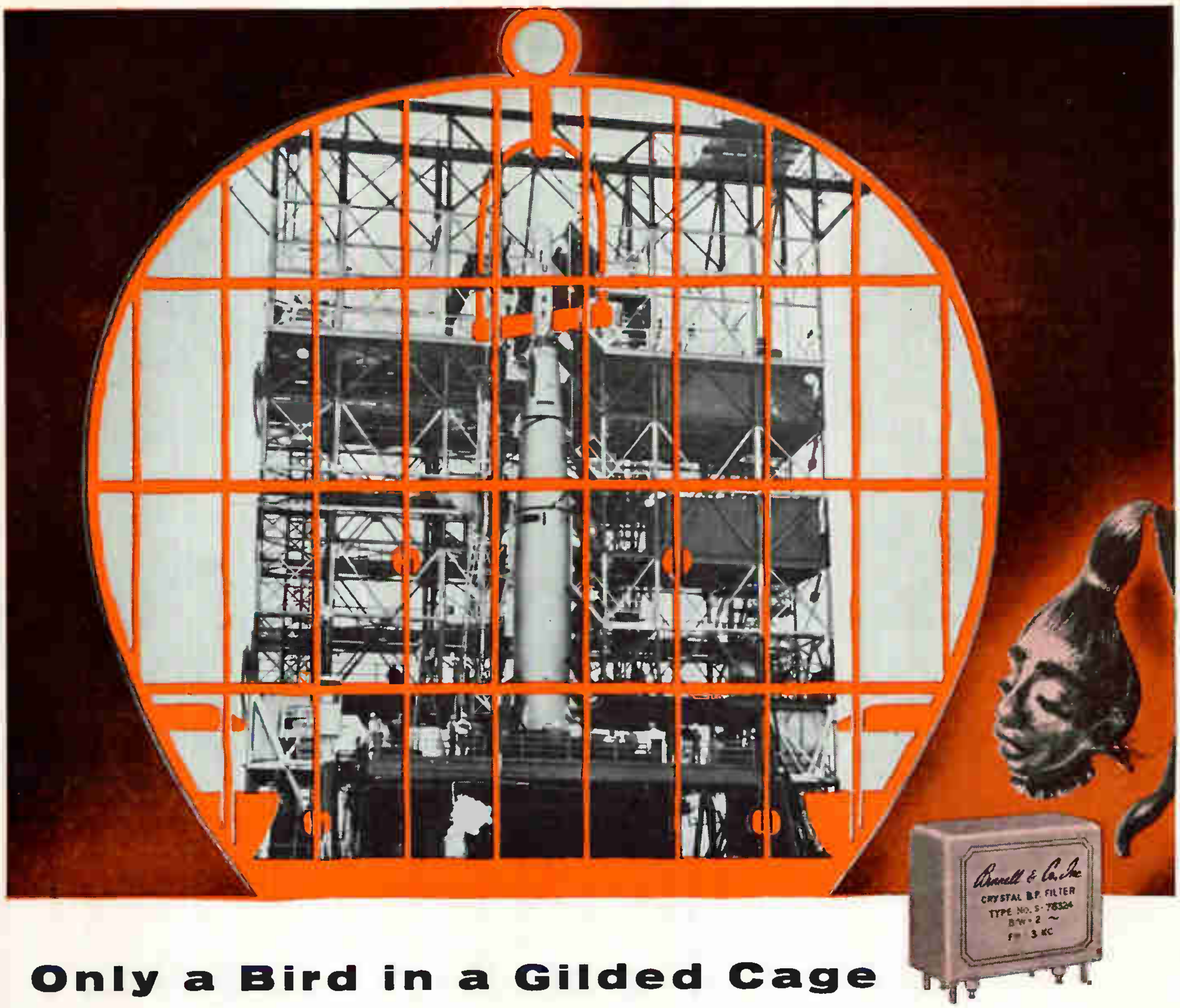


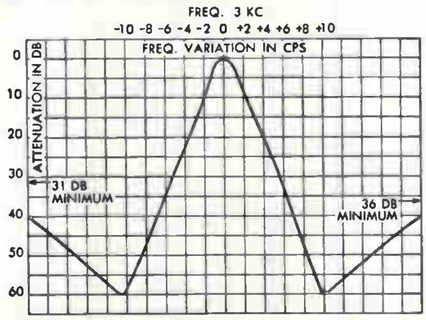
Only a Bird in a Gilded Cage

As succeeding generations of missiles penetrate the curtain of space that separates Earth from other planets, the importance of electronic guidance, control and airborne telemetry systems becomes obvious. For, without new engineering design techniques to provide reliable communication and control, the most advanced missile is but a bird in a gilded and very expensive cage.

As typical examples of what can be accomplished to insure maximum performance in missile telemetering, communication, data processing and other applications, Burnell & Co. has developed two new filters—a miniature 3 kc crystal filter and, employing modern synthesis techniques, a miniature 500 kc LC toroidal filter possessing low transient distortion characteristics.

TECHNICAL DATA
3 kc Crystal Filter

Attenuation—3 db B/W—2 cps
Shape Factor—30/3—5:1
Impedance—500K in and out
Temp. Coeff.—.021 cps °C
Size—3½ x 2$^{5}/_{16}$ x 1$^{7}/_{16}$
Insertion Loss—3½ db
Also available in any impedance from 500 ohms to 500K

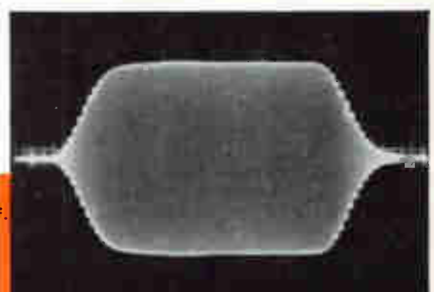


TECHNICAL DATA
500 kc LC Toroidal Filter

Attenuation—B/W 40 kc at 3 db
—200 kc at 50 db
Impedance—50 ohms in and out
Insertion Loss—4.5 db
Over and undershoot—
(for a step modulated 500 kc carrier)—less than 1%
Size—⅞ x 3 x 1½

Other Burnell filters are available in frequencies up to 30 mcs over a wide range of impedances.

Write for new catalog.



Filter response to step modulated 500 kc carrier

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August 18, 1961 Volume 34 Number 33

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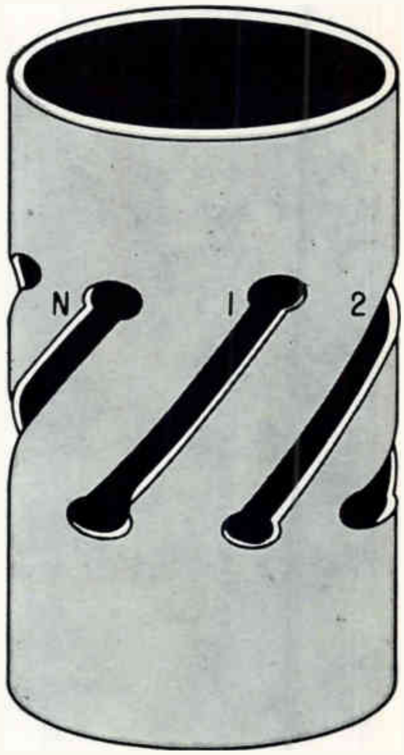


K-BAND ANTENNA. Accompanying illustration is a conceptual drawing of a pseudoisotropic source that is responsive to both vertical and horizontal waves and provides omnidirectional coverage in the horizontal plane. It is the basis for the K-band antenna in this issue by G. J. Monser and E. D. Botkin of American Electronic Laboratories in Lansdale, Pa. Their article begins on p 54.

Incidentally, if particularly concerned with designing low-frequency and very-low-frequency antennas, then you will want to refer to Monser's earlier articles in ELECTRONICS. These have dealt with pickup devices (p 68, April 14, 1961), design charts for l-f antennas (p 90, April 7, 1961 and p 86, March 18, 1960), and designing antennas for maximum l-f radiation (p 84, June 3, 1960, coauthored with W. D. Sabin of Motorola).

DEFENSE BUYING. The day of looking at military procurement problems and saying, as people do about the weather, "Everyone talks about it but no one does anything," is outdated. Present world conditions are too serious to let supposedly witty verbal lines stand in for national defense lines.

Hazeltine Corp.'s chairman of the board, W. A. MacDonald, believes the time has come for *constructive* suggestions for defense procurement. He thinks the low bidder should *not* always get the contract. He says other factors should be considered. A company's past quality, past deliveries and present capabilities always should be weighed, he says (His block diagram on p 28 suggests that Company B, although high bidder, should get a contract because its "effective price" is lower than Company A's.)

Executive MacDonald also thinks our country needs electronic systems developed and produced "at the most economical cost over the useful life of each system". What are your views? And what are your suggestions?

Coming In Our August 25 Issue

MEDICAL ELECTRONICS. Use of electronics as a weapon against disease, illness and infirmity is receiving world-wide attention. Speakers from 15 countries presented 299 papers on this subject at the joint convention of the 4th International Conference on Medical Electronics and the 14th Annual Conference on Electrical Techniques in Medicine and Biology in New York City recently. Associate Editor Bushor, who attended the five-day meeting, brings you the highlights in his article next week. You'll read about computer diagnosis, instrumentation for measuring circulatory parameters, various kinds of cardiac instrumentation, the infrared microscope, and electronic techniques in gastroenterology.

COMMENT

Revamping Patent Procedures

Regarding the "Washington Outlook" story on revamping U.S. Patent procedures in the July 14 issue, much more detail is required for clarification.

Does "patent applications would be published shortly after they were filed—" mean that this would be done without the customary search and prosecution procedures?

Also, when would the 17-year patent life begin? If it starts with actual use of the patent this Dutch system would be welcomed by many inventors because a great many patented inventions never get into use until they expire into the public domain.

BENJAMIN F. MIESSNER
MIESSNER INVENTIONS, INC.
MIAMI SHORES, FLA.

The whole idea of this plan is to avoid unnecessary work on the part of the U.S. Patent Office so it can more quickly process useful inventions. Therefore, publishing of information on inventions would be done before search and prosecution by the Office. By releasing information in this way, the need for the patent in industry could be more easily ascertained. The inventor is proteced by his filing date, so that once a need is ascertained, the search and prosecution can proceed to verify the validity of the invention, including the application filing date. The 17-year patent life would begin with the date of filing as indicated by the story wording: " . . . actual issuing of a patent on the filing . . . "

Rocket Antenna Breakdown

In your issue of June 9, 1961 under Electronics Newsletter, page 9, there is a paragraph entitled "Rocket Antenna Breakdown Investigated by Air Force."

This difficulty of antenna breakdown at high altitudes was experienced by the Martin Company, Denver Division, in 1956, and in January 1958 a contract was signed with the Purdue Research Foundation to make the necessary investigation. This investigation covered the determination of the actual breakdown electric field intensity of ionized air over a pressure range from 760 mm H_g to 10^{-2} mm H_g, and over a frequency range from zero to 10,000 megacycles.

The final report, dated Apr. 30, 1959, was entitled "Voltage Breakdown in Ionized Air at Frequencies from Zero to 10,000 Megacycles", by W. H. Hayt Jr., R. H. George, and H. J. Heim. This report contains a theoretical investigation and all experimental data in curve form so as to make it most useful to designing engineers.

I believe that a copy of the final report may be obtained from the Air Force or the Martin Company, but if not, the Purdue Research Foundation could probably supply it.

H. J. HEIM
PURDUE UNIVERSITY

Discriminator Without Coupling

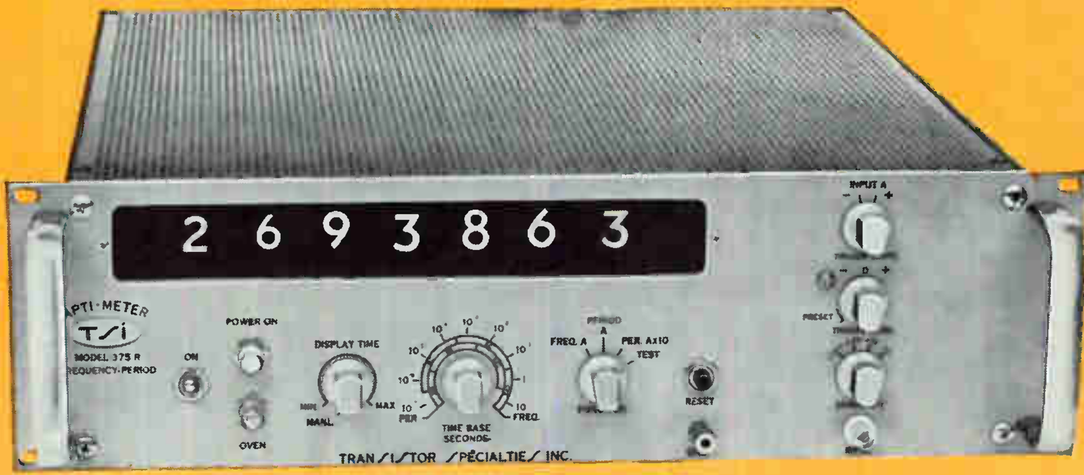
I am writing this letter in the hope that it may be useful to reader Shaphira (*Comment*, June 2) who looks for discriminators without magnetic coupling. Apart from that one discussed in the April 1 issue of ELECTRONICS (p 63), there are at least four more that were published in American books:

1. The "Weiss" on pages 302-308 of Volume 16 of the "Radiation Laboratory Series".
2. The "Peak Reading" pages 35-38 of Volume 23 of the same series.
3. The wide-bandwidth discriminator of fig. 17-11 page 452 of the same Volume 23.
4. The "Grandlund" detector in the article "Sky Wave F.M. Receiver" published in ELECTRONICS on December 1, 1949 (page 101).

I am very grateful to reader Shaphira, for his letter drew my attention to a kind of discriminator I completely overlooked in spite of being very interested in them.

It is very curious how things happen. Perhaps reader Shaphira will know a little more about discriminators by getting answers from New York via Barcelona as I did with his letter from Tel-Aviv.

ADRIAN GIBERT
COSMO CORP
BARCELONA, SPAIN



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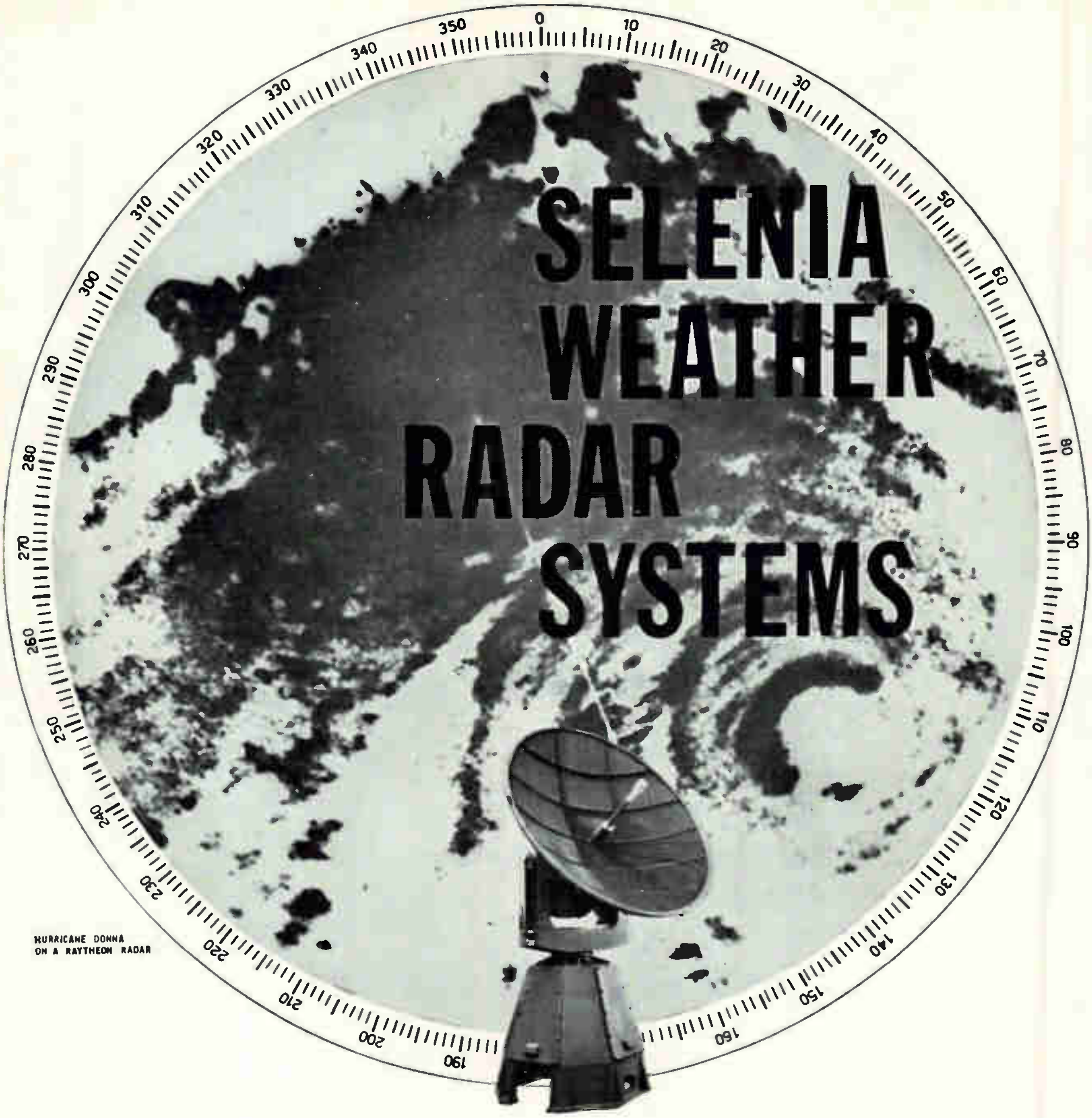

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ELECTRONICS NEWSLETTER

Superconductor Electrons Travel Only In Pairs?

SOME ANSWERS to the mysteries of superconductivity, superfluidity and related oddities of super-cooled materials have been provided by recent research work at Stanford University.

Described in a late issue of *Physical Review* Letters, the investigations suggest that the reason a superconductor will accept current only in discrete quantities of predictable sizes is that electrons in a superconductor move only in pairs and in unison, and that injection of less than the required amount of current throws the electrons out of step.

These "quantized" amounts of current, the investigators maintain, are inversely proportional to the size of the combined charge of two electrons, and can be predetermined by the formula $hc/2e$ where h is Planck's constant, c is the velocity of light, and e the charge of an electron.

Since random movement of electrons is believed to be the reason for electrical resistance, the concept of unified, marching movement of electrons, as contrasted with the chaotic motion at normal temperatures, is a likely answer to why superconductors offer no resistance to current flow.

The Stanford researchers used a tin-plated copper wire. Current, induced in the tin by electric coils, was measured by moving the superconductor rapidly up and down inside dewar flasks filled with liquid helium while observing the resultant magnetic field variations. Still being sought is the answer to why normally good conductors make poor superconductors, and conversely.

New Solar Unit's Power Improved By Factor of 6

A SUN-TRACKING solar-cell power unit, reportedly improving power capability of flat stationary cells by a factor of six, is announced this week by Hoffman Electronics.

Using 36 standard solar cells and measuring 12 by 24 inches, the power section is capable of 12 watt hours per average day. Sun-tracking portion of the unit uses two banks of nine cells each mounted at opposite ends of a cross bar, a simple bridge circuit, and a 10 milliwatt motor.

When the device is pointed directly at the sun, power output from these two banks is equal. When a power differential exists, the motor turns in either forward or reverse direction until the main power bank is again in optimum position. Among applications suggested by Hoffman are power sources for harbor buoys, and battery charges for any use where remote automatic operation is involved. To be introduced next week at WESCON, the device is expected to sell for approximately $150.

Self-Organizing Data Processor Gets Chore

SELF-ORGANIZING data processor developed by Raytheon incorporates rudimentary learning characteristics, and is working on military problems for the Department of Defense.

Called the Cybertron, the machine duplicates human learning processes of experience, trial and error, correlation of new facts with experience, instead of attempting to duplicate neural networks of the brain by electronics. As the first model works on military problems, larger Cybertron is being developed for speech compression, synthesis projects. First model has worked successfully on analysis of cardiograms, discrimination of radar and sonar echoes.

Extensive applications of advanced learning machines are seen in weather forecasting, language translation, analysis, sorting of industrial or agricultural products, and design of components for more highly discriminatory radars.

New Radar Generator

A GENERATING UNIT described as a major breakthrough in radar was announced by the Army last week.

The new generator will enable radar to pinpoint targets with 10 times the precision now available in comparable equipment, the Advanced Research Projects Agency said.

The generator, developed by Alco Products Co., Auburn, N. Y., and Westinghouse, will be used this summer to observe intercontinental ballistic missiles fired over the Pacific as targets for the Nike-Zeus antimissile missile.

Three British Firms Planning Big Merger

LONDON—Three British firms—the Plessey Company Ltd., Automatic Telephone and Electric Company Ltd., and Ericsson Telephones Ltd. —last week announced plans to merge into a new group with assets of over $126 million and a market capitilization of $210 million.

Aim of the merger is to avoid duplication of effort in the communications field and to promote more intensive and efficient use of research and production facilities. Both A.T.E. and Ericsson are to remain independent firms with their own boards and representatives on the main board of the new group.

Advanced Electronics Lags In Midwest, Survey Reports

CHICAGO—Area electronics firms lag behind east and west coast rivals in exploring advanced fields such as solid state, computers, microwaves, weapons systems, command and control systems or sophisticated instrumentation—according to preliminary results of survey initiated by IRE Professional Group on Engineering Management, sponsored by National Electronics Conference and supported by grants from more than 25 Chicago electronics companies. Despite some optimism during past year, situation hasn't changed noticeably, reports survey's director, Albert H. Rubenstein, industrial engineering professor at Northwestern University.

Survey findings (to be announced at NEC Oct. 9-11) indicate the area has less than a dozen new research-based enterprises.

The Chicago area also has poor success in recruiting and holding outstanding researchers, compared with other electronics centers, survey shows—adding that part of the difficulty comes from local manufacturers' reliance on production and sales dominance, instead of on research and development advances.

Manufacturers' attitude is also reflected in poor relations with local universities, report concludes. Most Chicago electronics companies are "low level" in sponsorship of advanced degrees, cooperative research projects or research seminars, says the report, adding that company support of such activities is completely lacking for a large percent of Chicago area firms.

Counters Trending Towards Solid State

INSTRUMENTS for frequency and time interval counting are trending towards solid state, according to displays in the new Electronic Engineering Representatives Road Show.

The new counters, with ultra-high-speed switching transistors affording wider frequency counting ranges and increased reliability, are also smaller and more portable than previous models. Low power consumption and corresponding minimal heat generation are other features.

All told, over 400 electronic instruments made by 60 manufacturers will be displayed in three eastern states by the EER traveling exhibit, which opens Sept. 7 at Ossining, N. Y.

Radiation-Checking Unit Now Size of .22 Shell

TINY radiation-measuring devices no bigger than a .22 shell and a wedding ring are now possible because of instrumentation research at the Atomic Energy Commission's plant in Richland, Wash.

These and other-sized ionization chambers are coupled with an ionization chamber pulse reader to furnish sensitive and accurate measurements of radiation doses.

A typical ionization chamber is an air-filled tube with a wire electrode in the center carrying an electrical charge. High quality insulators separate the tube and wire electrode. Radiation streaming through the chamber converts some of the air molecules to electrically charged ions that reduce the charge on the electrode.

The pulse reader measures the amount of current required to recharge the electrode. From this measurement, the amount of radiation that passed through the chamber can be determined.

Tests Computer Memories Before They're Installed

AN ELECTRONIC "exerciser" that tests core memory units before installation in computers has been developed by RCA.

The Core Memory Exerciser functions by setting up a pattern for writing digital information into the memory unit and reading it back, firm says. A comparator circuit determines whether the readout corresponds precisely with the initial input. When an error occurs, the location of the trouble is pinpointed electronically on a display panel.

Japanese Tv Chassis Sales to U.S. on Rise

TOKYO—Japanese tv manufacturers think they have growing opportunities for competing in the U. S. television market—by exporting tv chassis. As a matter of fact, what went to the U. S. last year were mostly chassis and most of this year's tv exports to the U.S. are also chassis.

Japan's tv exports to the U. S. during the first six months of this year were 6,705 units worth $401,401 as compared with 72 units worth only $7,774 during the same period last year.

In Brief . . .

SCIENTISTS reported last week that radio signals from Transit IV-A satellite are so accurate that navigators could use them to set their clocks.

THE 1961 German Radio and Television Exhibition will be held from next Friday to Sept. 3 in Berlin—for the first time after an interval of 22 years.

AUTOMATIC stabilization equipment for Navy's first hydrofoil antisubmarine patrol boat will be built by Hamilton Standard, division of United Aircraft, under a contract with Boeing.

COMMERCIAL PRODUCTION of a thermoelement in 16 varieties by soldering perforated plates was started last week by Japan Thermo-Element in Tokyo.

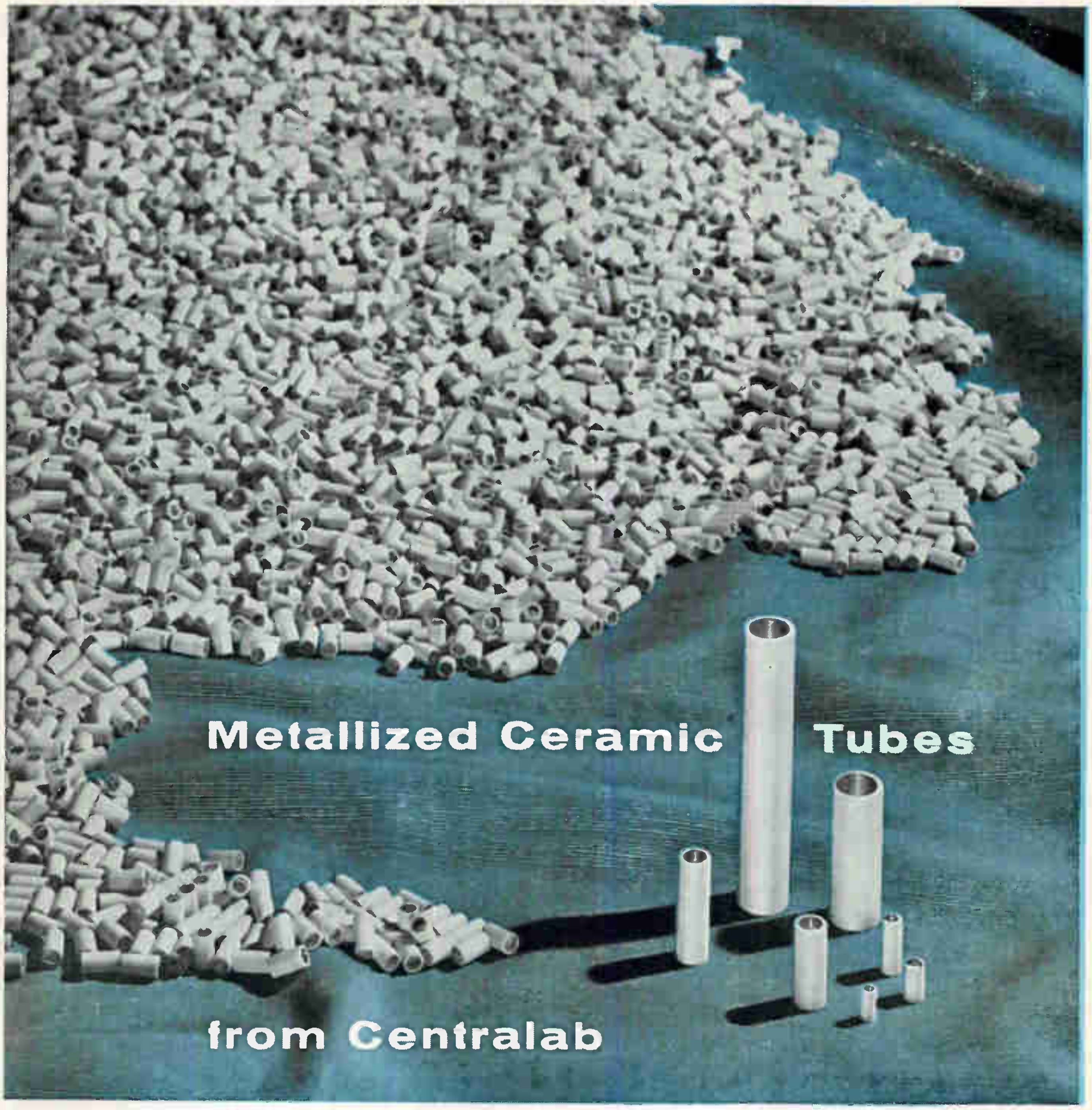
BENDIX SYSTEMS division gets an $8-million Air Force contract for work on a rocket-borne communications system.

A FOUR-COMPUTER seat reservation system has been ordered by British European Airways from Standard Telephones and Cables Ltd., London. Total cost: $13 million.

TWO NEW bibliographies listing government research reports, translations, and other technical documents on infrared light are available (10 cents each) from the Office of Technical Services, Department of Commerce, Wash. 25, D. C. Order: SB-466, SB-467.

INSTALLATION of secondary surveillance radar transponders in all civil aircraft flying above 25,000 feet above Britain will be compulsory within about a year, the Ministry of Aviation announced in London last week.

A $10-to-$12-million order for airborne radar antennas to be produced for governments of four European countries has been received by Dalmo Victor division of Textron Inc. The countries are Belgium, Italy, the Netherlands and West Germany.



for component hermetic sealing

Capacitors, resistors, transistors, diodes, coils, and other components will more readily meet MIL specifications for temperature, humidity, and vibration when hermetically sealed in CENTRALAB metallized tubes.

Metallized tubes of steatite or high alumina ceramic are available from CENTRALAB in a comprehensive range of standard sizes—many of which can be delivered in 48 hours. Tubes of other dimensions, including smaller sizes, can also be supplied, with initial delivery in 5 to 6 weeks, repeat orders in 3 to 4 weeks.

These tubes are internally metallized on both ends and will generally meet MIL specifications for thermal cycling from —65°C. to +125°C. Technical assistance for production sealing is provided by the CENTRALAB Engineering Department.

The standard sizes are listed in CENTRALAB Engineering Bulletin EP-978, available free on request.

STANDARD SIZE RANGES

Inner Diameters	Outer Diameters	Lengths
.105″ to .300″	.156″ to .395″	.250″ to 2.250″

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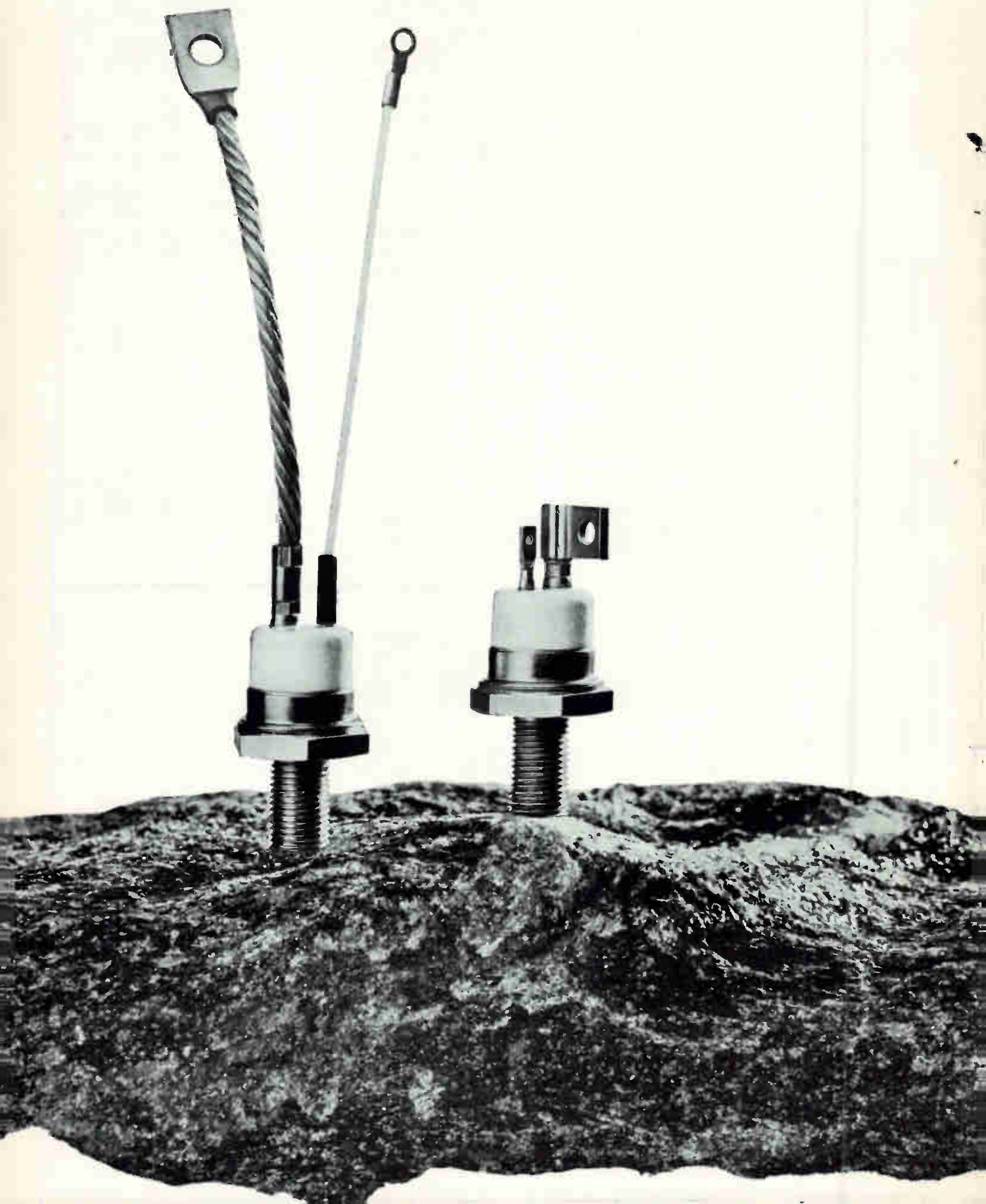

Westinghouse announces new 70-amp ratings in "Rock-Top" Trinistor® controlled rectifiers

Highest rated flag type in the industry. Type 809 Trinistor controlled rectifier series, in both flag terminal and flexible lead types, now immediately available in production quantities at 70-amp ratings! Exclusive Westinghouse "Rock-Top" construction offers superior electrical and mechanical characteristics for greater performance reliability under all operating conditions. Provides positive protection against arcing at highest voltages. Exclusive new flag terminal design has lower weight . . . requires less headroom. Outstanding parameters include: ▪ 600 nanosecond switching time ▪ efficiencies in excess of 98% ▪ minimum noise level ▪ peak reverse voltages to 480 volts ▪ ideal parameters for high-speed static switch functions.

Industrial, commercial, and military applications include: high-frequency power generation; variable frequency controls; pulse generation; ignitron firing; welding control. Trinistors also replace thyratrons, contactors, magnetic amplifiers, relays.

For more information, or technical assistance, contact your nearest Westinghouse representative, or write: Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Penna. *You can be sure...if it's Westinghouse.* SC-1046

For Immediate "Off-The-Shelf" Delivery, Order From These Westinghouse Distributors:

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ACK SEMICONDUCTOR, INC. Birmingham 5, Ala./FA 2-0588
CAMERADIO Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700
ELECTRONIC WHOLESALERS, INC. Melbourne, Florida/PA 3-1441
GENERAL RADIO SUPPLY CO., INC. Camden, N. J./WO 4-8560
GENESEE RADIO PARTS CO. Buffalo, N. Y./TR 3-9661
KANN-ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242
MILGRAY ELECTRONICS New York, N. Y./RE 2-4400
RADIO & ELECTRONIC PARTS CORP. Cleveland, Ohio/UT 1-6060
SCHWEBER ELECTRONICS Long Island, N. Y./PI 6-6520; Silver Spring, Md./JU 5-7023

MIDWESTERN

E.C.I. SEMICONDUCTORS, INC. Kansas City, Mo./WE 1-0829
ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9916
HALLMARK INSTRUMENTS CORP. Dallas, Texas/RI 7-8933
INTER-STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 5-8257
LENERT CO. Houston, Texas/CA 4-2663
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UNITED RADIO, INC. Cincinnati, Ohio/MA 1-6530

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ALMAC ELECTRONICS CORP. Seattle, Wash./PA 3-7310
ELMAR ELECTRONICS Oakland, Cal./TE 4-3311
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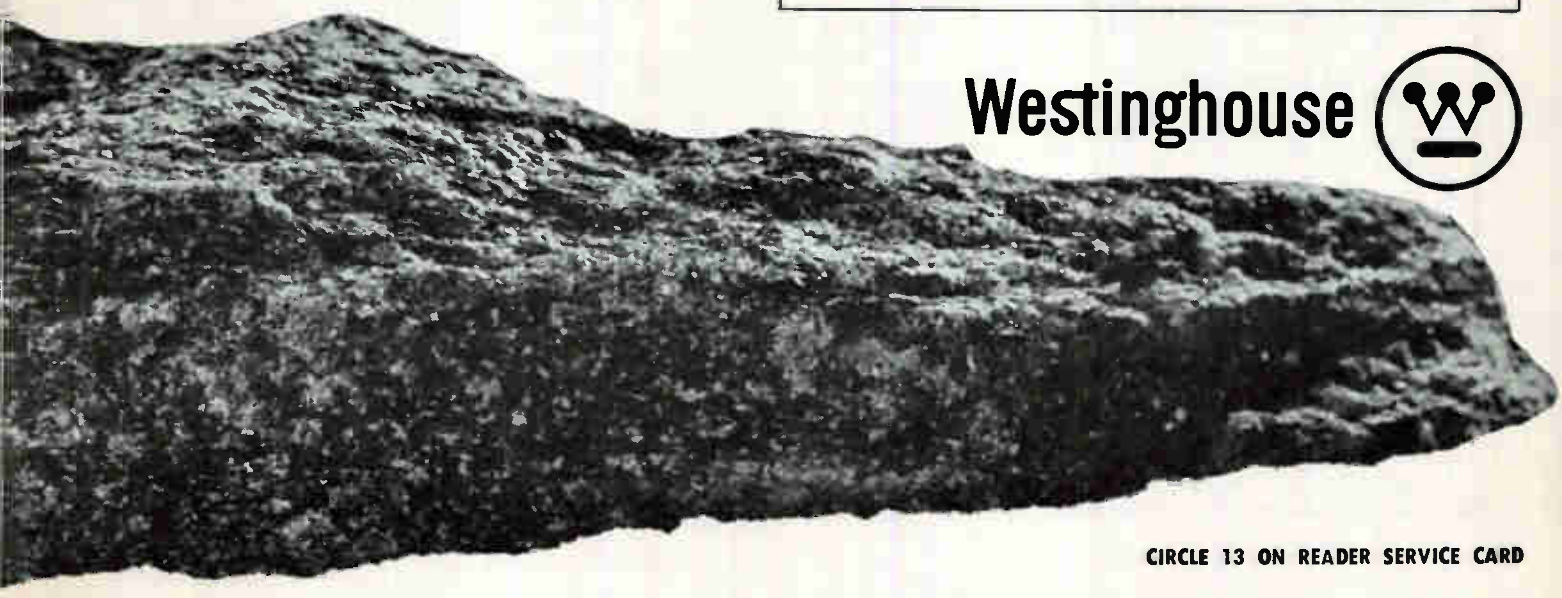


Westinghouse

CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK

STRONG OPPOSITION is mounting over the administration-backed plan to limit ownership of a communication satellite system to international carriers. The latest bloc to attack the ownership proposal comes from powerful Democratic congressmen led by Rep. Emanuel Celler (D.-N.Y.), chairman of the House Judiciary Committee; Senator Hubert H. Humphrey (D-Minn.); and Senator Estes Kefauver (D.-Tenn.), chairman of the Senate Antitrust Subcommittee.

The legislators, reportedly, will press hard to get the ownership extended to equipment makers such as General Electric, Lockheed Aircraft, etc. There has been mounting concern about the way the administration proposes to limit ownership of the system. The Department of Justice has always supported an ownership plan that would encompass international carriers, domestic carriers and equipment makers. The Federal Communications Commission, however, has overruled the Justice stand and come out in favor of limiting the ownership to the 10 international carriers.

Some legislators have come out in favor of the government retaining ownership of the system with industry operating it. As it stands, the FCC has asked the international carriers to submit an ownership proposal by Oct. 13.

CONGRESS has voted some $2.7 billion for space research in fiscal 1962. A large chunk of this will go to the electronics industry. Of the total, the military will receive $1 billion and the National Aeronautics and Space Administration $1.7 billion. Congress, however, cut some $112.5 million from the administration's request for the space agency funds. Some $75.5 million was trimmed from R&D spending with the balance coming out of salaries and expenses and construction.

The legislators left the job of deciding which specific programs that will be cut to NASA, however. At the same time, Congress added $85 million to the $100 million requested by the Administration for the Air Force's Dyna-Soar program that is designed to extend manned aircraft flight to the edge of space as a follow-on to the X-15 experiment. Estimates are that this will enable first flights to be made around 1965, some two years ahead of the previous schedule.

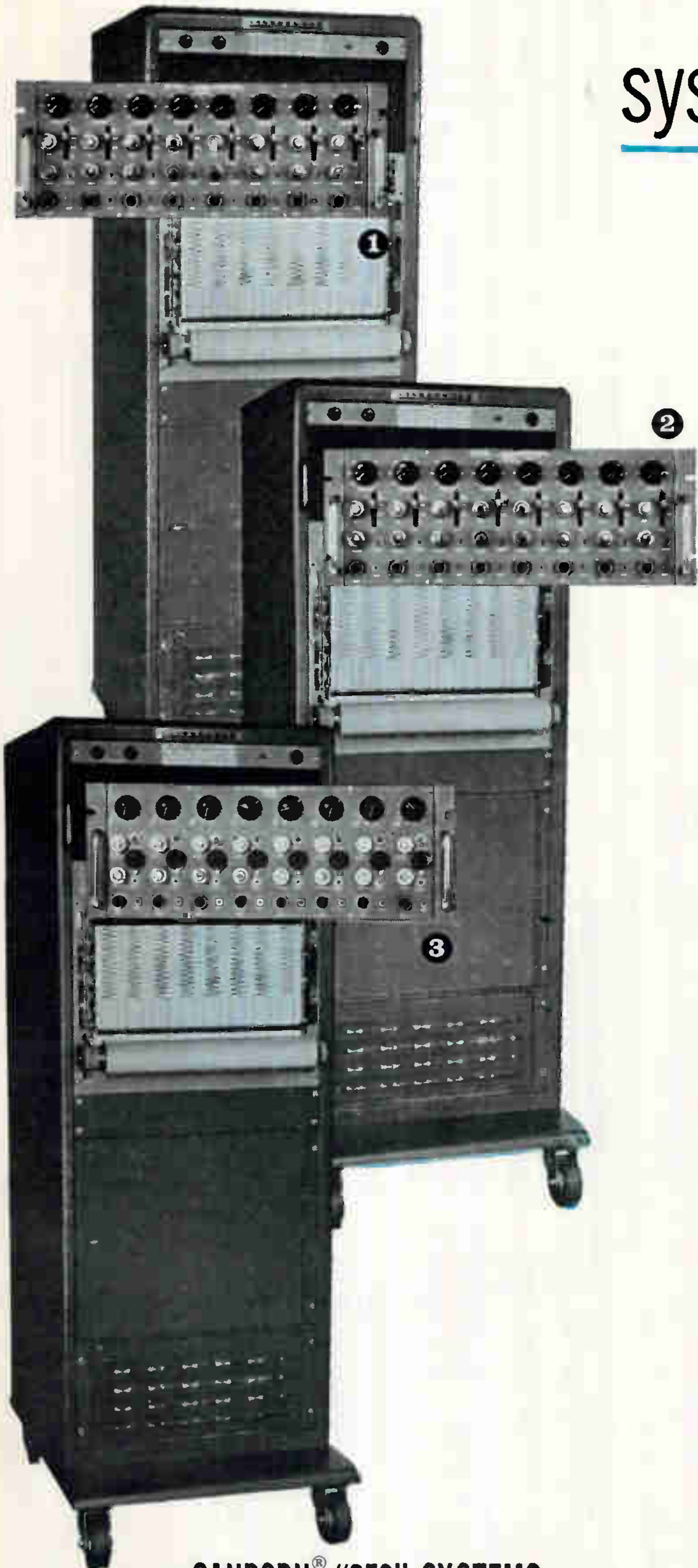
A NEW ASSISTANT Patent Office Commissioner will be appointed to direct the agency's research and development program. Patent Commissioner David L. Ladd says he is looking for a qualified person to fill the post now. Need for the appointment stems from a series of reports the Patent Office has made over the past few years to find a way to clear the log jam of patent applications.

The latest report made a few weeks back by Dr. Allen Astin, Director of the Bureau of Standards and John G. Green, Director of the Office of Technical Services of the Commerce Department, estimates that it will cost around $3 million a year over the next several years before full mechanization of the Patent Office search system can be achieved. Currently, only some $580,000 is budgeted for the program in fiscal 1962.

THE AIR FORCE has started a plant management survey of North American Aviation's Autonetics div. at Downey and Anaheim, Calif. A special team of procurement, production and auditing experts is checking the division's subcontracting practices, cost estimates, manufacturing operations, quality control policies and other management practices.

The Autonetics survey is the second Air Force survey of its kind. Late last year, a similar check was made at the Martin Co.'s Denver plant. It went on for two months. As a result, the company was reportedly ordered to expand competition for subcontracts, tighten up management of subcontractors and improve spare parts provisioning schedules.

match system sensitivity to your recording application



SANBORN® "950" SYSTEMS

Dynamic demonstrations of 950 Systems and other Sanborn oscillographic recording equipment at WESCON, Aug. 22-25 Booths 2014-2016

When your recording application calls for 6 or 8 direct writing, general purpose channels with identical sensitivity and input electronics, Sanborn "950" design provides a highly useful, economical answer in the precise sensitivity range you need. Choices include systems with:

1 HIGH GAIN AMPLIFICATION . . . 6 or 8 transistorized channels with floating and guarded inputs, 100,000 ohms resistance on all ranges, 10 to 2000 uv/div sensitivity. System response DC to 100 cps within 3 db at 10 div peak-to-peak amplitude. Common mode performance ±200 volts, max., rejection 140 db min. at DC. High gain stability, max. non-linearity 0.5%, low noise and drift. All channels have range, gain, function, position and galvanometer frequency compensation controls.

2 MEDIUM GAIN AMPLIFICATION . . . 6 or 8 transistorized channels with floating and guarded inputs; ½ meg. resistance on mv ranges, 1 meg. on volt ranges; sensitivity 0.5 to 20 mv/div and volts/10 div. System response DC to 150 cps within 3 db at 10 div peak-to-peak amplitude. Common mode voltage ±500 volts, max., rejection 140 db min. at DC. Same controls as High Gain amplifier.

3 LOW GAIN AMPLIFICATION . . . 6 or 8 channels, balanced to ground inputs 5 meg. each side; tube and transistor circuitry; sensitivity 10 to 500 mv/div and 1 to 10 volts/div. System response same as Medium Gain system. Common mode performance ±2.5 volts and 34 db min. rejection on most sensitive range. Amplifier available with or without Calibrated Zero Suppression.

All "950" systems have 350-style 6- or 8-channel flush-front, heated stylus recorder, using Sanborn rectangular-coordinate Permapaper.® Nine chart speeds, timer/marker stylus, built-in paper take-up. Systems housed in 63⅝" high mobile cabinets; amplifier and recorder occupy only 24½" of panel space. For complete descriptive literature and application assistance, call your Sanborn Industrial Sales-Engineering Representative; offices throughout the U. S., Canada and foreign countries.

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CIRCLE 15 ON READER SERVICE CARD

CIRCLE 16 ON READER SERVICE CARD→

Almost all military forces count their strength in

systems using Sperry electronic tubes

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To Contractors and Subcontractors on U. S. Government Projects

Western Electric offers the high reliability JAN 2N1195 Transistor

The JAN 2N1195 is a diffused base germanium mesa transistor for video, radio frequency, and switching applications. This transistor is not selected from a broad distribution of electrical values. Laureldale's controlled manufacturing conditions assure the circuit designer of uniform lot-to-lot transistor characteristics.

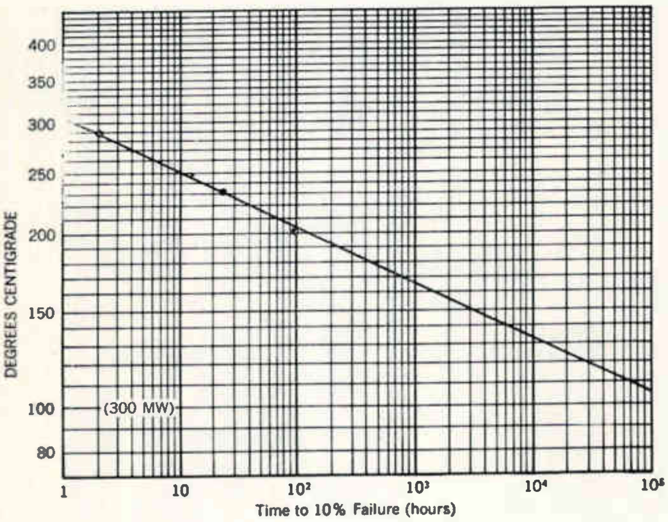
MAXIMUM RATINGS AT 25°C

Power dissipation in free air	225 MW*
Collector breakdown voltage	30 Volts
Emitter breakdown voltage	1 Volt
Maximum junction temperature	100°C

*Conservative—300 MW capability has been established

TYPICAL ELECTRICAL CHARACTERISTICS

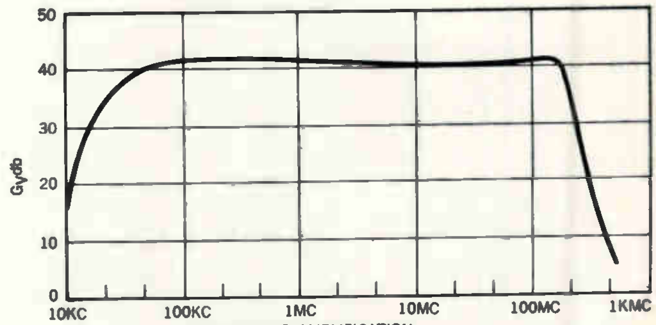
f_{ab}	750 MC
$R_e h_{ie}$ (250 MC)	55 Ohms
C (dep)	1.2 $\mu\mu f$
h_{fb} (1000 cps)	.98



RELIABILITY

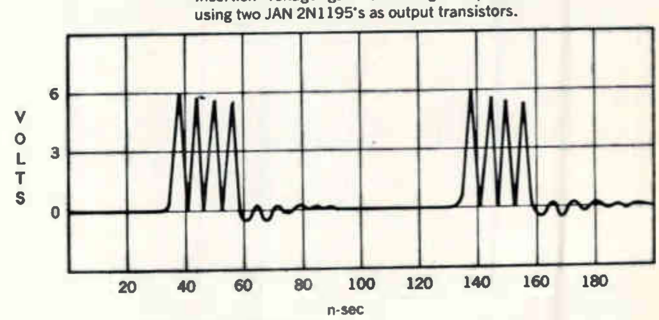
Lot-by-lot life tests have established a failure rate of less than 0.1% for 1000 hours at 100° C.

This chart illustrates results obtained at high storage temperatures and demonstrates the inherent reliability of the JAN 2N1195 transistor.



BROAD BAND AMPLIFICATION

Insertion voltage gain of 8-stage amplifier using two JAN 2N1195's as output transistors.



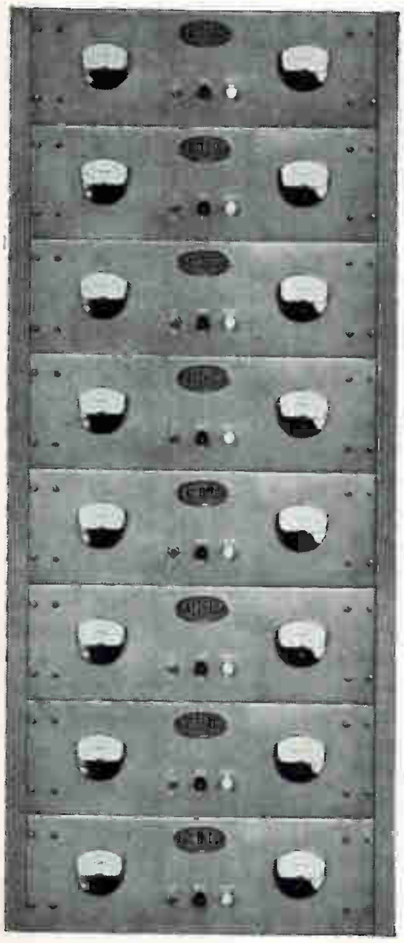
HIGH SPEED SWITCHING

Output of 160 MC multiplexer using JAN 2N1195 transistors.

The JAN 2N1195 transistor can be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, please address your request to Sales Department, Room 102, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone – Area Code 215 – WAlker 9-9411.

Western Electric

MANUFACTURING AND SUPPLY — BELL SYSTEM — UNIT OF THE BELL SYSTEM



—power
—for control

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—for computers

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If it's regulated dc power you need (for almost any application), Raytheon's new "RD" line of Basic Power Packages is worth investigating.

Available in 132 ratings from 3 to 1,000 volts at 50 to 3,000 watts, these compact supplies are fully magnetic in design.

Result: surprisingly low cost and an extra measure of reliability.

Write today for catalog data including a selection chart listing all available models. Raytheon Company, Power Supply and Voltage Regulator Operations, Keeler Avenue, South Norwalk, Conn.

RAYTHEON

RAYTHEON COMPANY

POWER SUPPLY AND VOLTAGE REGULATOR OPERATIONS

CIRCLE 19 ON READER SERVICE CARD

Metallic Vapor Plasma: Future

GROUNDWORK for future plasma pulsed propulsion systems is being readied at Electro-Optical Systems, Inc. (Pasadena, Calif.). Being performed for the Office of Aerospace Research, the work so far has consisted of preliminary experiments producing relatively large amounts of metallic vapor plasma by electrically exploding metallic wires and thin metallic films. High temperature expansion of the plasma has resulted in measurable thrust that may have future propulsion applications.

However, before determining propulsive properties, more knowledge must be uncovered on the properties of the exploding wire and film and that of the plasma.

How much overheating can be placed in a film or wire as a function of material, size, configuration and power level while the material is still in a compact state? What about the dynamics of the expansion process: does the metallic vapor plasma expand with a high degree of directness or not and with what velocity? What is the temperature, radiation and state of the expanded plasma?

A simple model of the exploding film has been advanced by Francis H. Webb, who is heading the research. He likens the plasma expansion to that of a uniformly and instantaneously heated slab of gas confined on one side so that it would expand mainly in one direction.

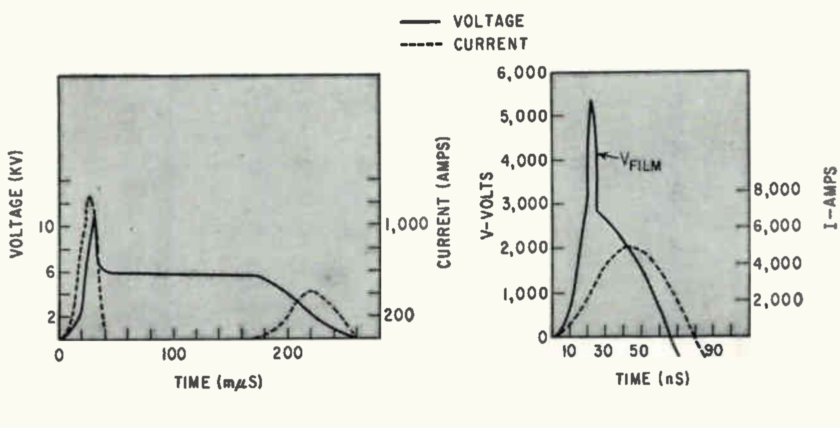
He says that it is important to place the thermal energy into the system before it has expanded appreciably since any further heating would only go into random thermal motion. Heating of the film, therefore, should be uniform. At low to intermediate power levels, hot spots and nonuniform conduction have been observed in wires and especially in wide exploding films. It must be determined if areas of uniform or near-uniform heating exist as a function of dimensions, material and specific power level.

These problems may be reduced in the confining arrangement he has used, says Webb. In this system, the film is either mechanically backed or backstrapped on one side before being electrically heated to a high temperature.

Although, much less data is presently available for rapidly exploded films than for rapidly exploded wire, films would appear to be more suitable for propulsion because greater directionality would be anticipated, says Webb.

Also, required heating time is probably shorter than in wire of the same mass per unit length. This was indicated by current and voltage waveform data on an exploded aluminum film 8,000 angstroms thick by 2 mm wide by 0.1 inch long, and by similar data on a one-mil aluminum wire one cm long.

As exemplified by the diagrams, the exploding phenomena can be subdivided into three phases or regions which may be distinct or overlapping. The first region is the initial conduction region where the material heats up and explodes. The second region is the dwell phase



Voltage and current waveforms used in exploding aluminum wire, left, and aluminum film, right

Propellant?

where the vaporized material forms a low-conductivity plasma. The third region is where a resurge of current called post-dwell conduction occurs in the plasma. The time before the post-dwell phase is reduced if the voltage is increased, and, at sufficiently high voltages, the post-dwell and initial conduction phases merge.

A luminous front velocity of 2 cm per μsec was observed 100 nsec after current initiation in the explosion of the 8,000-angstrom-thick aluminum film. This would correspond to a thrust of 40 millipounds per pulse.

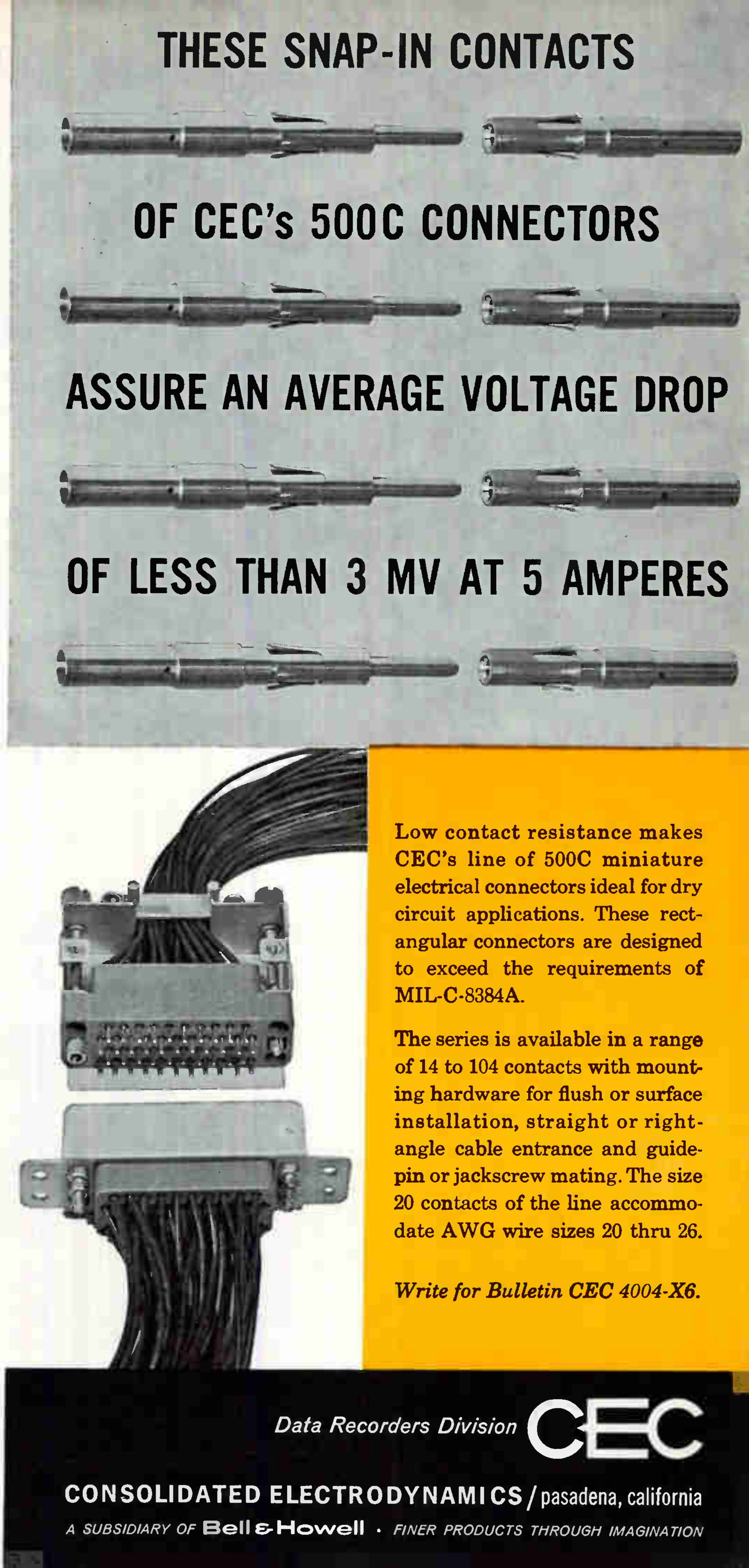
In the work on wires it was found that some type of relaxation process appears to take place at the onset of vaporization. This seems due to overheating in air. Overheating of above 20 ev per atom has been observed and higher values appear attainable by using smaller wires and by going to faster circuits and higher voltages. Thus, large amounts of energy up to many times that of vaporization energy can be placed in the wire during the initial conduction phase. In fact, at high power levels it was seen that several times the vaporization energy is obtained in the first phase, whereas at low power levels only energy content corresponding to about the onset vaporization is obtained in the initial conduction phase.

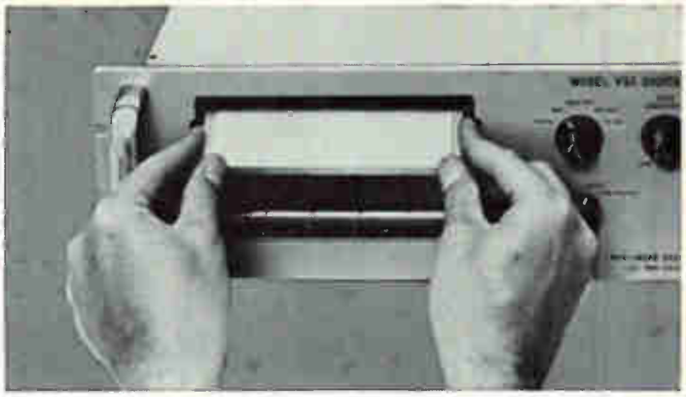
Resistivity was measured as function of apparent specific energy content for different specific power levels. Apparent resistivity was seen to increase rapidly at low power levels with increasing energy. But this is reduced at higher power levels.

79 Radio Stations Going To Stereo F-m This Year

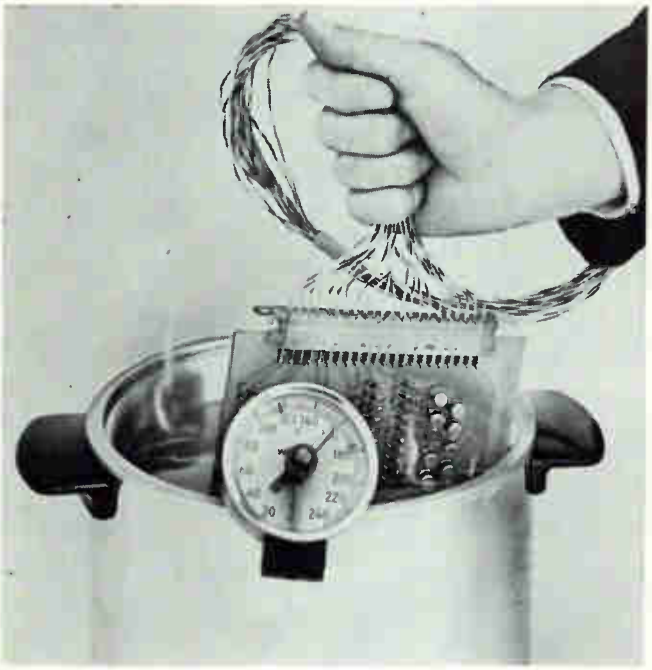
F-M STEREO radio poll of 600 stations by National Association of Broadcasters shows this week that 79 stations will go to stereo by year's end and 123 by the end of 1962.

CIRCLE 21 ON READER SERVICE CARD→

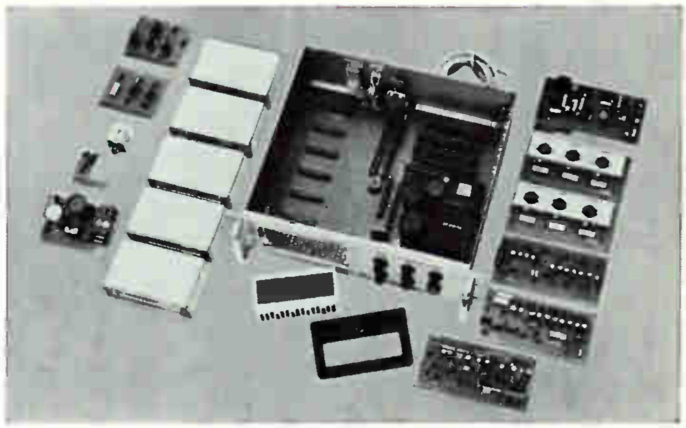




SNAP-OUT READOUT, exclusive on all NLS digital instruments, permits 20-second bulb replacement through the front panel without tools. Precisely engraved readout numerals can be read all day from close up or far away without eye fatigue.



"NO POTS AT ALL" STABILITY of the NLS V44 digital voltmeter is checked by the "boil in oil" test at 158 F. This design feature eliminates all trimming of decade and amplifier circuits.

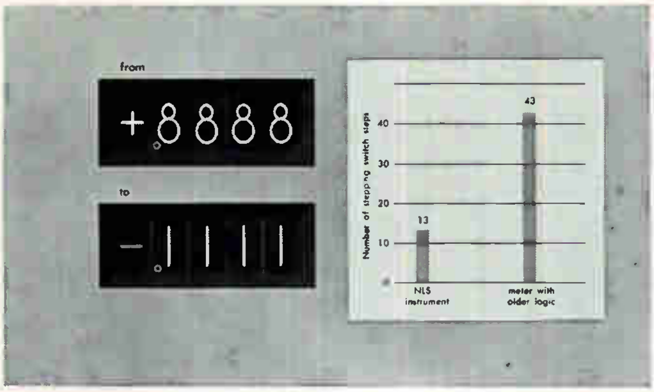


99% PLUG-IN MODULAR DESIGN provides easy access to all components, simplifies servicing with plug-in parts replacement, drastically reduces maintenance costs, keeps instruments on the job.

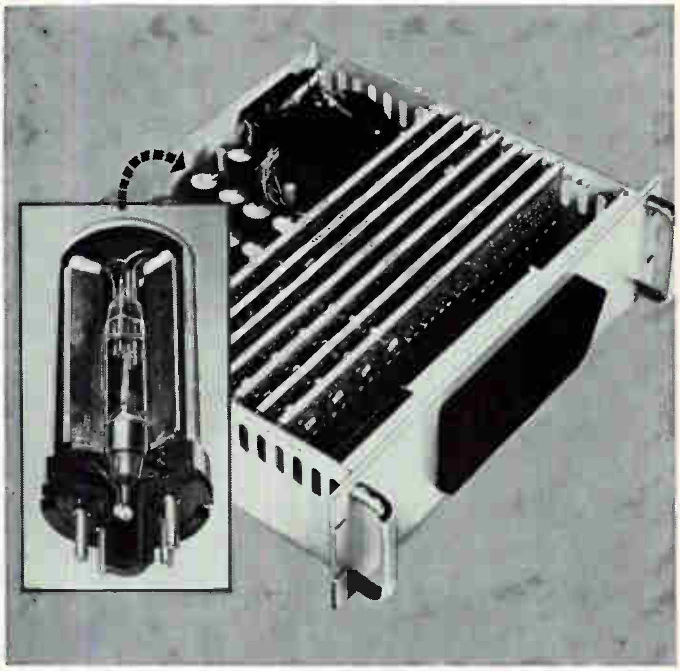
INNOVATION..... the

PLUG-IN OIL-BATH STEPPING SWITCHES in Series 30 instruments outlast dry switches by a factor of five ... completely eliminate periodic disassembly for manual lubrication of switches . . . and permit replacing switches in several minutes for fast troubleshooting and repair.

LOW-COST DIGITAL VOLTMETERS with quality features such as plug-in stepping switches (above) were introduced by NLS. Today, NLS provides a complete line of low-cost industrial instruments including digital voltmeters, ohmmeters, a digital millivoltmeter with ±0.01% precision, and low-cost models with printout.



"NO-NEEDLESS-NINES" LOGIC in Series 30 eliminates unnecessary, time-consuming, wear-producing cycling of stepping switches through their 9's and 0's positions. In the typical sample above, the NLS instrument with "No-Needless-Nines" logic makes the reading change in 13 stepping switch steps compared to 43 steps for meters with older-type logic. The new logic also permits fast measurement of varying voltages.



MERCURY-WETTED RELAYS AND TRANSISTORIZED CIRCUITRY are combined for ultra-reliable operation of NLS Series 20 instruments. Mercury-wetted relays, used for switching operations in Series 20 DVMs, make contact through a pool of liquid mercury and have a life expectancy of 57 years operating continuously at full instrument speed.

FULLY AUTOMATIC OPERATION, pioneered by NLS, includes automatic selection and indication of range and polarity. Human error is virtually eliminated.

important difference in digital voltmeters!

"Is there a significant difference in digital voltmeters?"

Definitely — these eight design and construction features show some of the important differences between NLS instruments and those of other manufacturers. These are the engineering innovations that assure accuracy and reliability ... that minimize maintenance and downtime ... that add greater long-term usefulness.

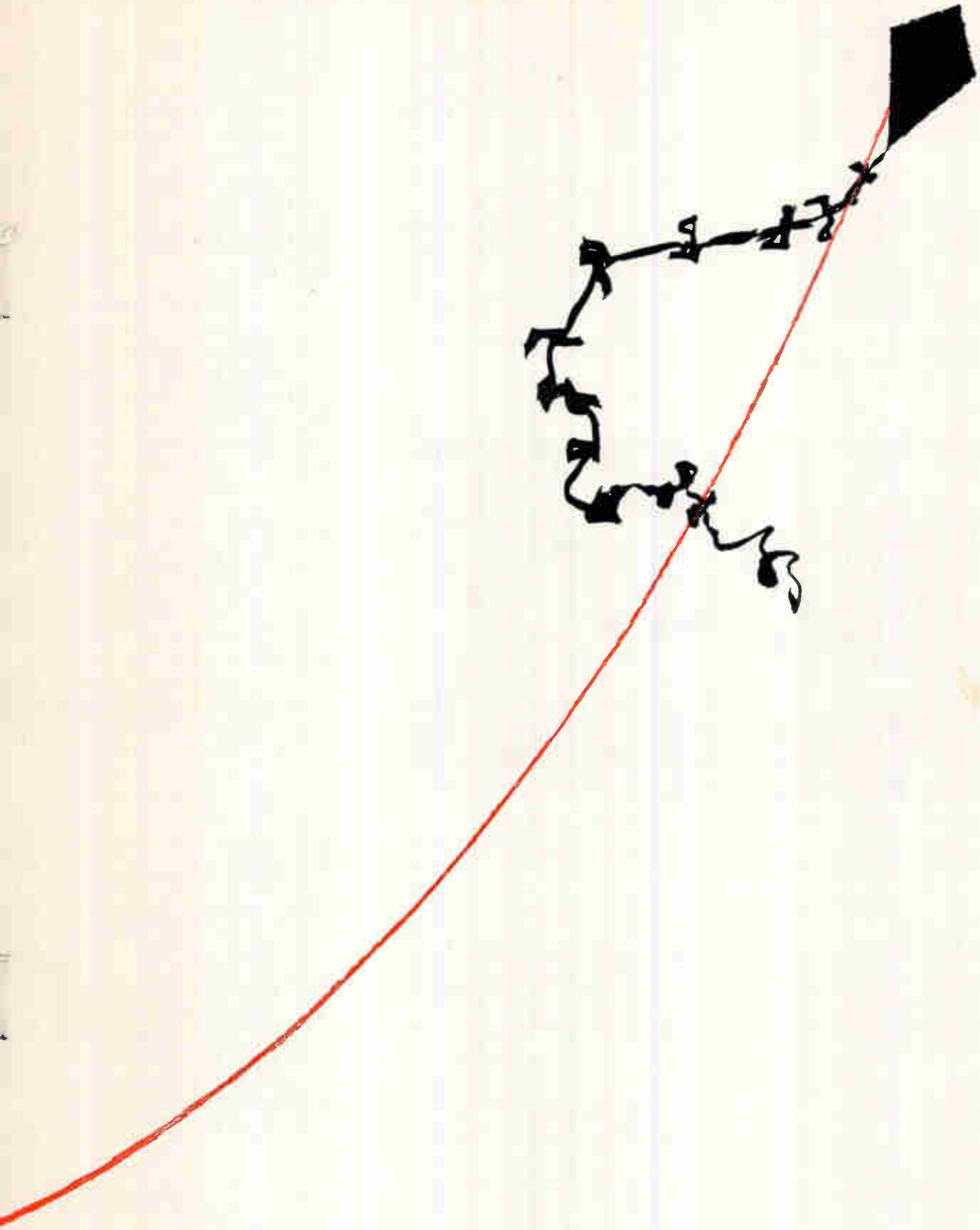
The fact that NLS originated the digital voltmeter and continues to introduce the major innovations is another sign of superiority in digital voltmeters.

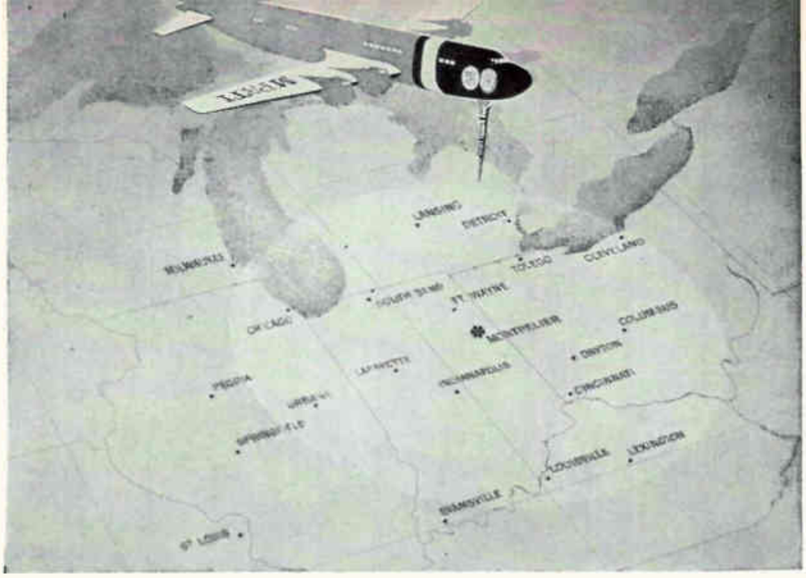
Call your NLS office or rep for a demonstration of the instrument of your choice or write today for the informative NLS catalog that describes the world's most complete line of digital voltmeters ... by purpose ... by price.

Visit Us At WESCON (Booths 1518-1520) And At The Los Angeles ISA SHOW (Booth 105)

non-linear systems, inc. *Originator of the Digital Voltmeter*
DEL MAR, CALIFORNIA

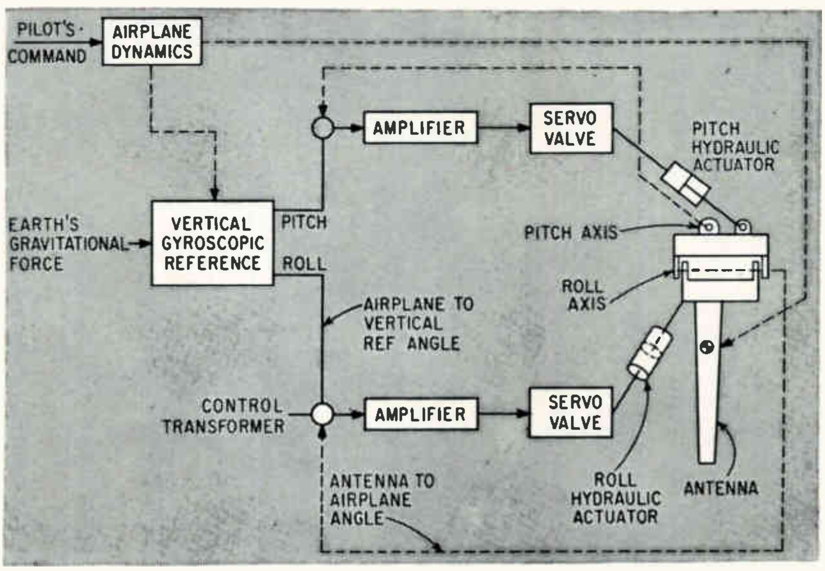
CIRCLE 23 ON READER SERVICE CARD





Signals from airplane flying at 23,000 ft over north central Indiana will cover 300-to-400-mile circle

Flying television station carries six tons of telecasting equipment. Facilities installed by Westinghouse include master control panel, two video tape recorders, two high-powered transmitters and a vidicon camera to transmit announcements and station identification



How antenna stabilization works. Continuous feedback keeps antenna within ±2 degrees of true vertical

Midwest Plan

EDUCATIONAL TV adds a "blue sky" dimension to its potential next month when Midwest Program for Airborne Television Instruction launches its first full academic year —broadcasting 17 half-hour elementary, high school and college courses from a four-engine DC6 orbiting 23,000 feet above Montpelier, Ind., with identically-equipped transmitter plane on standby.

Aiming to reach two million of five million potential students within 127,000 square mile six-state reception circle by June '62 close of academic year, MPATI participating schools during coming months will require an additional million dollars worth of receivers, antennas and distribution systems. Success will open up possibility for a nationwide net of regional airborne systems providing communication not only from air to ground but also from ground to air with eventual applications all over the world.

Electronic "fallout" from MPATI includes a special computer, developed by Westinghouse to accept signals from standard navigation TACAN or VORTAC receivers within 100-mile range, then report position instantaneously while ship follows a figure eight pattern within a ten mile orbit.

Transmitting plane must maintain its altitude and position within fairly narrow limits for optimum design of school receiving antennas. Special navigation system maintains position accurately, even when ground is obscured by clouds.

ITT Federal interrogator measures distance to Fort Wayne VORTAC station (or any other within radio range). Unit measures time interval between transmitted pulse and answer from ground station to give slant range.

Direction to same station is measured using VOR, standard equipment for DC6's, with Collins navigation receiver. Range and angle outputs are adapted and fed into a special Westinghouse navigation computer.

Pilot feeds N-S and E-W offset distances from VORTAC station to center of desired orbiting into computer which then generates elec-

May Mean 'Sky's the Limit' for Class Tv

tronic display on crt's of Westinghouse navigation indicators.

Unique gyro system senses degree of bank along flight path, refers to pendulum during level flight portions of figure eight pattern—feeds correction signals to servos operating hydraulic hookup which keeps 24-foot antenna vertical for optimum radiation pattern.

High gain antenna requires stabilization in roll and pitch axes within very narrow limits to keep adequate power on receivers within two hundred miles of aircraft. Support gimbals permit antenna to move in all three axes. Yaw is self aligning while for roll and pitch, vertical gyro, electronic control system and hydraulic power provide stabilization.

Two hydraulic systems are provided. Main system operating from engine-driven pump may be used to: 1) lower and retract and 2) vertically stabilize antenna.

Automatic roll and pitch axes position feedback controls vertical stabilization (drawing). Electronic sensing and amplification of error is followed by hydraulic power amplification and positioning of antenna gimbal structure relative to airframe.

Vertical gyro in figure measures aircraft roll and pitch angles with respect to vertical and provides synchro output signals which are electrical reference signals (inputs) to roll and pitch control transformers. Transformer shafts are mechanically positioned to measure antenna-to-aircraft roll and pitch angles. Resultant outputs of control transformers are electrical error signals from antenna with respect to vertical. Error signals, electronically amplified, control hydraulic valves regulating flow of oil to actuators properly positioning antenna. Continuous feedback keeps antenna within plus or minus two degrees of true vertical. System operates for plus or minus 20 degree roll angle and for 9 degrees of downward pitch.

Aboard transmitting plane, pair of Ampex video tape recorders or vidicon camera chain feeds through control console to conventional driver circuitry. Aural carrier, one-tenth visual peak power, is combined in Adler exciters feeding 10 kw uhf transmitter using new Varian 833 C klystron and weighing less than 2,000 lb.

Use of single 10 kw amplifier for both picture and sound is believed to be unique in tv except for emergency service. Vestigial sideband filter operates at very low power levels instead of following main amplifier as in most tv stations.

Another unique application is use of single antenna for broadcasting sound and picture for both channels. Diplexing filter prevents interaction between channel 72 and 76 transmitters coupled to 11-ft slotted cylinder coaxial antenna mounted on 24-ft mast radiating 50 kilowatts effective over 200-mile circle. Selection of high end of frequency band permits smaller antenna with greater gain to deliver satisfactory signal up to 215 miles.

Streamlined mast, designed and wind tunnel tested by Douglas, equipped with pneumatic deicing boot and supported by massive gimbal structure, carries radiating element—12-ft section of 3⅛-inch diameter aluminum coaxial line.

Additional 12-ft section of line is used to stand radiating section off from plane structure, providing overall length of 24 feet.

Horizontally polarized antenna has gain of nearly 10 db. Standing wave ratio is less than 1.80 for frequency range of 815 to 850 mc (channels 72 and 76).

Vertical beamwidth is approximately 9 degrees. Stabilization of plus or minus two degrees is necessary for the system which handles power output of both 10 kw transmitters.

Elimination of critically adjusted and expensive tracking equipment—including airlifted parabolas to keep broadcast signal "on nose" of plane moving at 290 mph.—eliminated live broadcasts from ground during planning stage of project. Narrow band 3 mc experimental broadcasts are continuing from specially equipped standby plane on limited basis to five specially equipped schools. MPATI plans full-dress test of 3 mc system—which promises to double capacity of existing tv channels—during holidays. Application, calling for changes in driver units, is not likely before September, 1963, at earliest.

Importance of good antenna, well located, is biggest educational challenge reported by MPATI specialists. "We're delivering adequate signals wherever antennas are adequate," they say, "except where we're directly blocked by a mountain or by buildings". Unnecessarily high antennas aggravate fading. Antenna manufacturers are now designing improved antennas with beam restricted in the horizontal plane but compressed vertically for maximum gain.

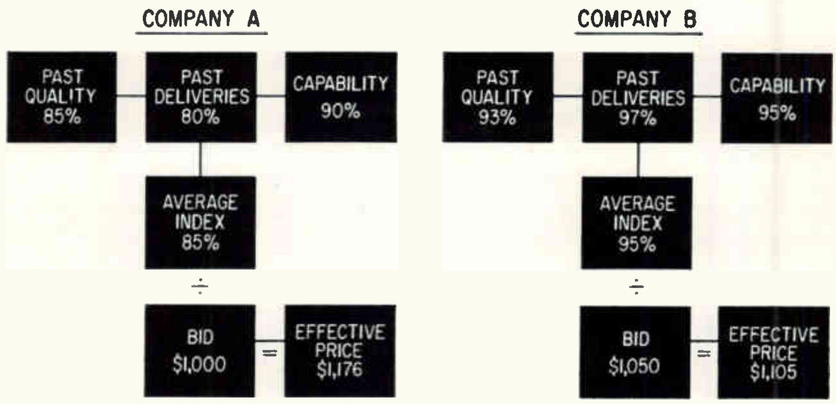
Specification manual developed for guidance of local technicians installing MPATI receiving equipment in schools notes that in many cases antenna must be experimentally moved vertically and laterally several times to locate point of optimum reception.

Growing acceptance and use of MPATI throughout six state region is expected to result in demand for at least 2,000 new receivers and other equipment for schools during coming year. Nine major manufacturers have spent total of $100,000 equipping 31 elementary and secondary schools with master antennas, distribution systems, dozen 23 inch receivers per school. Cost of five-room system averages about $500 per room, runs from $3,500 to $5,500 per school.

Long run annual cost of program will be in neighborhood of $3 to $5 million a year with share per student depending on participation. With expected two million sharing program by next spring, added cost would range with price of one new textbook, for adding new dimensions to existing system of education now costing about $350 per pupil. Equivalent coverage using ground transmitters has been estimated to require 14 stations, cost three times as much, depending on location and height. Movies would be many orders of magnitude more expensive.

DEFENSE BUYING: Needs New Evaluation

By W. A. MacDONALD
Chairman of the Board
Hazeltine Corporation
Little Neck, N. Y.



Under Hazeltine's suggested plan, Company B, although high bidder, would be awarded the contract because factors other than initial bid result in a lower effective price

MUCH HAS BEEN SAID in recent months about the high cost of defense electronics. It seems to me that most comments have merely been critical of industry and/or the defense department, without making any sound recommendations for solving the complex problems which beset defense procurement.

Many suggestions which have been offered would destroy industry's incentive for government contract work and render impossible the efficient operation of the Defense Department.

What we need are recommendations directed toward the development and production of the *superior systems* we need for our nation's defense *at the most economical cost over the useful life* of each system.

Bulletin

WE REGRET to report that Mr. MacDonald, the author, died last Friday. This article, then, is his final message to our industry—an industry he loved and worked for 45 years.

The Editors

First of all, let us recognize that Government contracting officers are capable people, who are doing an admirable job under tremendous pressure from many sources. By the same token, most companies involved in government electronics projects are good, corporate citizens.

But remember, they too are hampered by various pressures in their activities.

Both are confronted by a serious problem: we must achieve a better ratio of initial cost to maintenance cost by reducing the exorbitant expenses of maintaining equipment.

Only 25 percent of the government budget allocation for electronics goes into new weapons systems, and the annual maintenance costs of electronic weapons systems is about 60 percent of their initial cost (many times greater than the maintenance expense for home or industrial equipment).

To reach a solution, it is essential to establish empirical criteria for contractor evaluation. Hazeltine has developed a system which, with some modifications, would seem quite appropriate for the government.

The purpose of the system is to arrive at the true cost of a contractor's performance of an order, and thereby permit an accurate evaluation of the risk involved in placing any future procurement with that company.

A computation of the three principal factors of

(a) quality
(b) delivery, and
(c) potential performance

produces a final single figure of merit in percent. This figure is divided into the quoted bid price. The result is an effective price, which is indicative of what it will cost to do business with the particular supplier (block diagram).

By enabling a contracting officer

ABOUT THE AUTHOR

W. A. MACDONALD, chairman of the board of Hazeltine Corp., Little Neck, N. Y., has been associated with problems of defense procurement since the beginning of World War II when his company first became a supplier of defense electronic systems. For his contributions to electronics during the war, he was awarded a Presidential Citation. He has served as a member of the Electronics Equipment Industry Advisory Committee on the Munitions Board, the Department of Defense Advisory Group on Reliability of Electronics Equipment (AGREE), and as a director of the Electronic Industries Association.

A veteran of 45 years in the electronics industry, MacDonald joined Hazeltine in 1924 as its first employee. He is a Fellow of the IRE and the Radio Club of Am-

Factors Now?

to consider capability, quality and delivery performance, as well as price, such a procedure could obviate much of the pressure which now hinders government procurement.

To anticipate technological changes and provided for their use, it is suggested that a continuing product improvement and modernization clause be incorporated into selected electronic systems procurements. Since such contracts run for several years after the initial design is submitted, periodic progress reports would recommend beneficial changes and indicate improvements made.

Such a procedure would measurably reduce maintenance costs, extend the useful life of each system and improve its operational capabilities.

While certain government agencies have adopted contractor evaluation procedures, and some have employed product improvement clauses in a few of their contracts, these concepts are used to only a minor extent.

In many cases, philosophies concerning the important task of defense contracting should be reconsidered.

We in electronics can play a vital role in achieving the objective by virtue of our technical experience and our positions in both industry and government. It seems to me that we should discuss these ideas, and the basic philosophies, and make constructive recommendations to the Defense Department.

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erica, and is a licensed professional engineer with 110 U. S. and foreign patents to his credit. During World War I, as a Signal Corps officer, he worked with Capt. E. H. Armstrong on the first superheterodyne receiver. Many years later, he became a founding member of the Armstrong Research Foundation. Recently, he was elected a director of The Western Union Telegraph Co.

Moving-Target

DOUBLE-CANCELLATION moving-target indicator (mti) system of French design incorporating two storage tubes as memory devices is undergoing evaluation by the Federal Aviation Administration in Atlantic City.

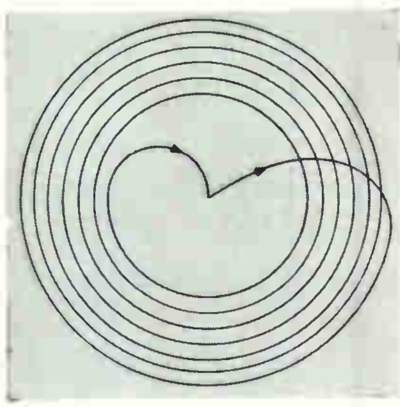
Intercontinental Electronics Corp., U. S. affiliate of the French company, CFS, says the system called MA-372 has been operational for 740 hours without requiring adjustment to correct for variations in pulse repetition frequency. INTEC is handling the engineering and installation of systems in this country.

The two-tube system has been operational for six months in a dual-diversity radar system at Orly Airport near Paris.

The system eliminates fixed-target signals from the ppi presentation of radars having a 30-Mc intermediate frequency at ranges from 0 to 62 miles.

The memory-tube cancellation circuits are claimed to follow wide variations in pulse repetition frequency so that it is no longer necessary to maintain close tolerances of prf and magnetron firing time.

Toleration of wide prf variation enables the system to eliminate radar susceptibility to blind velocities, says INTEC. This is done through wobbulation of the trigger frequency. Wobbulation is a continuous oscillation of prf around a nominal frequency. It is claimed that a 10-percent prf wobbulation can almost completely eliminate blind velocities. A blind velocity



Electron spot sweeps across target in synchronism with radar pulses

Radar Using Storage Tubes

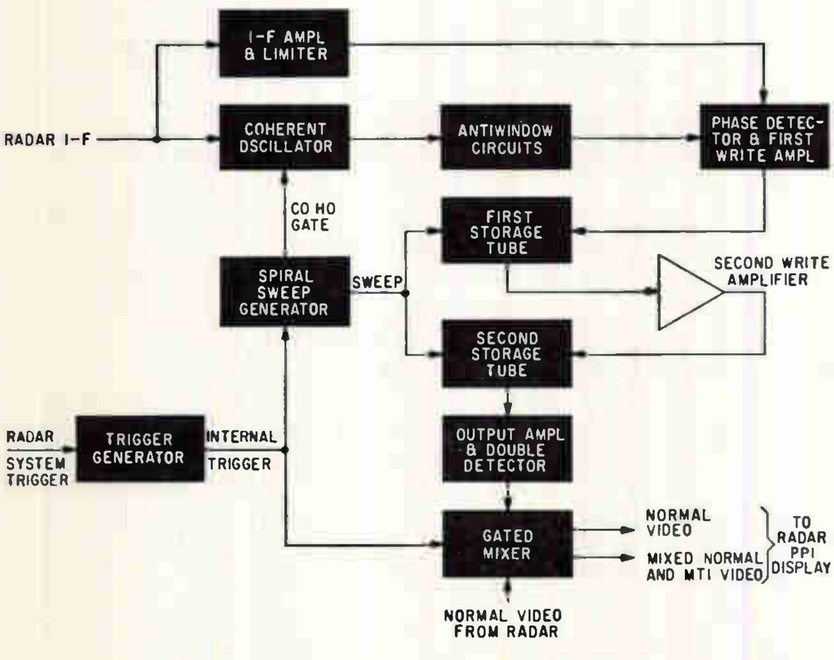
is a target speed so related to radar prf that the target return is eliminated from the radar display.

As with other mti systems, the MA-372 is driven by radar trigger pulses generated by the magnetron, and also has an internal trigger for synchronizing the cancellation process. Similarly, it uses the radar i-f signal to obtain exclusive moving target information and to provide a servo pulse for its coherent oscillator, which provides the reference signal for distinguishing stationary or moving targets.

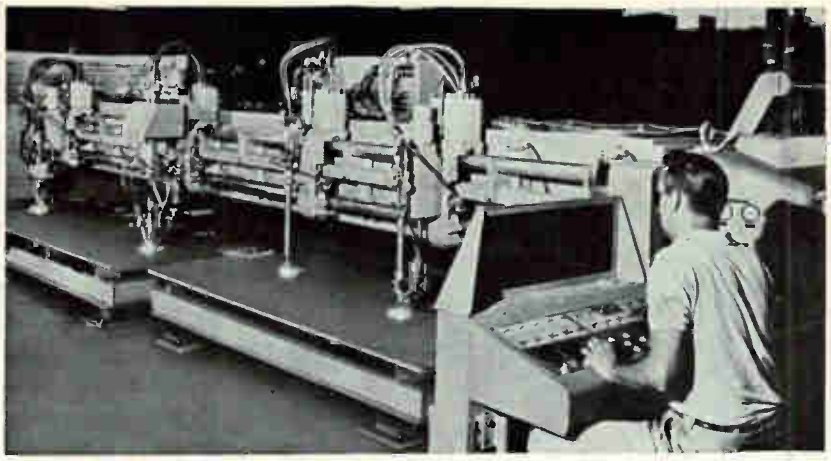
The mti doppler technique using the coherent oscillator reference signal is used to obtain from a phase detector (see block diagram) an amplitude-varying signal representing moving targets and constant amplitude signal representing fixed targets. The first memory tube eliminates the main-lobe fixed-target signals, while the second memory tube eliminates side-lobe modulations from fixed echoes. Anti-window circuits eliminate clutter due to slowly moving objects.

Here's how fixed echoes are cancelled in the TCM-13X memory tubes: an electron spot sweeps the tube target element in synchronism with a radar pulse as shown in the diagram. When no signal is aplied to the tube, all the points on the spiral sweep are charged to equilibrium potential, V, and a constant current of secondary electrons appears on the tube's collector. If, at a given time, a signal of, for example, +8 volts, is applied to the target, the whole surface of the target is brought to a potential of V+8 volts. At the point where the sweep is located when this signal is applied, the ratio of secondary omission becomes less than one, and the point returns to potential V. When the applied signal disappears, the whole target surface returns to potential V except the point in question, which will be at potential V-8 volts.

During the following sweep, if the same signal of +8 volts again appears at the same point, this point is raised to original potential V, so that the rate of secondary omission during the sweeps remains constant. Thus, all fixed-echo (fixed-amplitude) signals disappear, and only signals of changing amplitude — moving echoes—remain. The tube collector therefore picks up signals proportional to the amplitude difference between successive signals applied to the tube target element.



Simplified functional block diagram shows memory-cancellation function performed by storage tubes in mti system



Under digital control, four torches slice into steel plates

Tape Controls Flame-Cutter

SHIPYARDS, manufacturers of earth-moving equipment, railway cars and other heavy steel plate fabricators are the anticipated market for a new, huge, numerically controlled flame-cutting machine. It will cut complex flat and beveled parts from plate of any length, up to six inches thick and 22 feet wide. Air Reduction Sales Company unveiled the machine at its plant in Union, N. J., last week.

Controls are a modified General Electric Mark Century solid-state digital control unit. Punched-tape programs are prepared from part dimensions, with instructions added for auxiliary cutting functions. Machine motions to produce contours and adjustments in cutting head positions to compensate for kerfs and beveling are automatically computed. These computations, simplifying programming, are handled by an all-NOR logic section in the control unit.

Cost of the machine is well over $100,000, several times the price of conventional template-following or tracer-controlled machines. Airco believes the additional cost for digital control is justified by elimination of full-scale templates or patterns and improved speed and accuracy. In addition, it permits the use of general-purpose computers to prepare programs directly from engineering sketches and to determine nesting of parts for minimum scrap.

The machine also has a variable-speed servo drive control. The signal from cutting-head position monitors gates silicon controlled rectifiers to control acceleration, deceleration and running speed of the cutting-head drive motors. Other control modifications direct gas and oxygen flow, preheat, pierce and additional flame-cutting operations.

Space Blood Recorder Going to Hospitals

A PROJECT MERCURY completely automatic electronic blood pressure recording system is being made available to hospitals and physicians by its developer, The Garrett Corp.'s AiResearch Manufacturing Co. of Los Angeles.

The system consists of a sensing device, the familiar cloth occluding cuff, an electronic transducer, and an oxygen cylinder which inflates the cuff to 220 millimeters in 30-second cycles.

The sensing device placed over a convenient artery is supposedly sensitive enough to record through an overcoat. During deflation of the cuff, the sensor picks up all cardiovascular sounds and feeds the resulting signal to the transducer, which filters out non-cardiovascular sounds and also cardiovascular sounds not clearly identified with systolic and diastolic levels. The filtered signal is amplified and recorded on tape to permit fewer visits by patients whose blood pressure must be checked constantly.

MEETINGS AHEAD

Aug. 22-25: WESCON, L. A. & S. F. Sections of IRE, WEMA; Cow Palace, San Francisco.

Aug. 23-Sept. 2: National Radio & TV Exhibition, 1961 British Radio Show; Earls Court, London.

Aug. 23-25: Gas Dynamics Symposium, ARS, Northwestern Univ.; Evanston, Ill.

Aug. 28-Sept. 1: Heat Transfer Conf., International; Univ. of Colorado, Boulder, Colorado.

Aug. 30-Sept. 1: Semiconductor Conf., AIME; Ambassador Hotel, Los Angeles.

Sept. 4-9: Analog Computation, International Conf., International Assoc. for Analog Comp., and Yugoslav Nat. Somm. for ETAN; Belgrade, Yugoslavia.

Sept. 6-18: Computing Machinery, National Conf., ACM; Statler-Hilton Hotel, Los Angeles.

Sept. 6-8: Nuclear Instrumentation Symposium, PGNA of IRE, AIEE, ISA; N. C. State College, Raleigh, N. C.

Sept. 6-8: Space Elec. & Telemetry, PGSET of IRE; Univ. of New Mexico, Albuquerque, N. M.

Sept. 6-13: Electrical Engineering Education, Internat. Conf., ASEE, AIEE, PGE, of IRE; Sagamore Conf. Center, Syracuse Univ., Adirondack, N. Y.

Sept. 8-10: High-Fidelity and Home Entertainment Show, Chicago; Crystal Ballroom, Palmer House, Chicago.

Sept 11-15: Instrument-Automation Conf. and Exhibit, ISA; Sports Arena, Los Angeles.

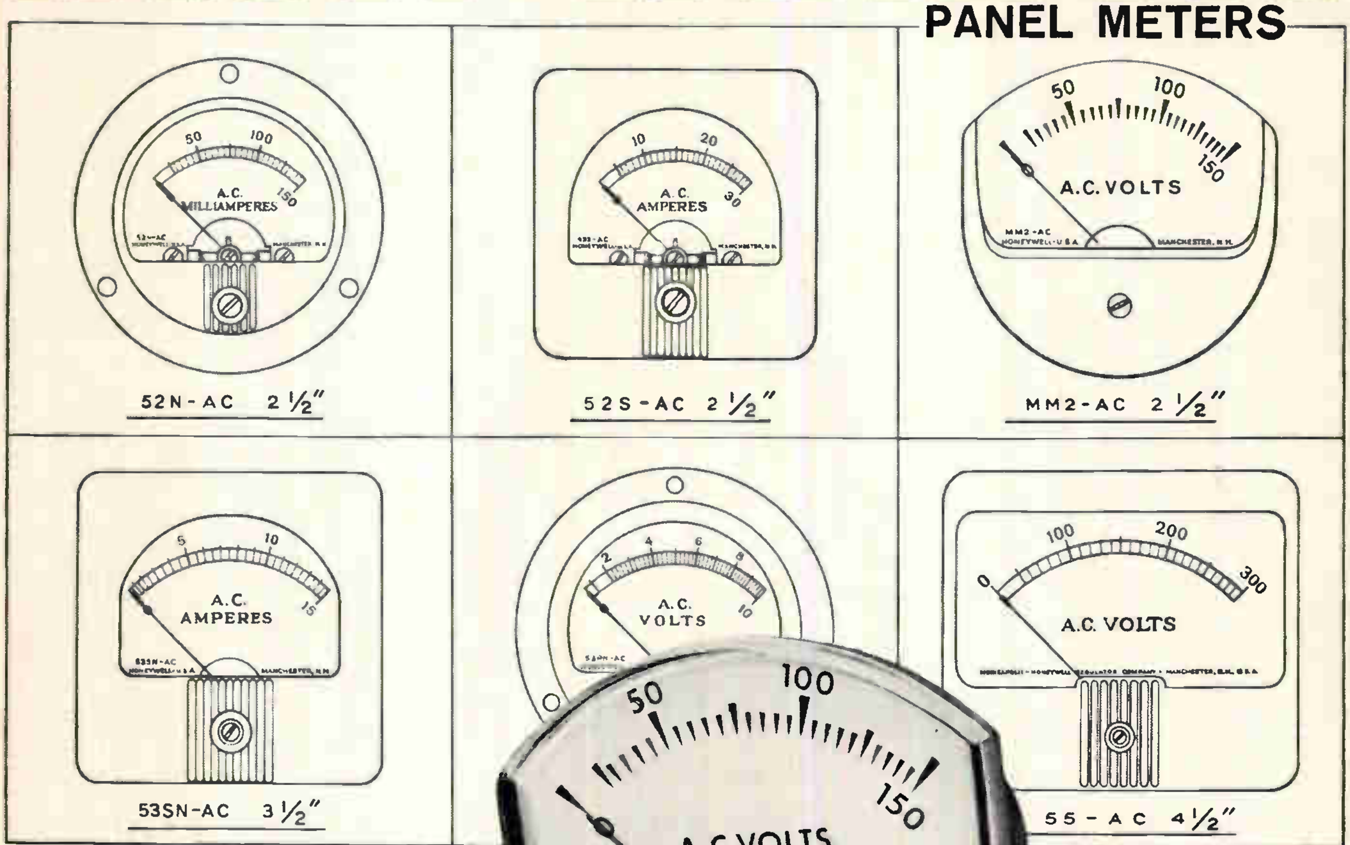
Sept. 14-15: Technical-Scientific Communications, PGEWS of IRE; Bellevue Stratford Hotel, Philadelphia.

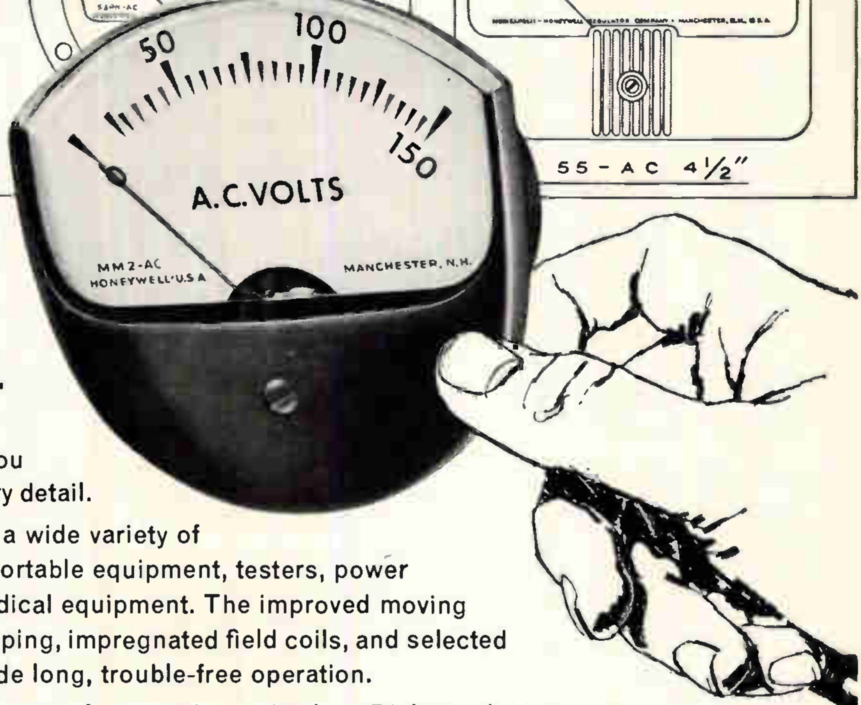
Sept. 14-15: Engineering Management Conf., IRE; Hotel Roosevelt, N. Y. C.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Int. Amphitheatre, Chicago.

Nov. 14-16: Northeast Research & Engineering Meeting; NEREM; Commonwealth Armory and Somerset Hotel, Boston.

THE NEW HONEYWELL
IRON VANE AC
PANEL METERS





Here are the AC counterparts of Honeywell's popular DC panel meters. Iron Vane AC Meters are perfectly matched to the DC range and are available in both the Medalist and "standard" case styles. This means a minimum of trouble and expense in mounting. And you are assured of harmonious styling in every detail.

Iron Vane AC Meters are designed for a wide variety of commercial applications — including portable equipment, testers, power supplies, generator equipment and medical equipment. The improved moving iron mechanism features magnetic damping, impregnated field coils, and selected fixed and moving iron material to provide long, trouble-free operation.

These meters are available in a wide selection of case styles and colors. Dials can be custom designed with your company name, trade-mark or other data. For full information, contact our representative in your area — he's listed in your classified telephone directory. Or us: Precision Meter Division, Minneapolis-Honeywell Regulator Co., Manchester, N. H., U. S. A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario and around the world: HONEYWELL INTERNATIONAL — Sales and service offices in all principal cities of the world.

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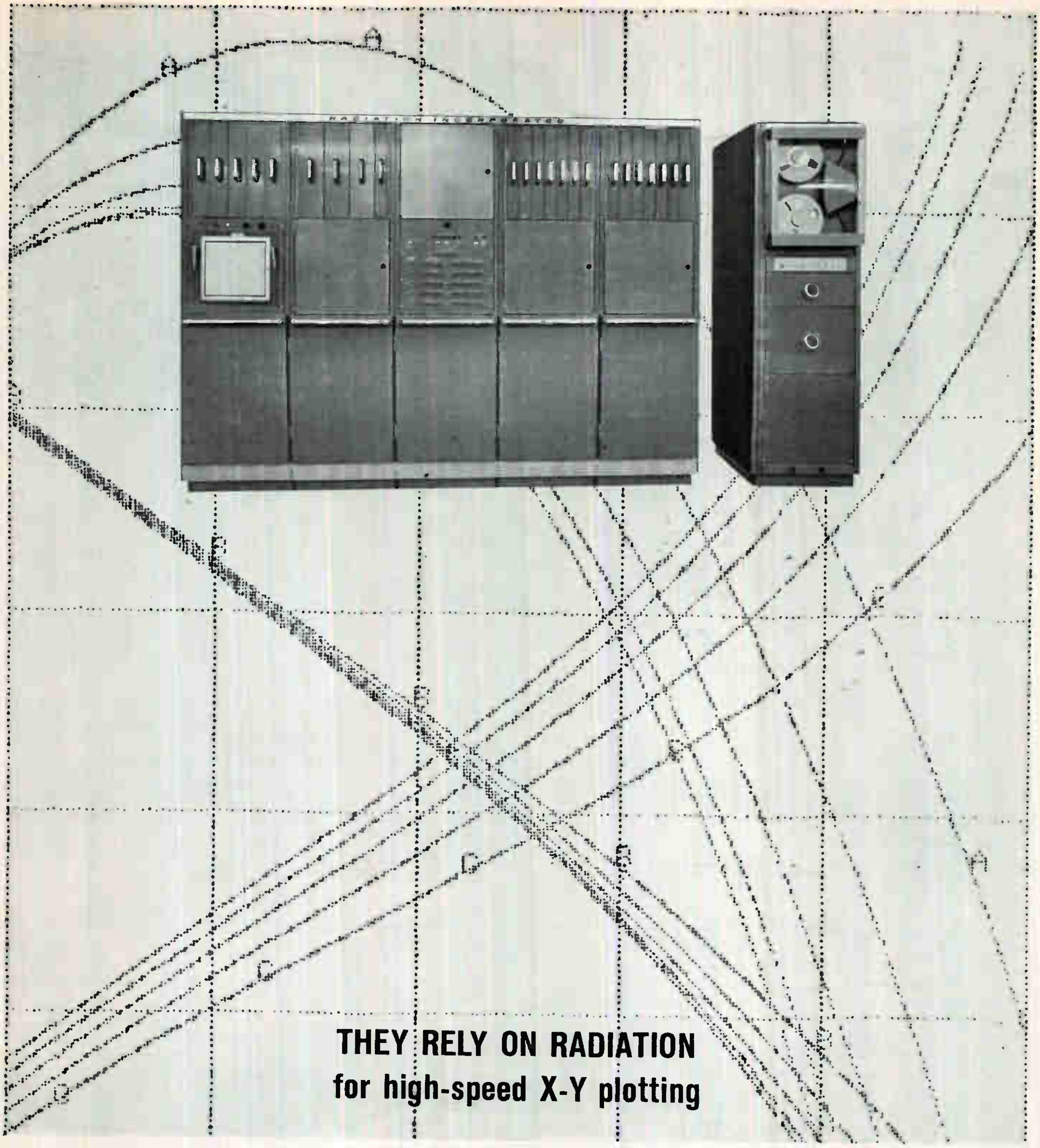
CIRCLE 35 ON READER SERVICE CARD



This X-Y Plotter, designed and built by Radiation for Kirtland AFB, plots five variables graphically against a selectable fifth variable from magnetic tapes generated by digital computer. It also provides identifying notations and text in alpha-numeric characters—at a speed of 50 data points per second.

Radiation engineers achieved a number of technological advances with the Plotter. For example: this highly automated equipment provides quick selection, independent scaling and zero-shifting for each variable. It can reproduce an unlimited number of report-quality copies of the plot. Advantages of the system are inherent digital accuracy, savings in time and labor, and simplified analysis of significant data.

The X-Y Plotter illustrates Radiation's ability to design, engineer and build advanced electronic systems for defense and industry. Perhaps you can take advantage of this unusual capability. We'll gladly send more information and a copy of our "Capabilities Report." Radiation Incorporated, Dept. AW-7, Melbourne, Florida.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

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CIRCLE 37 ON READER SERVICE CARD

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a continuing series on technical topics of specific interest to engineers

Folio 15 REFERENCE DATA FILE SANGAMO

Ripple Current in D.C. Filter Capacitor Applications

A.C. ripple current rating of an electrolytic capacitor is one of the important factors in filter applications. Excessive ripple current can cause excessive temperature rise and can shorten life. This is why it is desirable to understand the facts concerning the effect of ripple currents before specifying electrolytic capacitors for filters.

A typical filter-capacitor application is shown in Figure 1 (a), where a singlephase, full wave bridge rectifier is supplied from a 60 cycle, sinusoidal input. If the switch to the resistive load is open, the capacitor will be charged to peak voltage during the first 1/240 second and will hold its charge, maintaining a constant D.C. voltage across its terminals. There will be no significant A.C. voltage ripple under these conditions, as shown in Figure 1 (b).

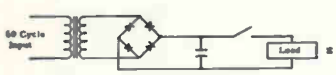


Figure 1 (a)

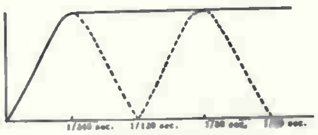


Figure 1 (b)

Figure 1—Typical full wave, singlephase bridge rectifier circuit operating on 60 cycle input is shown in 1 (a). Rectified voltage wave shown in 1 (b) is a constant D.C. voltage so long as load switch remains open.

However, conditions change when the load switch of Figure 1 is closed. The capacitor will be charged to peak voltage during the first 1/240 second as before, but after rectifier voltage reaches peak and begins to decrease, capacitor voltage remains higher than rectifier voltage. The capacitor must now supply load voltage and current until rectifier voltage is again equal to or greater than capacitor voltage. How rapidly capacitor voltage drops during intervals when it is supplying the load is governed by size of load and, hence, rate of discharge of the capacitor. Total drop ΔE, shown in Figure 2, is proportional to load current. These drops are what produce the ripple voltage. Ripple voltage is decreased when the filter capacitor is increased in capacity.

ΔE is the total peak-to-peak ripple voltage and is a complex wave containing harmonics of the fundamental ripple frequency. Exact heating effect calculations on the capacitor would involve determining the effective voltage for each harmonic, determining the rms current from known total impedance of the capacitor at this frequency, and calculating the watts loss from the known resistive component of the capacitor at this frequency. Total loss would be the sum of these individual harmonic contributions. This is a most complicated procedure since harmonic contents vary with application and complete impedance and resistance data versus frequency is not readily available for each capacitor design.

It is well to keep in mind that suppliers' ripple ratings are most usually based on tests conducted using 120 cps sinusoidal currents. Even though the true rms current in a practical situation is equal to the suppliers' rating, it does not mean that the heating effect will be the same as that obtained on the suppliers' test. This is due to the different wave forms involved and the harmonic current components mentioned above. However, an accurate rms current measurement is a very close approximation and is a practical first approach.

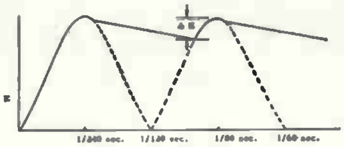


Figure 2

Figure 2—When load switch of Figure 1 is closed, capacitor supplies load voltage and current between successive rectifier input peaks. As capacitor discharges, its terminal voltage drops by amount ΔE, creating ripple voltage.

One method of making this measurement is to insert a low impedance thermal ammeter in series with the negative lead of the capacitor. The impedance of this meter must be small compared to the capacitor impedance or the ripple current will be altered. Large errors can be produced by this method, especially if a large low impedance capacitor is being tested. A thermal type ammeter is recommended for this test since a true rms reading can be obtained from a complex wave and the impedance of this type of meter is very low.

Another approximate measurement can be obtained by inserting a low value resistor or shunt in series with the capacitor and reading the voltage drop with a vacuum tube voltmeter. An additional error is encountered in this method unless the voltmeter used is a special type which reads true rms voltage.

A third method is to estimate, calculate, or measure the ripple voltage and divide by the capacitor impedance. The same errors exist here as mentioned above.

The above methods have been used very satisfactorily; however, when there is doubt or if complicated duty cycles are involved, the most satisfactory answer is obtained by measuring the capacitor case temperature rise by inserting a thermocouple between the insulating sleeve and aluminum can midway between top and bottom. If the ambient temperature is also measured at the same time, temperature rise of the capacitor above ambient can be determined.

Equipment should be operated in this test at maximum load for approximately 2 hours or until two successive measurements, taken 15 minutes apart, show no change in capacitor or ambient temperature. A Sangamo DCM capacitor is safely loaded if temperature rise is not more than 8°C. for 65°C. ambient or 12°C. for 40°C. ambient.

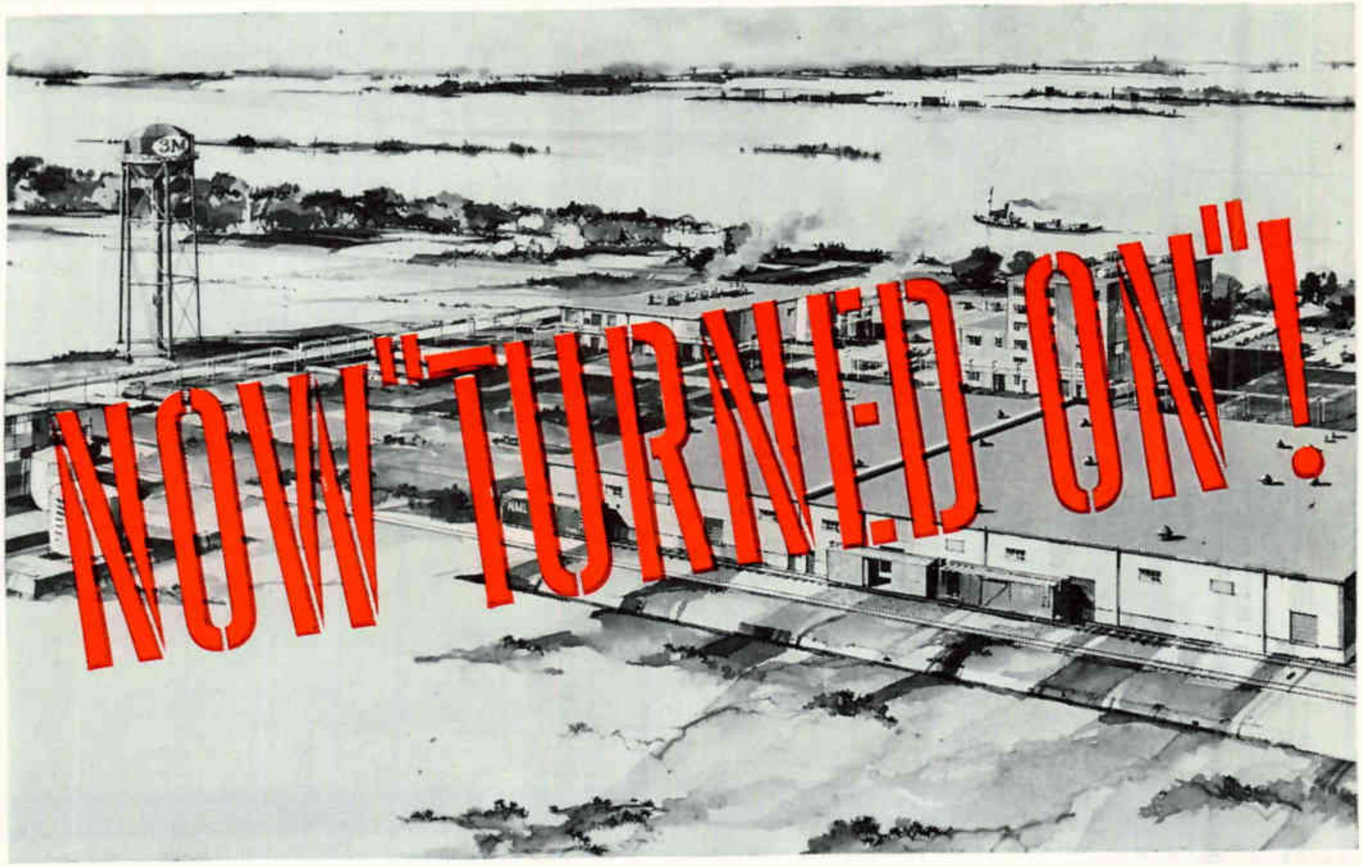
EC61-5

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

— designing toward the promise of tomorrow

3M COMPANY CHEMICALS

THE RAW MATERIALS OF PROGRESS



New 3M Fluorochemicals Plant!
New KEL-F® 81 Brand Plastic!

New plant and plastic will provide quality uniformity with volume . . . many advantages for processors and users

The New Product

- KEL-F 81 Plastic . . . retains the excellent end-properties of the original, but offers completely new processing advantages made possible by new manufacturing techniques and facilities.
- KEL-F 81 Plastic features exceptional consistency and uniformity . . . *not only within each lot, but from lot to lot as well.*
- Molecular weight of KEL-F 81 Plastic is carefully controlled by today's most modern quality control methods and machinery.
- Consistency in processing conditions provides a further uniformity standard for KEL-F 81 Plastic.
- KEL-F 81 Plastic is available in several forms to provide highest adaptability to customers' processing.

The New Plant

- Now on stream at Decatur, Alabama . . . newest, most modern chemical plant devoted exclusively to the production of quality fluorochemicals.
- Latest processing and quality control equipment, designed by one of the pioneers in fluorochemistry and fluorochemicals production.
- Production versatility that can move swiftly from pilot stage to full production of products adaptable to a wide range of customers' needs.
- Entire operation specifically designed to ensure highest uniformity in 3M Fluorocarbon chemicals.
- An integrated system of rail, truck and waterway transportation will provide fast delivery for your fluorochemical needs.

The big new 3M plant alongside the Tennessee River is now on stream with high-volume quality production of 3M Fluorochemicals to meet the expanding demands of industry. Featured are . . .

New Processing Advantages

One of the major products to be produced by the new plant is "KEL-F 81 Plastic" . . . chemically similar to previous KEL-F products, but now available with substantial revisions in processing advantages . . . for use in many industrial applications . . . especially in electrical, electronic, aero-space, and many chemical processing plants as a resilient, dense thermoplastic molding material, with product improvements you will welcome. For example . . .

Assured Uniformity!

In 3M's new Decatur plant, every precaution has been taken to ensure the highest uniformity of quality for KEL-F 81 Plastic production . . . both within a lot and from one lot to another.

Qualified processors will be offering KEL-F 81 Plastic in a variety of physical forms, each tailored to specialty requirements of product or process. They will meet exceptional degrees of resistance to chemical attack, heat, cold, moisture, dielectric properties, etc.

Stepped-up Fluorochemicals Production

3M—Decatur not only will manufacture KEL-F 81 Plastic . . . it will produce the full line of chemical products carrying the KEL-F brand name . . . plastics, elastomers, dispersion coatings, greases, oils and waxes.

Accelerated Delivery!

A completely integrated network of transportation will serve the Decatur plant, helping 3M give industry fast delivery of KEL-F Plastic and other products in the fluorochemical family. Railroad lead tracks and newly constructed highway arteries, with automatic loading facilities will speed these products to customers.

"KEL-F" is a reg. TM of 3M Co.

Technical Help!

3M technicians as well as a technically oriented sales force stand ready to provide practical technical help to manufacturers seeking to apply the advantages of KEL-F Halofluorocarbon Products to their applications. Their services (based on extensive field and laboratory tests) as well as 3M lab facilities and services of qualified processors will be available for help in overcoming problems involving the use of any of these products.

Production Assistance!

3M sales and lab representatives offer a wealth of experience with fluorochemicals, to assist qualified processors in setting up efficient production procedures to better serve your needs.

New Technical Brochure!

Just off the press—a brand new brochure giving complete technical data on KEL-F 81 Plastic. It contains complete laboratory and test data on the chemical and physical properties of KEL-F 81 Plastic, (also processing details) together with much practical data on its use in compression, injection, transfer, and extrusion molding. Please write on your company letterhead, indicating the nature of your interest. Write: 3M Chemical Division, Dept. KAX-81, Minnesota Mining and Manufacturing Company, St. Paul 6, Minn.

Properties Profile

on

KEL-F® 81 PLASTIC
BRAND

KEL-F 81 Plastic is a fluorocarbon plastic, a thermoplastic resin formed by the homo-polymerization of chlorotrifluoroethylene. The high degree of fluorination of KEL-F 81 Plastic is responsible for its chemical inertness and thermal stability. The inclusion of chlorine in an otherwise carbon-fluorine molecule results in exceptional moldability and mechanical toughness.

Crystallinity. KEL-F 81 Plastic is crystallizable, but not necessarily crystalline, the degree and kind of crystallinity in a given sample being a function of its thermal history. The "quick quenched" resin is spoken of as amorphous, and the "slow-cooled" resin as crystalline. When crystalline, KEL-F 81 Plastic is a denser, more translucent material with higher tensile modulus, lower elongation, and greater resistance to the penetration of liquids and vapors. The amorphous plastic is less dense, more elastic, with greater optical clarity and toughness.

Physical Properties. The physical properties of KEL-F 81 Plastic combine mechanical, chemical, electrical, and optical advantages. And the most useful applications center around combinations of the following properties:

1. Useful temperature range: from -400°F. to +400°F.
2. Resistance to deformation and flow at high temperatures, pressures
3. Zero moisture absorption
4. Abrasion resistance
5. Radiation resistance
6. Chemical resistance
7. Electrical properties
8. Infra-red transmission
9. Inert to liquid oxygen
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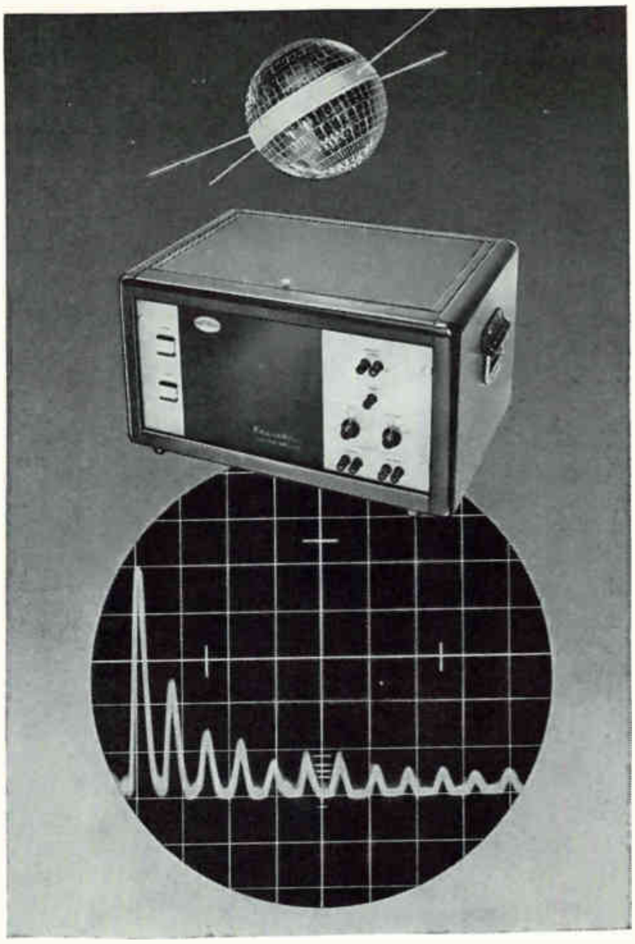

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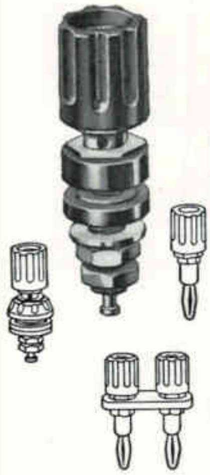

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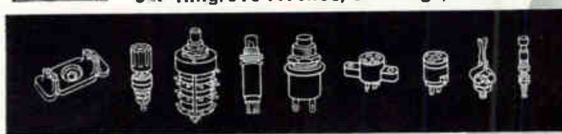

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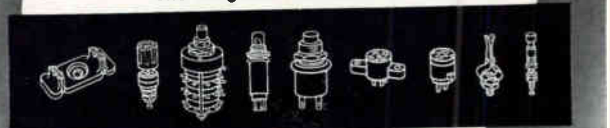

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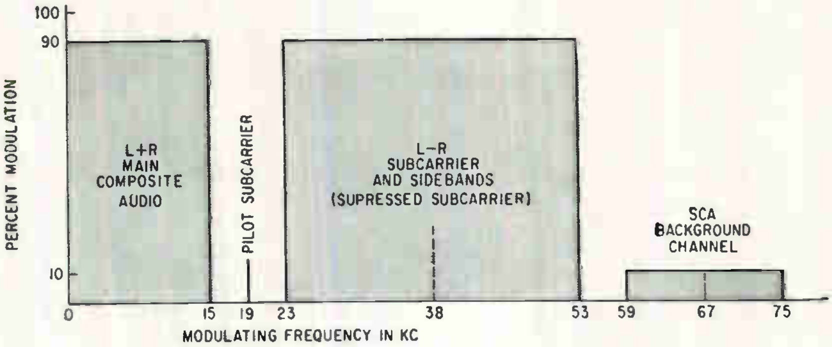


FIG. 1—Spectrum of f-m stereo broadcasting system composite modulation, showing the modulation frequencies involved.

Multiplex Adaptors for Compatible F-M Stereo Reception

By LESLIE SOLOMON
Associate Editor

WHEN AN F-M BROADCASTING station is transmitting a compatible stereophonic signal, in accordance with the FCC adopted method, the composite signal at the output of the f-m detector (before deemphasis) appears as shown in Fig. 1. The total signal is composed of L + R, which is the compatible signal used by unmodified receivers, a 19 Kc ± 2 cps pilot subcarrier that modulates the main carrier between 8 and 10 percent, and the L − R double sideband suppressed carrier a-m signal that is the second harmonic of the pilot carrier and crosses the time axis with a positive slope simultaneously with each crossing of the time axis by the pilot subcarrier.

The advantage of sum and difference matrixing in conjunction with the a-m suppressed carrier subchannel is the interleaving effect. This allows a maximum of 90 percent modulation of the main carrier either by the L + R audio or the L − R suppressed carrier subchannel.

It is possible that an SCA (Subsidiary Communications Authorization) background music channel may be at approximately 67 Kc. This subcarrier can modulate the main carrier up to 10 percent and carries sidebands of approximately 8 Kc each side. Crosstalk from this channel into either audio channel must be 60 db down from 100 percent modulation.

The frequency response of the L − R channel is identical to the main L + R channel within 0.3 db over the audio range (including preemphasis) and the phase response is identical to within ±3 degrees, resulting in approximately 30-db separation over the range 50 cps to 15 Kc.

There are several approaches to the design of a multiplex adapter. The post-detection method, shown in Fig. 2, separates the subcarrier information with a 38-Kc bandpass filter, demodulates it and by subtraction and addition of L + R and L − R, obtains separate L and R. Time delays introduced by the 15-Kc and 38-Kc filters must be compensated for.

A unit in which the detection process and matrixing are accomplished in one stage is shown in Fig. 3A. This Zenith Radio Corp. circuit is an electronic switch, which is on for 50 percent of the time and off for the other 50 percent at the subcarrier rate. If two switches are used with opposite phase relationship, one switch output will produce mainly right and some left signal, while the other switch will produce mainly left with some right signal. Subtraction of some L + R signal will produce the correct signal. In Fig. 3A, the signal from the f-m discriminator is passed through a 67-Kc rejection filter to the control grid of the 6AR8A switch tube, while a high-amplitude 38-Kc sine wave is applied to its deflection plates. The 6AR8A then functions as an electronic switch with outputs taken from the plate circuits. Matrixing is accomplished by mixing the plate output signal with the cathode signal. If only audio components are taken into account, one of the plates will produce mainly the left signal and a little right while the other plate will produce mainly the right signal and a little left. The cathode produces a balanced L + R signal.

A circuit in which matrixing is completely accomplished before detection is shown in Fig. 3B. If the amount of subcarrier information is raised by a special circuit, complete detection can be achieved. The circuit shown in Fig. 3B can be substituted for the 67-Kc rejection

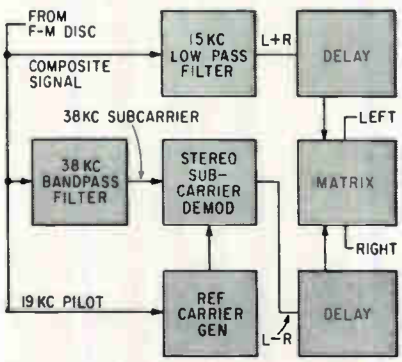


FIG. 2—Demodulator with post-detection matrixing

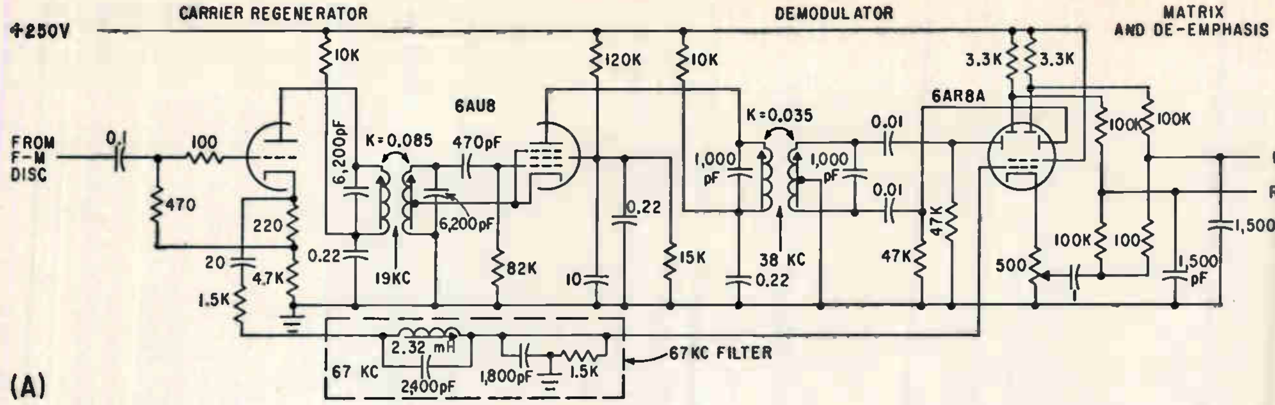
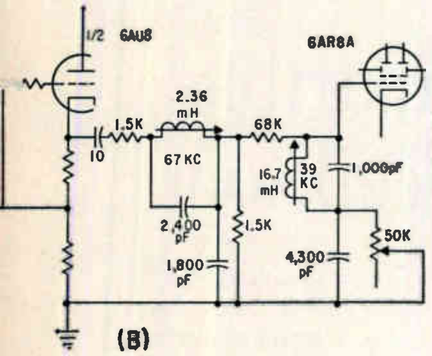
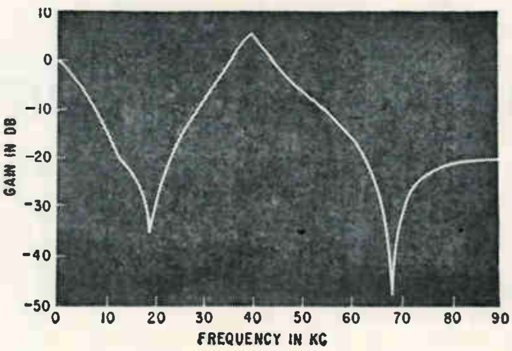


FIG. 3—Zenith stereo demodulator (A) and alternate filter (B) below





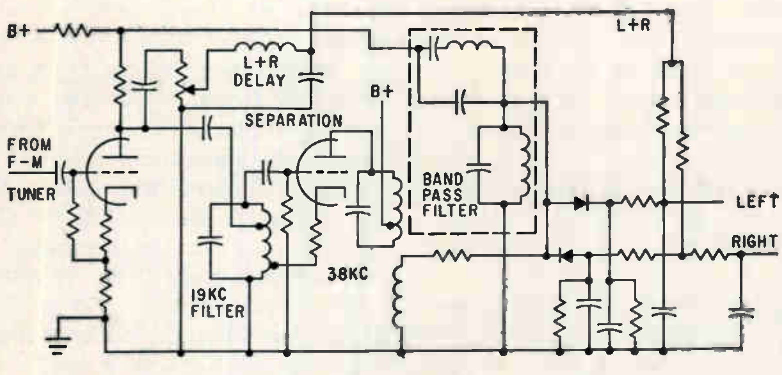


FIG. 4—GE synchronous oscillator circuit

filter shown in Fig. 3A. Deemphasis is accomplished in this circuit.

As shown in Fig. 3A, the pentode portion of the 6AU8 accepts the 19-Kc pilot signal and doubles it to 38 Kc in the plate load, and this signal is applied to the 6AR8A deflection plates. This is one variation of the locked oscillator technique. Another variation is the GE circuit shown in Fig. 4. Here the composite signal is amplified in the first triode and the amplified signal is applied, by an amplitude separation control and a delay network, to the output matrix. The output of the first triode is also applied by a bandpass filter to the detector. The filter is tuned to provide a bandpass between 23 and 53 Kc with the series arm displaying an antiresonance at SCA frequency (61 Kc). If this antiresonance is not designed into the circuit, an annoying whistle may result from mixing between the SCA and the stereo subcarrier.

The output signal of the first triode is also coupled to the pilot frequency filter. This filter is coupled to the second triode which operates as a synchronized oscillator. The oscillator output tank circuit is tuned to double the pilot frequency (38 Kc) and applied through a coupling coil to the detector. The detector consists of a pair of rectifiers connected to the input with opposite polarities as shown in Fig. 4. Filter capacitors and resistors are connected between the detector outputs and ground. Stereo separation is dependent on the degree of balance of the output resistance bridge. This device has a high output impedance and the insertion loss ranges between 6 and 10 db. In this circuit, the phase reinserted subcarrier can shift up to ±35 degrees from correct insertion before stereo separation is reduced to 20 db. If the subcarrier is incorrectly inserted to the sidebands, the L − R detected signal decreases with accompanying distortion, with any distortion being dependent on the reinserted subcarrier-to-sideband amplitude ratio.

Carrier generation by an automatic phase correction (apc) loop is also being tried. The operation of this circuit is similar to that used for subcarrier generation in a color tv set but is simpler because the pilot carrier is present at all times rather than in gated bursts.

For high-quality stereo reception, the f-m tuner used should have low distortion; otherwise components of distortion caused by frequencies between 6 and 15 Kc can fall into the pilot or L − R subchannel resulting in spurious signals.

This nonlinear distortion can be either inherent in the receiver or the result of improper tuning. Inherent distortion is related to the phase characteristics of the r-f and i-f section of the tuner and the linearity of the discriminator. It is important that the i-f section have, and be able to maintain, a flat linear phase characteristic within the passband. This can be done by a better designed and tuned or a broader response i-f section. A wide-band discriminator should provide the necessary linearity.

Of equal importance is the need for flat discriminator output voltage versus frequency characteristics (±½ db to 60 Kc). Variations from a flat response may adversely affect separation and distortion. Separation is affected because the energy level of the subcarrier is usually reduced and proper matrixing is precluded. This can be solved by an L + R level adjustment that need be set only when the adapter is first connected to the tuner.

Distortion may also be introduced by a falling discriminator output characteristic because unequal a-m sidebands may result. A falling discriminator output characteristic can be considered as an equivalent deemphasis network and a time constant can be computed. A preemphasis network with an equivalent time constant could be introduced in the stereo adapter, so as to produce an overall characteristic that is essentially flat both in amplitude and phase versus frequency. This could be made adjustable and would also simultaneously produce proper separation.

Vector analysis of an f-m tuner exhibiting an equivalent 5 μsec deemphasis in its output voltage versus frequency characteristic shows that a major cause of poor stereo performance is related to the level difference between the L + R and L − R channels. Some adjustment device should be included.

In the center of the audio spectrum, around 1 Kc, channel gain difference may be the determining factor whereas at the band ends, phase differences may become the determining factor. Transmitters will be kept so that channel gain will not vary more than 3½ percent of unity between 40 cps and 15 Kc and phase differences will be maintained within 3 degrees within this audio band. At present however, there are no standards for multiplex adapters.

Using a method developed by the Radio Receiver department of General Electric, it is possible to accurately judge not only transmitter performance, but also special test signal generators used to produce the composite stereo signal used in receiver and adapter design. It is important that the discriminator output voltage versus modulating frequency characteristics of the receiver be flat within ½ db to 60 Kc. In this discussion, the 19-Kc pilot signal will be omitted.

When L + R audio is added to the L − R 38-Kc sidebands signal, a composite produced at the discriminator output appears as shown in Fig. 5A. The axis is flat and linear if the L + R and L − R channel gains and phase shifts are equal to each other at the audio frequency in question. A phase or gain difference between channels is easily recognized on the composite signal.

Figure 5B shows the composite signal with an incorrect amplitude relation between L + R audio and L − R sidebands signal. For this illustration, the L + R audio and L − R sideband envelope have coincident zero points. Figure 5C shows a composite signal with correct amplitude relation but incorrect zero axis crossings of the L + R and L − R sideband envelope.

A detailed examination of the effects of a 10-degree phase difference is shown in Fig. 5D. Vector 1 and the sine curve represent the audio frequency through the L + R channel. Vectors 2 and 3 and the sine curves represent hypothetical vectors that describe the envelope of the sidebands signal. The diagrams of Fig. 5D show that the sideband envelope lags the audio zero crossing by 10 degrees.

If curve 1 is added to curve 2, the upper envelope of the composite signal is described. Similarly, if curve 3 is added to curve 1, the base line of the composite signal is described.

Height h of crossing point X of the envelope curves can be used to determine the difference in zero crossings of the L + R and L − R sidebands in degrees.

Ordinate h of the zero crossing of the sideband envelope is established by the value of sine wave 1 as $h = A \sin \omega t$ where $\omega t = \phi = 10$ degrees, therefore $h = A \sin 10$ degrees.

Since the height of the composite is normally twice the height of sine wave 1, it is necessary to multiply h by 2 when comparing the composite signal. Therefore $\phi = \sin^{-1} (h/2a)$.

As the angular difference between L + R and L − R sideband envelope approaches zero, C approaches $2a$ and the method becomes exact. This method has been used successfully in transmitter and signal generator alignment.

BIBLIOGRAPHY

L. Solomon, Modifying an F-M Transmitter for Compatible Stereo Multiplex, ELECTRONICS, July 14, 1961.

Adrian J. DeVries, Design of Sterophonic Receiver For a Stereo System in the FM Band using an AM Subcarrier, Zenith Radio Corp., Chicago, Ill.

Antal Csicsatka and Robert M. Linz, Factors Affecting Overall Performance of FM Sterophonic Receivers, Radio Receiver Dept., GE Co., Utica, New York.

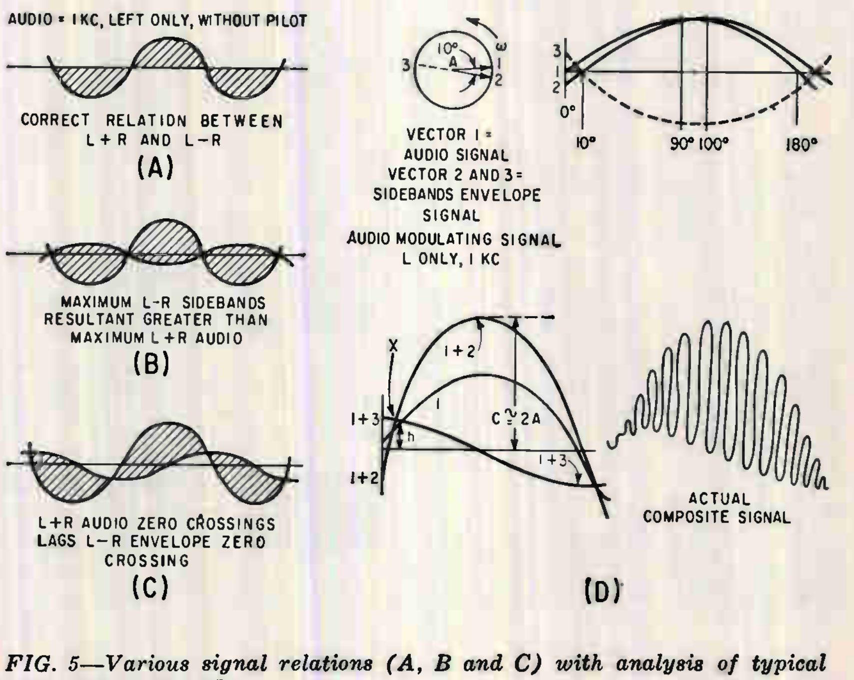
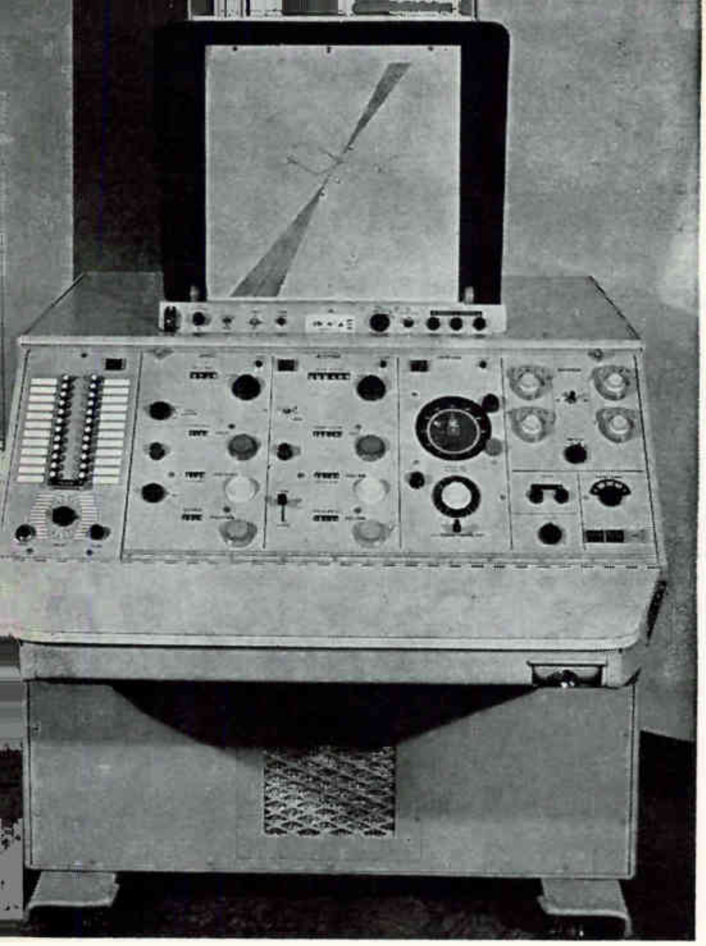


FIG. 5—Various signal relations (A, B and C) with analysis of typical phase difference (D)



Target generator has controls for speed, altitude and heading. The display serves as a ground reference and also indicates target location

Air Traffic Control

Federal Aviation Agency is using simulator to test traffic control procedures. Operators "fly" airplanes from take-off to landing, follow a flight plan and execute maneuvers on command of control tower operators. Complex traffic control problems can thus be studied in real time, with a high degree of realism

By EDWARD B. BOYKE, Jr.,
ROY L. EDWARDS, JR.
ROLAND E. NICHT
Aircraft Armaments, Inc., Cockeysville, Maryland

ELECTRONIC AIR TRAFFIC CONTROL SIMULATOR, installed at the National Aviation Facility Experimental Center near Atlantic City, New Jersey, simulates aircraft targets for large-scale tests of air traffic control methods. Put into operation in the spring of 1960, the simulator has been used to solve procedure problems for enroute and terminal-area traffic.

The simulator has sufficient realism to simulate accurately air traffic control functions, starting with pretakeoff contact with the local control center and continuing through enroute control, terminal area control, and approach and landing at the destination. A problem area 200 miles square is provided, with scales for increased accuracy in selected portions. The simulator allows realistic, full-scale tests of Air Traffic Control (ATC) equipment.

The system was designed to simulate air traffic control problems using present manual ATC equipment; and to provide inputs to semiautomatic ATC equipment now being developed.

Four functions are performed by the air traffic control simulator. First, aircraft coordinates are generated under the control of pilot operators. Second, radar simulators provide video outputs that are equivalent to the radar outputs obtained from real aircraft at the same coordinates in space. Third, air-to-ground, ground-to-air and ground-to-ground ATC communication channels are simulated by telephones. The fourth function is assembly and reduction of data re-

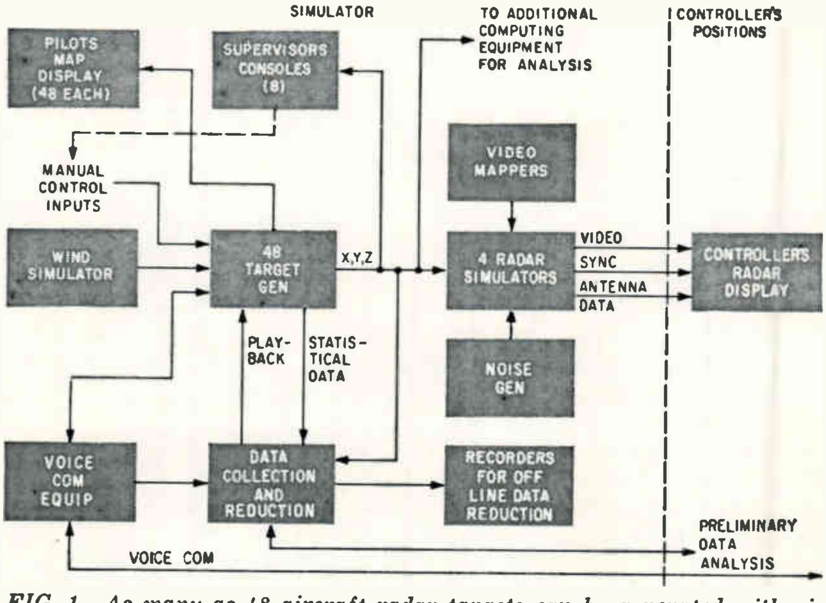


FIG. 1—As many as 48 aircraft radar targets can be generated with air traffic simulator. Controller's radar display provides a realistic simulation of what a control-tower operator would see.

Simulator Tests Flight Procedures

quired for evaluating ATC procedures. The data collection and reduction system can play back problems for reexamination.

Major components of the simulator are shown in Fig. 1. Each of the 48 target generators is manned by a pilot operator who uses manual inputs to control speed, altitude and heading in accordance with his flight plan and instructions from air traffic controllers. An additional input to the target generator is wind information, which adds realism. The outputs of the target generator are space coordinates and altitude (X, Y, and Z) analogs, and digital control signals. In the radar simulators the analog information from the target generators is converted to spherical coordinates, and video information is generated. The radar simulators can act with a live radar to combine real and simulated targets. Each of the three search radar simulators can simulate three types of current Federal Aviation Agency air traffic control radars; the fourth radar simulator acts as a ground-controlled-approach (GCA) radar.

The data collection and reduction system (DCRS) uses a large special-purpose digital computer. Inputs to the DCRS, defining all important simulator parameters, are provided by the 48 target generators and the communications system.

The DCRS performs three basic functions. First, data essential for preliminary analysis of a simulated problem is computed and printed out during the problem. This includes information on aircraft in conflict, ATC sector where each aircraft is, aircraft identity, the time and other information on aircraft passing over ATC fixes, mileage flown, time in holding patterns and other data.

Second, all problem parameters are recorded on magnetic tape in IBM 709 computer format for offline detailed analysis.

Third, voice communications, problem time, aircraft coordinates and target generator control signals are recorded on magnetic tape. This data is later fed back to the target generators to position X, Y and Z-coordinate digital servos. The X, Y, and Z servos provide data to reproduce a previously recorded problem.

The target generator shown in the photograph provides control of those portions of the air target's characteristics that must be simulated. The front panel provides control of speed, altitude and heading. Each of these controls can be changed in position by the derivative of the controlled quantity. For the speed control, separate acceleration and deceleration inputs are provided. For altitude control, climb and dive rates can be introduced. For heading, selectable turn rates are provided. For each of these inputs it is possible to preselect the speed, altitude or heading at which the rate control should stop; thus the pilot operator can respond to the controller's directions for a descent to an assigned altitude or a turn to an assigned heading. Pushbuttons enable the pilot operator to insert such information as time in holding patterns or runway occupancy time into the data collection equipment.

Controls are also provided on each target generator for selecting the map origin and scale for the pilot's display. As shown in the photograph, a display at the top of the target generator indicates the target's present position. Throughout a problem the pilot operator refers to the display to monitor progress, report arrival at fix points, and for all required visual reference to earth.

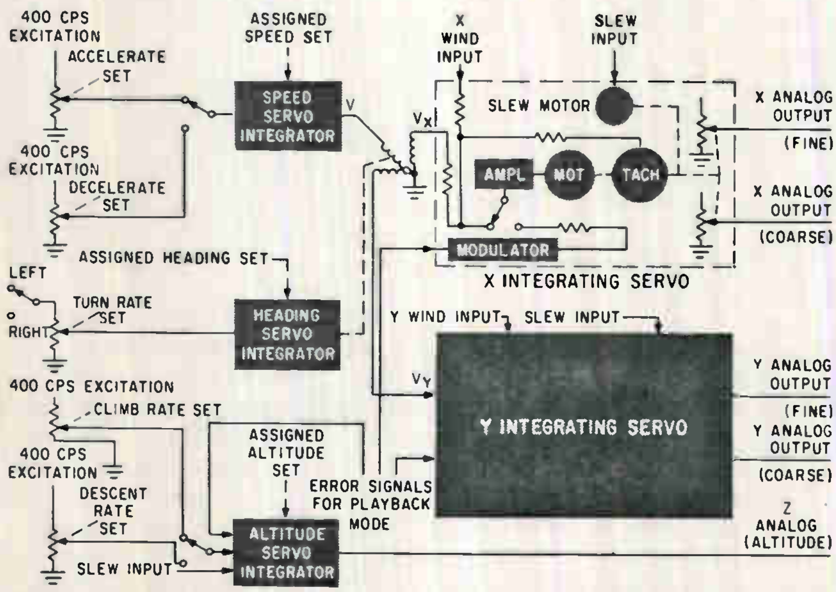


FIG. 2—Simplified block diagram of a target generator. Voltage analogs of a target in a 3-coordinate system are developed. Slew inputs are used in setting up a problem

The target generator circuit, illustrated in the block diagram of Fig. 2, uses double integration to obtain the X and Y outputs from the accelerate/decelerate and turn rate inputs. The result of the first integration is target speed and heading which is applied to the heading resolver. The X and Y components of target velocity are derived from the resolver and again integrated to produce the position outputs. Climb and descent rates are handled in the same manner and are integrated once to provide the altitude output.

All integration is done by electromechanical assemblies, using a 400-cps rate servo similar to that shown for the X-integrating servo. A hybrid tube-and-transistor amplifier drives the servo motor and tachometer; tachometer output is fed back to the amplifier input, thus controlling motor speed. Inte-

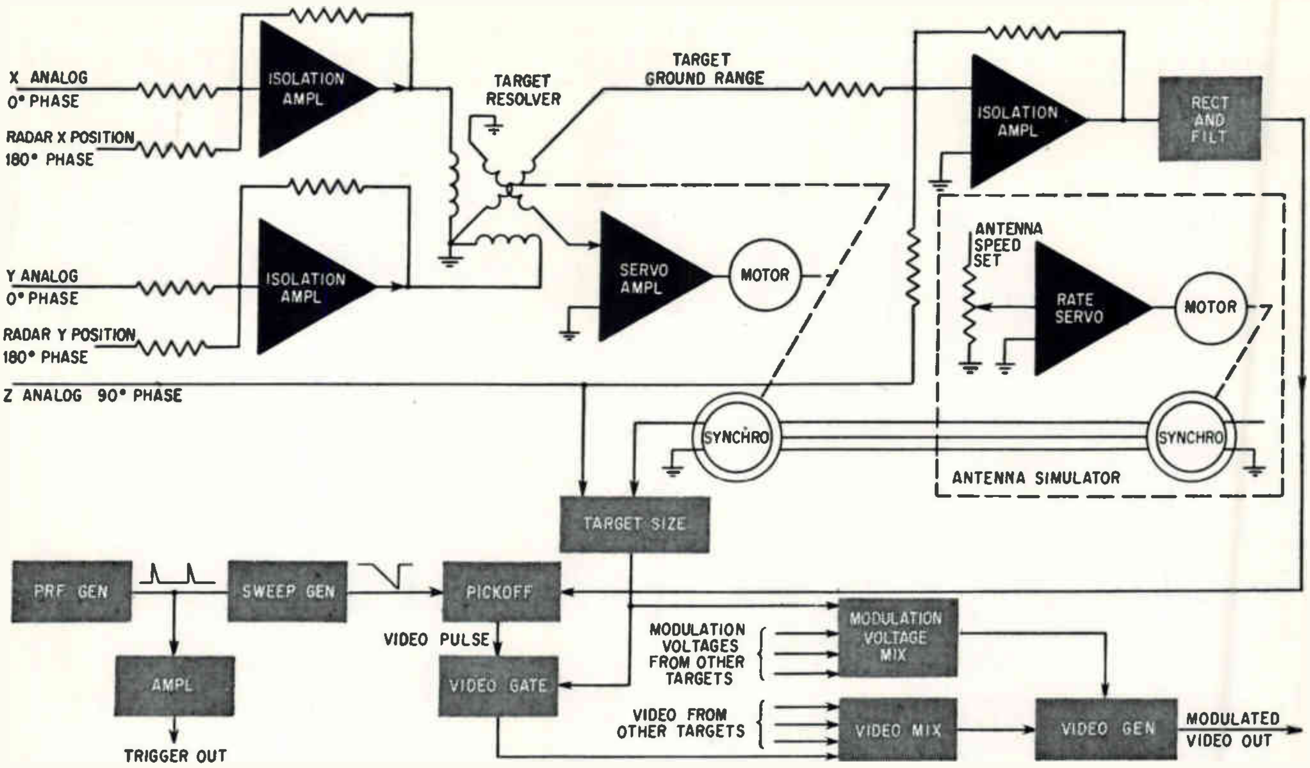


FIG. 3—Search radar simulator uses a synchro null technique to gate target signals

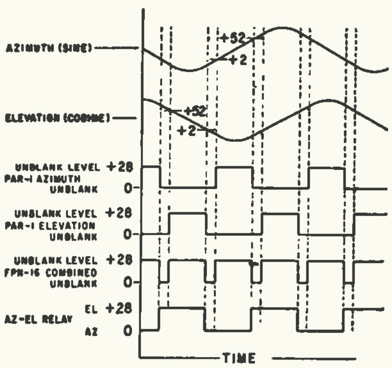


FIG. 4—Timing waveforms of the precision radar (GCA radar) simulator

gration error is approximately 0.5 percent.

Dials driven by the integrating servos show the pilot operator the speed, heading and altitude of the simulated aircraft. The X and Y positions are indicated less directly by the light spot on the pilot's display. To permit rapid setup of a problem, slew motors are provided on the servos.

The X and Y analog voltages are produced in a coarse/fine system for increased analog accuracy. The search radar simulators use the coarse analog, and the precision radar simulator uses the fine analog. Some items, such as the pilot's display, are switched from coarse to fine as necessary.

The simplified block diagram of a search radar simulator is shown in Fig. 3. The search radar simulators accept target position information from the target generators as X, Y, and Z analog voltages. The X and Y voltages are applied to range-scaling isolation amplifiers and then combined to give ground range of the target. Combining is performed with a vector solver that positions a resolver, giving ground range and angle as outputs. The altitude analog voltage is shifted 90 degrees and added to target ground range. This vector sum is a voltage proportional to the slant range of the target. It is then rectified and filtered to provide a smooth negative d-c voltage proportional in amplitude to the slant range of the target.

A central prf generator is used in the search radar simulator to produce a pulse train equivalent to that of the set being simulated. The prf generator synchronizes a linear sawtooth generator whose amplitude determines the voltage-to-time conversion for video pulse delay corresponding to target range. Target range voltage and the sawtooth are applied to a diode pick-off circuit, which produces a target video pulse at the correct range. A modulating voltage is generated that combines the effect of target size, the antenna beam shaping voltage and the elevation beam pattern. The output video pulse is mixed with the outputs of all other target channels and applied to a video generator, which uses the modulating voltage and yields the pulsewidth and amplitude for the radar output. This mixed video signal is then combined with noise and video mapper signals and sent to the radar displays.

Antenna gating is performed by gated-synchro null comparison. The shape of this null closely corresponds to the main lobe of a radar antenna pattern. When the position of the antenna and the target coincide, synchro output approaches a null. This null voltage is rectified and filtered in the target size circuit to provide a d-c gating voltage that controls the amplitude of any range pulses generated. Whenever the target is not within the antenna pattern, the gating circuit cuts off the target video, and no target is presented. The antenna simulator consists of a servo that drives synchros and resolvers at rates that simulate the antenna's characteristics. The output synchro of the antenna simulator drives the gating synchro on each of the vector solver servos. The antenna simulator servo runs as a rate servo when the simulator is not connected with an operational radar; when it is connected with an operational radar, the servo will follow the radar antenna position.

A precision simulator was developed for GCA radars PAR-1 and FPN-16. The two radars require identical electrical analog antenna positional data; basic system differences are the mode of data transmission and display.

The GCA radars have separate azimuth and elevation antennas that alternately scan a narrow sector over the runway; elevation antenna limits are −1 to +6 degrees and azimuth limits are −5 to +15 degrees, referred to the runway bearing. Radar returns are displayed alternately on the radar crt. The elevation antenna scans vertically and can be slewed in azimuth within the limits of the azimuth sector; the azimuth antenna scans horizontally and can be slewed vertically within the limits of the elevation sector.

Motions of the GCA antennas are translated into four d-c analogs: azimuth and elevation scan angles, and azimuth and elevation slew positions. Data is also transmitted for a video display of antenna beam dimensions in the slew directions.

The antenna simulator of the precision radar simulator uses a precision sine-cosine potentiometer driven at 60 rpm to produce simulated azimuth and elevation scan-angle voltages simultaneously, as illustrated in Fig. 4. Unblanking and other data are generated by a precision commutator and cam-operated switches, also driven at 60 rpm. The time between unblanking signals is sufficiently long to allow switching transients to decay completely before video display.

Simulated radar targets for the azimuth beam are generated by a system using resolved range sweeps, pickoffs and beam gates, illustrated in Fig. 5. The resolved sweeps and pickoffs perform rectangular to polar coordinate conversion, producing target range and bearing data compatible with GCA radar systems. Rotation of the azimuth sweep resolver with a servo following azimuth scan angle produces sine-cosine range-sweep components suitable for comparison with X-Y target position data. The comparison yields a video pulse at target range when antenna angle and target bearing coincide.

The elevation scanning function is produced similarly. A linear potentiometer is rotated, with a sector-scanning servo following elevation scan angle, to produce an elevation-scanning vector that may be compared directly with target generator altitude voltage.

Simulated antenna slewing complements the scanning functions. A sweep-resolver produces the bearing data pertaining to the elevation scan antenna; a linear potentiometer supplies the elevation data pertaining to the slew position of the azimuth antenna.

Optimum system accuracy is maintained by an X-Y coordinate-rotating circuit. The ambiguous 90-degree resolver shaft angle conditions, producing a zero X or Y component of sweep output, are avoided by converting target analog (X-Y) data. The block diagram of Fig. 6 shows the coordinate-rotating approach. Target coordinates are rotated counterclockwise in 30 degree increments by summing coefficients of angles in operational amplifiers. Optimum operating conditions for the system of range sweeps and pickoffs require a runway true bearing of about 250 degrees (third quadrant); both the X and Y sweep components are then negative and have about the same amplitude. Addition of the coordinate-rotating system between the target generator and the X-Y pickoffs permits target simulation within 30 degrees of the optimum bearing. A runway bearing of 190 degrees true bearing, for example, would require a rotation angle of 360 − (250 − 190)

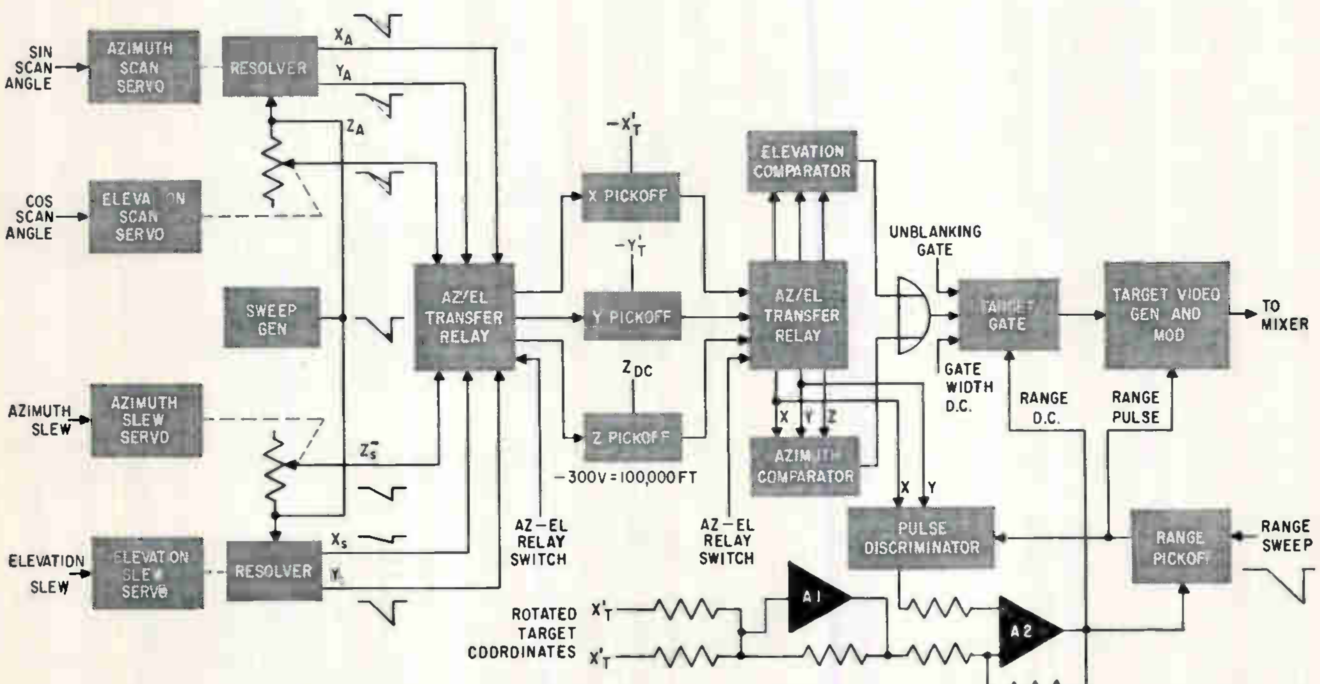


FIG. 5—Precision radar simulator generates the same type of signals as a GCA radar

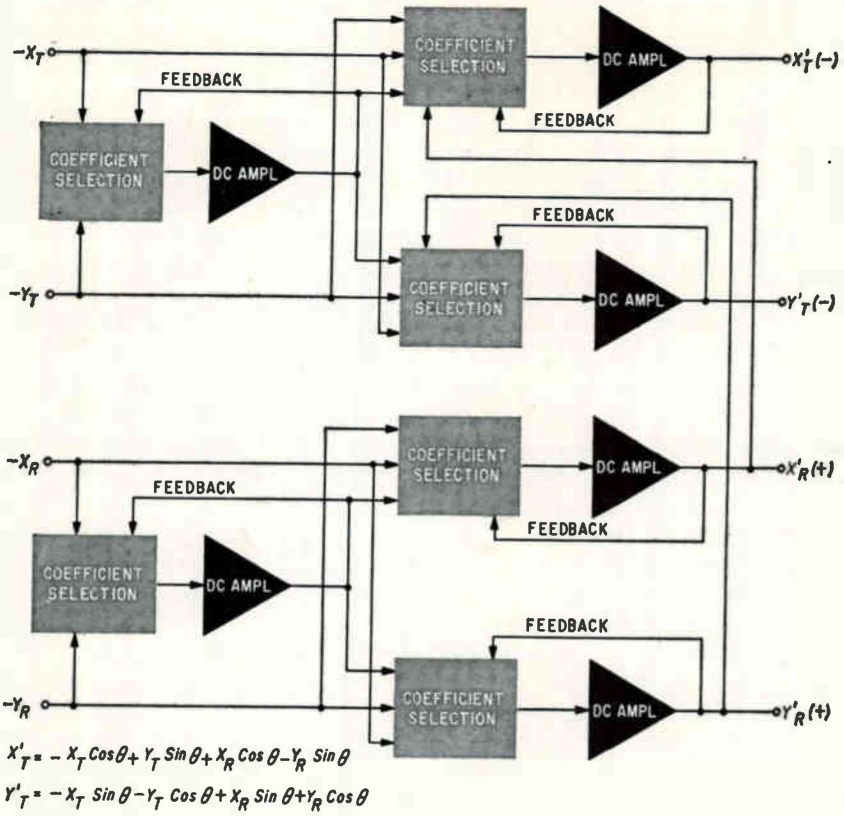


FIG. 6—Accuracy of the GCA radar simulator is increased by coordinate rotation

= 300 degrees.

Referring again to Fig. 5, optimized X_T'-Y_T' analog target voltages are fed continuously to the target X-Y pickoffs, which alternately compare analog X_T'-Y_T' d-c against the X-Y sweep waveforms that represent azimuth scan and elevation slew (in azimuth) positions. Pickoff outputs are distributed through an azimuth-elevation (AZ-EL) time-sharing relay.

Coincidence of azimuth scan, X, Y pulses occurs at the range and bearing of the simulated target but cannot be displayed as video: pickoff pulse width required to simulate target size does not realistically simulate target shape.

A satisfactory target video display is simulated by gating a range pulse instead of the X, Y coincidence pulses. The range pulse is generated continuously at precise target range by a pulse discriminator and feedback amplifier. Figure 5 diagrams the operations of pulse error correction.

Summing amplifier A_1, Fig. 5, produces the first approximation of target range by summing X-Y analogs. Differential summing amplifier A_2 receives an error voltage from the pulse discriminator to correct the range d-c into the range pickoff and reduce the timing error between X-Y coincidence and the range pulse.

The azimuth X-Y coincidences now trigger the target gate, which controls the display time of the range pulse according to the simulated antenna beamwidth. A modulation waveform is derived from the target gate square-wave output, with an integrating network, to smooth the target video envelope.

Triggering of the target gate with X-Y coincidences produces unsymmetrical video displays because of the bidirectional scanning operation of GCA radars. The X-Y coincidences define the center of a target that appears to increase in size with range. But since a target on a real radar gets smaller as the range increases, the target gate pulse width must decrease similarly if realism is to be preserved.

A logarithmic increase in the length of the X-Y coincidence envelope results from the requirement for constant target size on the display. Compensation for this increase is obtained by delay of the target gate pulse, at the cost of a nonoverlapping video display. Overlapping displays are secured by fixed phase-lead networks in the scan servo amplifier inputs, permitting superimposition of succeeding distant targets. A monostable delay multivibrator, whose delay increases logarithmically with decreasing control voltage, was developed to delay the target gate pulse and permit symmetrically

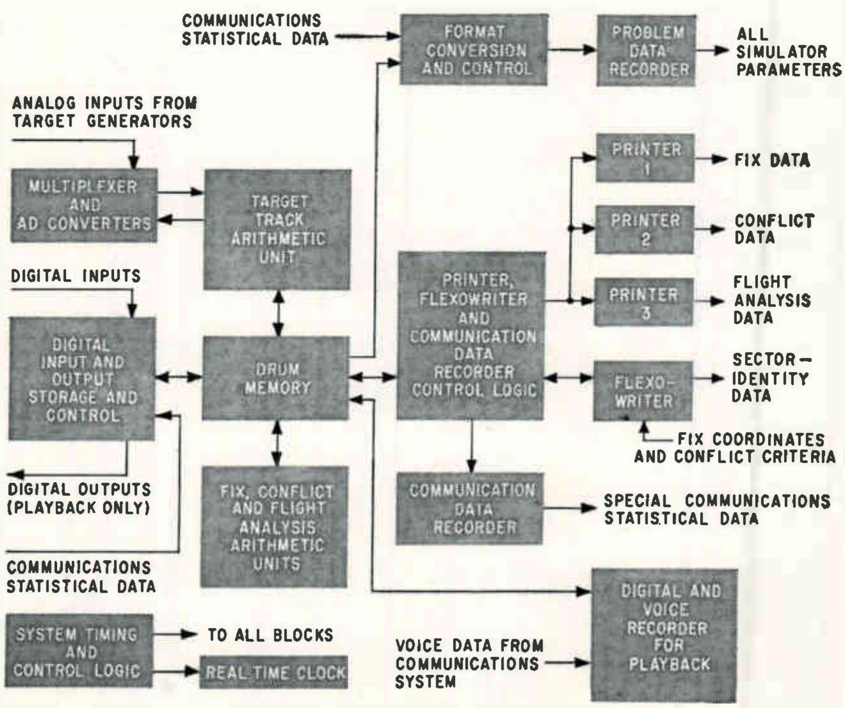


FIG. 7—Data collection and reduction system. Problem parameters are recorded on tape and problems can be replayed

overlapping video displays.

The simulated antenna slewing functions are treated somewhat differently: gating pulses generated from X, Y and Z pickoff slew data pulses are compared with the scanning pickoff pulses. Target X, Y azimuth scan pulses must coincide within the limits of the elevation slew gate pulse to produce an azimuth target pulse.

Target elevation (Z) scan pulses must coincide with range pulses within the limits determined by the azimuth X, Y slew gate positions to produce elevation target pulses.

A simplified block diagram of the data collection and reduction system (DCRS) is shown in Fig. 7. Inputs are analog and digital signals from the target generators, voice and digital data from the communications system. The analog signals are target generator X, Y and Z coordinate data and target velocity. Target generator digital signals are target identity, ATC sector containing the target, contact closures defining time in holding patterns, time at undesired altitude, number of times in holding patterns, number of undesired altitude changes and number of undesired speed changes. Communications data consist of 500 contact closures that indicate the status of various communication lines. These contacts define all data needed for statistical analysis of the communications system.

The five major sections of the DCRS are: system timing and control; magnetic-drum memory; digital and analog input and output equipment; 3 special-purpose arithmetic units; and readout and recording equipment.

The system timing and control section controls overall system operation and contains the system timing generator. Clock frequency is 213 Kc. The basic computer word contains 16 bits, of which 15 bits are used for instructions or data and the 16th for timing and control functions. The timing generator provides signals to all other sections and controls the real-time clock.

The system memory is a 10-inch magnetic drum operating at 4,000 rpm. The drum contains 64 tracks including one engraved timing track; each track contains 200 16-bit words, with a density of 102 bits per inch.

The digital portion of the input-output equipment uses conventional diode logic to sample the state of contacts in the target generators and communications system, plus six 50-bit flip-flop registers to provide six control signals to each of the 48 target generators during playback. The analog section consists of a multiplexer, A/D converters and the associated target track updating arithmetic unit. Incremental techniques are used in converting analog data to digital form and for storing the results.

The A/D conversion accuracy is 0.025 percent. One A/D converter per target generator plus two spares are provided; each converter contains a d-c amplifier, digital attenuator and comparator. Converter control logic is time-shared by all 50 channels.

In the record mode, the X, Y, and Z servos in the target generators operate as conventional analog integrating servos. In the playback mode they operate as digital or bang-bang servos under control of the DCRS system.

A simplified block diagram of an X-coordinate playback mode servo loop is shown in Fig. 8. During the record mode each time an A/D conversion is made (every 60 msec), an incremental X bit and four servo mode control bits are recorded on tape. Once each three seconds the full X coordinate value is also recorded.

During playback the full 15-bit X value is read onto the magnetic drum each three seconds. Recording the full value allows the system to be easily slewed to an intermediate point and also reduces system errors due to random bit dropout.

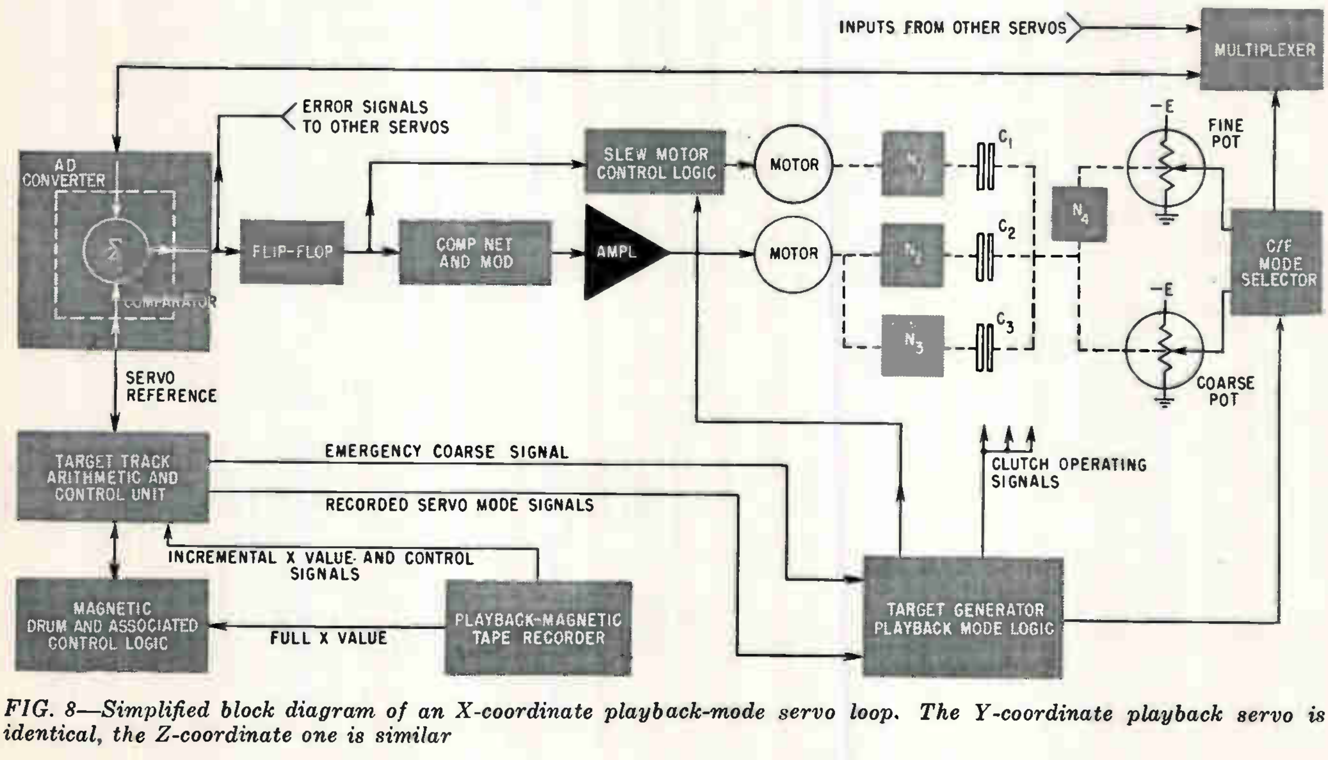


FIG. 8—Simplified block diagram of an X-coordinate playback-mode servo loop. The Y-coordinate playback servo is identical, the Z-coordinate one is similar

Omnidirectional K-Band Antenna Uses Slots, Probes and Horns

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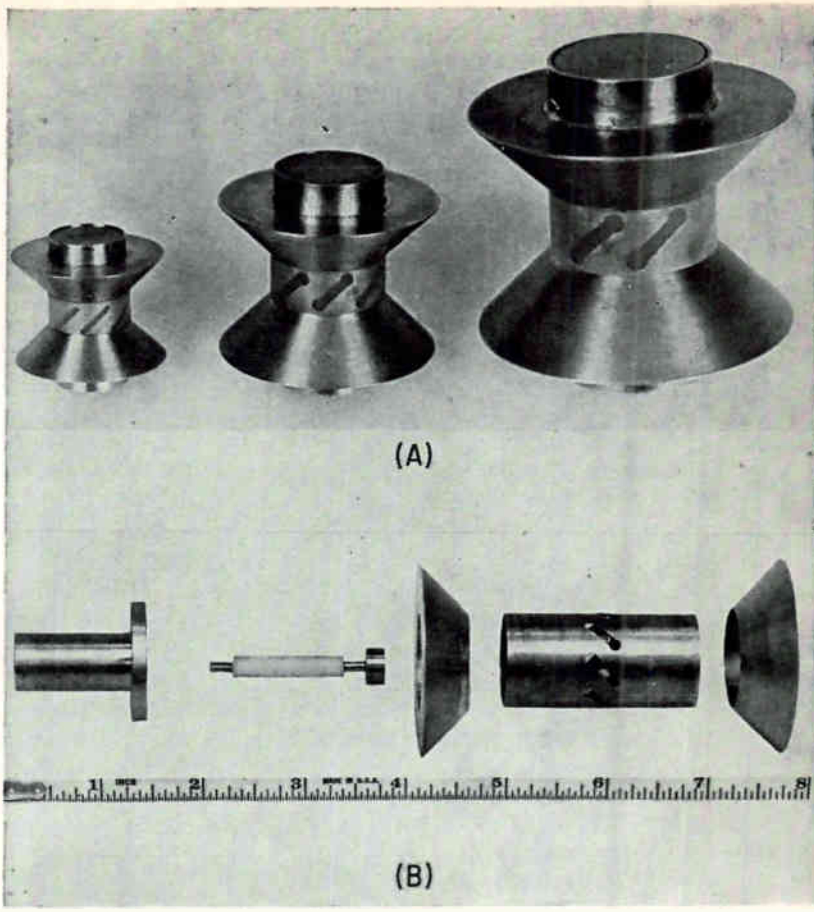


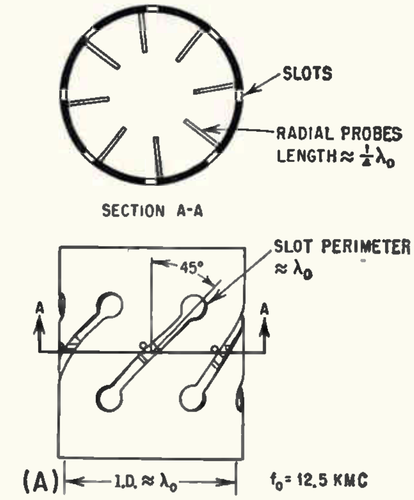
FIG. 1—Different versions of the new antenna for different frequency bands are shown in (A), the 10-to-15-Gc version is at far right; its individual components are shown at (B)

A NOVEL K-BAND omnidirectional antenna was developed for coverage in all directions in a horizontal plane with a nominal 30-degree elevation beamwidth centered on the horizon, operation from 10 Gc to 15 Gc with a voltage standing-wave ratio less than 3 to 1, and reception of both vertical and horizontal waves. Figure 1 shows the completed antenna.

It was necessary to consider array requirements for omnidirectional coverage, slot radiators, and propagation mode bandwidth. A pseudoisotropic source, see Fig. 2A, is responsive to both vertical and horizontal waves, and gives omnidirectional coverage in the horizontal plane. Although Silver[1] reports that at least six longitudinal slots are needed (same frequency and size of circular guide), by summing source radiations vectorially it can be shown that eight slots are needed to meet the stated requirements. Small conical horns were added for greater directivity; and to improve coupling from the slots, short radial probes were used. The resonant frequency of the slot-probe pair was staggered for better coupling over the bandwidth.

Figure 2B shows the complete assembly mounted on the rectangular waveguide. The propagation mode used in the rectangular guide was TE_{10}. In the circular guide, the TM_{01} mode was used. Both modes have a bandwidth greater than 50 percent, measured as a ratio of similar mode cut off frequencies.

Degree of match was measured over the frequency band for no radome over the slots, a 20-mil polystyrene window and a 20-mil Rexolite window. Addition of the protective cover affected mismatch loss slightly over a narrow band.



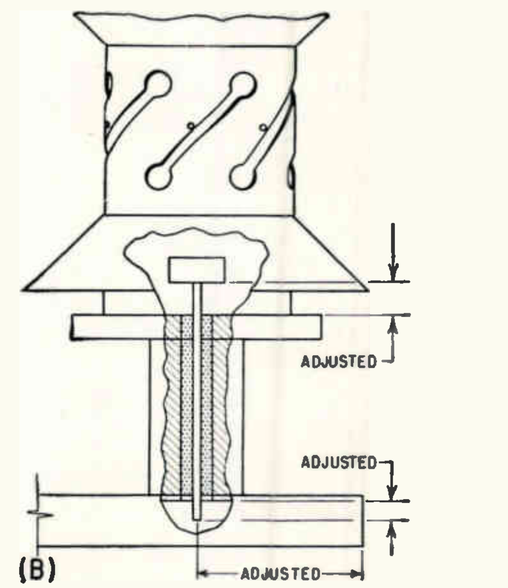


FIG. 2—Slot array with radial probes for the antenna core, (A); method of matching antenna to a rectangular waveguide, (B)

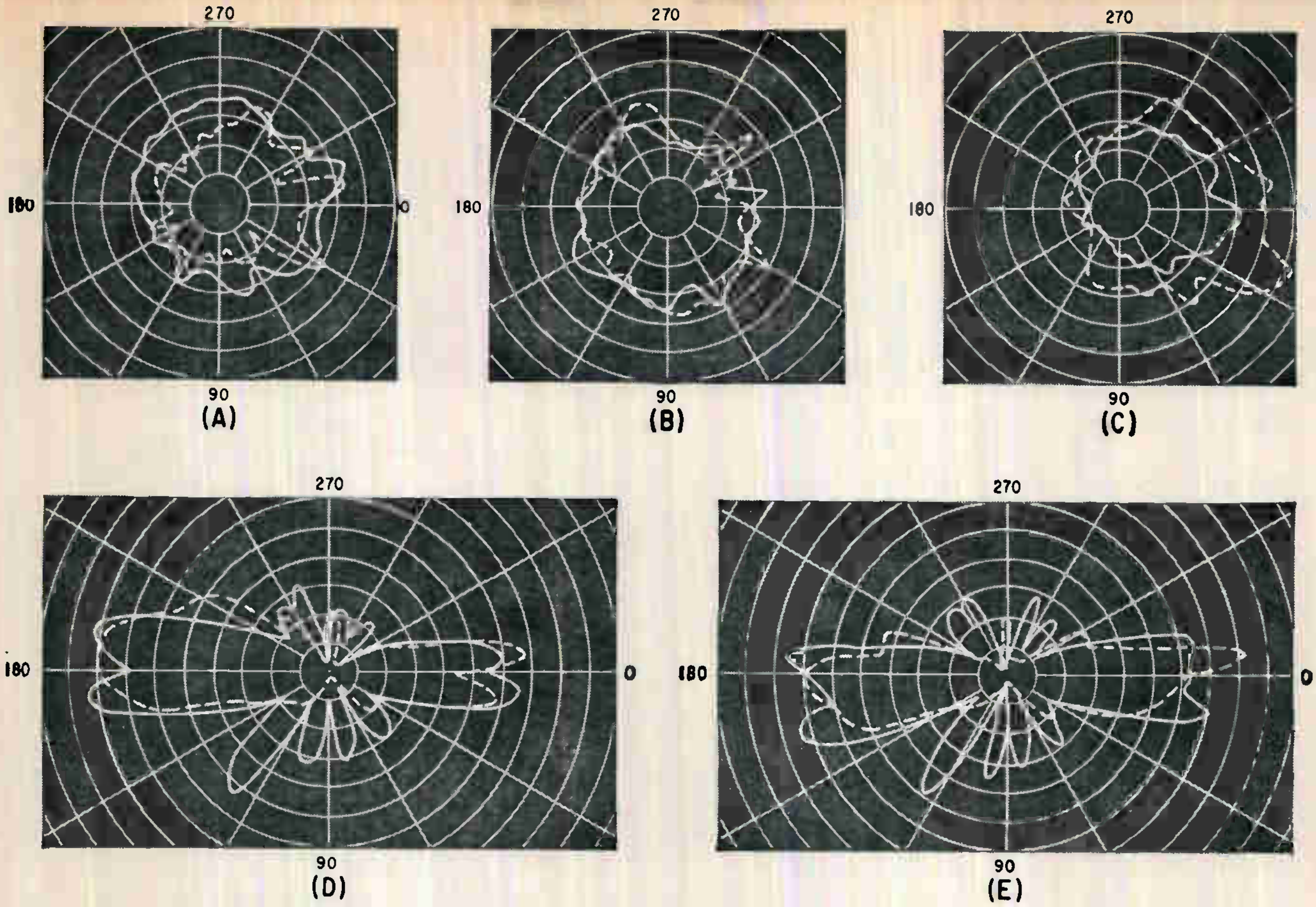


FIG. 3—Measured azimuth patterns at $\theta = 90$ degrees are shown in (A), with 10 Gc vertical polarization in solid line and horizontal polarization in dashed line. Same pattern for 12.5 Gc is plotted in (B), and for 15 Gc in (C). Elevation patterns for $\theta = 0$ degrees are shown for 12.5 Gc in (D) and for $\theta = 90$ degrees for 12.5 Gc in (E)

Figure 3, A to C, shows azimuth coverage from 10 Gc to 15 Gc for both vertical and horizontal waves. As may be observed, coverage was 360 degrees.

Figures 3D and E show typical elevation coverage for both vertical and horizontal waves. Elevation patterns of both polarizations were recorded for two vertical cuts over the 1.5 to 1 bandwidth. From these patterns, it was observed that the half-power beamwidths ranged from 30 to 50 degrees; the energy maximum was close to the horizon and spurious lobes were all below the main beam maximum.

In Fig. 4 the relative response of the antenna to vertical and horizontal waves has been plotted. At each frequency constant incident signal power was maintained and the ratio of response measured.

Figure 5 illustrates measured gain by comparison with a gain-standard horn and computed directivity plotted as a function of frequency. Because of approximations used in the computation of directivity[2], and system linearity, which was about ±1 db over 20 db range, the displayed curves are indicative of performance.

A complete set of units up to 36 Gc were built and tested over their respective 1.5 to 1 frequency bands.

REFERENCES

(1) S. Silver, "Microwave Antenna Theory and Design," McGraw-Hill, New York, 1949, p. 307.

(2) J. D. Kraus, "Antennas," McGraw-Hill, New York, 1950, p. 25.

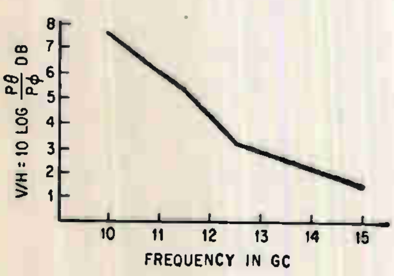


FIG. 4—Vertical and horizontal plane wave polarization is plotted against frequency in Gc

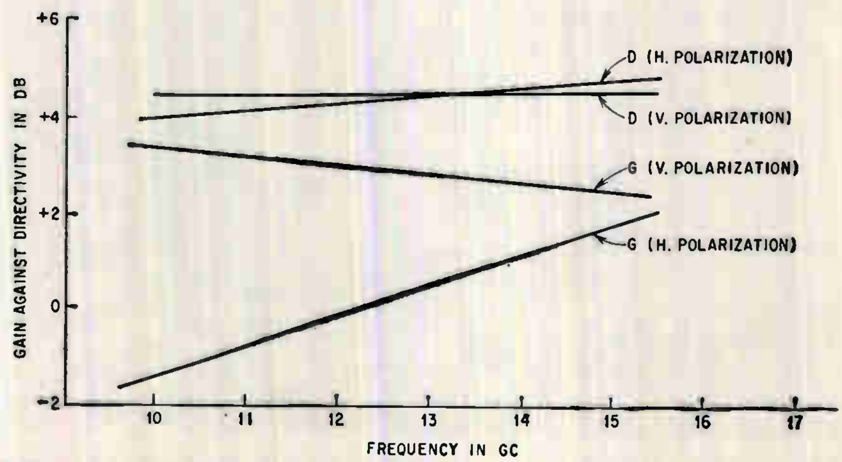


FIG. 5—Plot of gain and directivity against antenna frequency

Applying the Kerr Cell To Nanosecond

Kerr cell must operate at high voltage with low time-jitter, low r-f noise and high rates of current rise. Hydrogen thyratrons and low-inductance circuits permit 5-nsec exposures

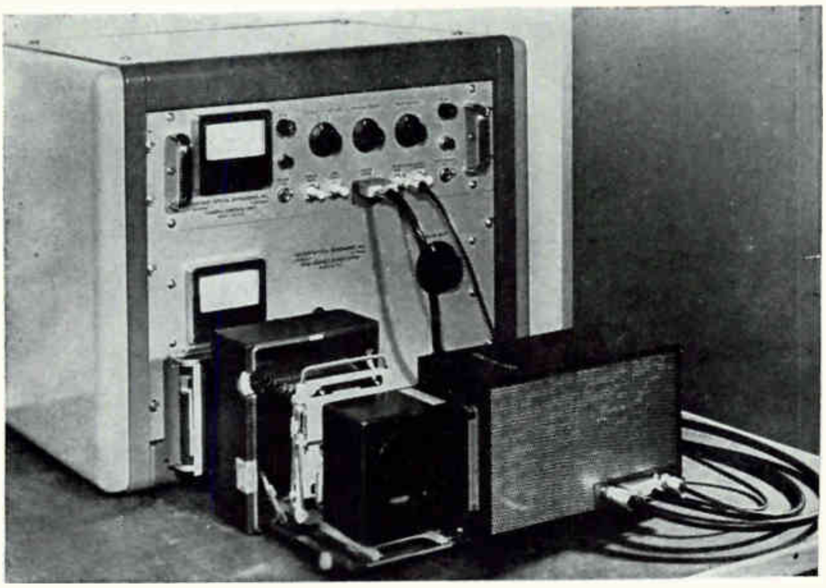
INTEREST in light or optical modulators is high because of recent successes with optical wavelengths for information handling, optical radar, optical communications and, most recently, lasers. One versatile optical modulator is the electro-optical Kerr-cell shutter that has previously been used as a high-speed electronic camera shutter. The high angular resolution capability of modern optics and the modulation frequency bandwidth capability of the Kerr cell, extending from low audio frequencies up into the hundred-megacycle frequency range, are useful for studies and applications involving the transmission of modulated light beams over long distances. To date, the Kerr cell has been used as a modulator in an experimental optical communication system[1] as well as in laser studies.

In its use as high-speed electronic camera shutter, the Kerr cell and its modulation circuits have been highly developed. High-speed photography is itself a complex technology whose forefront lies in the submicrosecond exposure-time range and in the frame-rate range of 10^6 frames per second and higher. The Kerr cell is a member of a family of high-speed shutters that includes the image converter and the rotating-mirror framing camera. Each of these devices has characteristics that makes it well suited to specific experimental situations. For those situations that require high optical resolution with exposure time down to 5 nanoseconds and trouble-free operation in the presence of high transient electromagnetic fields, the Kerr-cell shutter gives satisfactory performance. While it is primarily a single-exposure device at these brief exposure times, techniques are available by which multiple Kerr-cell frames at rates near 10^8 per second can be achieved.

In principle, Kerr-cell operation is straightforward (Fig. 1A). The ordinary Kerr cell is composed of two flat plates or electrodes immersed in a fluid which becomes birefringent upon the application of an electric field. When such a cell is oriented between two polarizers crossed for minimum transmission, the arrangement constitutes an optical shutter. With no voltage applied, light cannot be transmitted because of the crossed polarizers. A voltage applied to the electrodes alters the state of polarization of the light. Transmission through the second polarizer is thus accomplished. Consequently, the duration of the transmitting period or exposure time is related to the duration of the applied voltage pulse. The lower limit to exposure times is given by the molecular relaxation times of the working cells fluids. For nitrobenzene this time is about 50 psec, so exposure times as low as 10^{-10} second are feasible.

The relation between Kerr-cell transmission and applied voltage is given by[2]: $T = T_o \sin^2 [(\pi/2)(V/V_o)^2]$, where V_o is the so-called full-open voltage, so that the actual curve of transmission against voltage is nonlinear (Fig. 1B). Consequently, for brief exposures, where the voltage pulses are more likely to be bell-shaped than square, the effective exposure time can be less than the voltage-pulse duration, as shown in Fig. 1C and 1D. The effects of ringing on the trailing edge of the pulse, if no greater than 40 percent of the main pulse, are negligible.

Thus the primary problems in a Kerr-cell system are electrical rather than optical. The principal requirements for such a circuit are: (1) it must produce pulses of high voltage corresponding to gradients of about 18 Kv per cm of aperture



Complete Kerr-cell system, with control unit and power supply in a single cabinet (rear). The Kerr cell is mounted on the remote high-voltage pulser

Photography

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and of brief duration (about 10^{-8} second and less); (2) it must be capable of synchronization with the phenomenon being studied (about 10^{-9} second or less); and (3) pulse durations must be readily changeable and cover a wide range.

Kerr-cell pulsing circuits consist of a high-voltage switch, pulse-forming network and the Kerr cell as a load. These circuits resemble radar pulser circuits and many techniques have been taken from radar technology.

The selection and use of a switch that will provide capability for both high voltage operation and low time jitter is a problem. For laboratory use, the switching circuits should also provide low r-f noise generation and high current rates of rise at the required switching speed. Excessive r-f noise on switching can make it difficult to obtain other related electrical data from the experiment. For the Kerr-cell shutter system described, the driving or full-open voltage is 35 Kv, corresponding to an aperture of 0.8 × 1.5 inch. The corresponding electrical capacitance is approximately 50 pf. Consequently, for switching times of about 5×10^{-9} second, the switch must handle currents of about $I \cong C \cdot \Delta V/\Delta t =$ 350 amp.

Two types of high-voltage switches were considered: triggered spark gaps, hydrogen thyratrons and combinations of these. Although spark gaps can provide switching times as low as 10^{-9} second, there are at least three disadvantages attendant with their use here. First, switching jitter cannot ideally be reduced to 10^{-9} or even 10^{-8} second with simple techniques. Second, the switching time is characterized by the generation of large r-f noise fields. Third, even pressurized spark-gaps tend

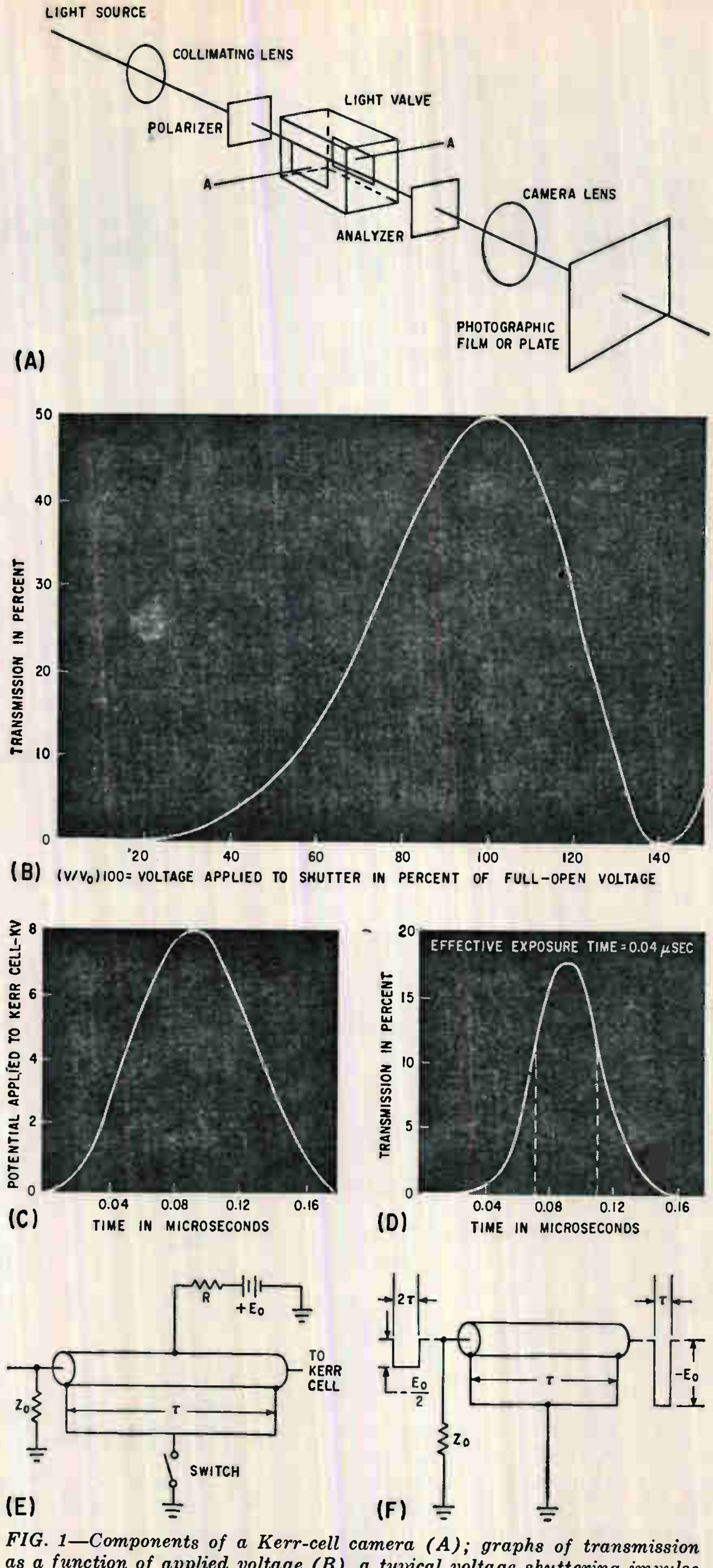

FIG. 1—Components of a Kerr-cell camera (A); graphs of transmission as a function of applied voltage (B), a typical voltage shuttering impulse (C), and the resultant sharpened transmission pulse (D); schematics illustrating the operation of the pulse-forming network: (E) prior to closing switch and (F) voltage-time sequences after switch is closed

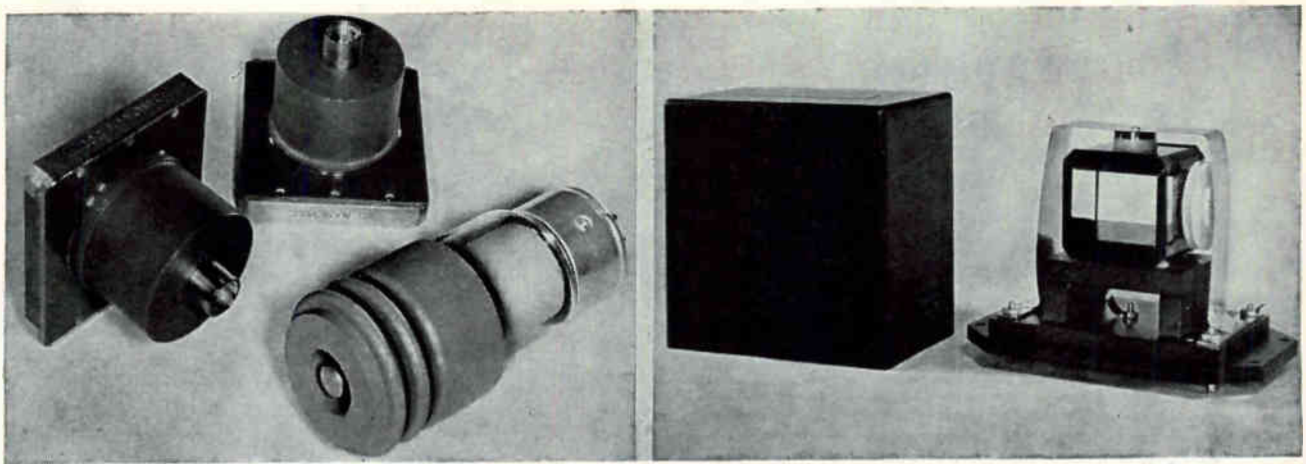

FIG. 2—Pulse-forming networks and potted hydrogen thyratron (left) and enclosure and Kerr cell (right)

to become erratic in triggering after a small number of breakdowns, and require critical adjustment.

Thyratrons, on the other hand, can provide anode current rates of rise or switching times of about 5 to 10 nanoseconds[3] and, in addition, can be triggered with a time jitter of less than 10^{-9}.

The circuit of the Kerr-cell pulser uses type 6587 hydrogen thyratrons exclusively. The requirement for brief operation has been partly met by the design of a low-inductance circuit and partly by operating the hydrogen thyratron at increased gas pressure for higher rates of anode-current rise. Since gas pressure can be controlled by the voltage applied to an internal voltage-sensitive hydrogen reservoir, a separate lead from the reservoir is brought out on a separate tube pin to vary the reservoir voltage from a panel control.

The requirement for a high-voltage pulse has been met in part by aging and packaging of the thyratron for the elevated voltages, and in part by a pulse-forming network (pfn) shown in Fig. 1E and 1F. The normally grounded side of the line is charged up to supply voltage, E_o, through charging resistor R. When the switch is closed, a voltage pulse of duration 2τ and magnitude $-E_o/2$ appears across characteristic impedance Z_o, where τ is the one-way electrical length of the line. A pulse of amplitude $-E_o$ and duration τ appears across the end of the line to which the Kerr cell is attached.

The most persistent problem during development and refinement of this pulser was in the packaging of the thyratron and pfn for reliable operation at the 35-Kv plate voltage and in the restricted geometry required for the minimum inductance configuration. The anode of the thyratron is potted in a convoluted flexible plastic which, in spite of the small volume of insulation, permits operation of the thyratron at voltages as high as 50 Kv. Details of the pulse-forming network and thyratron packaging are illustrated in Fig. 2A. The anode cap of the thyratron plugs into the pfn line connection with a minimum of connector length. Solid metal bars along two sides of the upper surface of the pfn constitute a low-inductance ground connection, while one plate of the Kerr cell plugs almost directly into the h-v output pulse connector of the pfn. Within this restricted geometry, networks have been fabricated that cover the exposure time range from 5 nsec to 10 μsec.

A complete camera system with this Kerr cell and modular pulse generator is shown in Fig. 3 and the head photograph. The remainder of the system consists of a control unit and power supply chassis containing the thyratron fixed filament and variable reservoir voltage supplies and the high-voltage power supply.

Applications are generally of two types. The first are high energy density experiments, such as exploding wires,[4] constrained channel arc breakdown and single-crystal explosive detonations, in which the phenomena are small in size, highly self-luminous, and have time durations much less than one microsecond. The second type of experiment involves lower energy densities by several orders of mag-

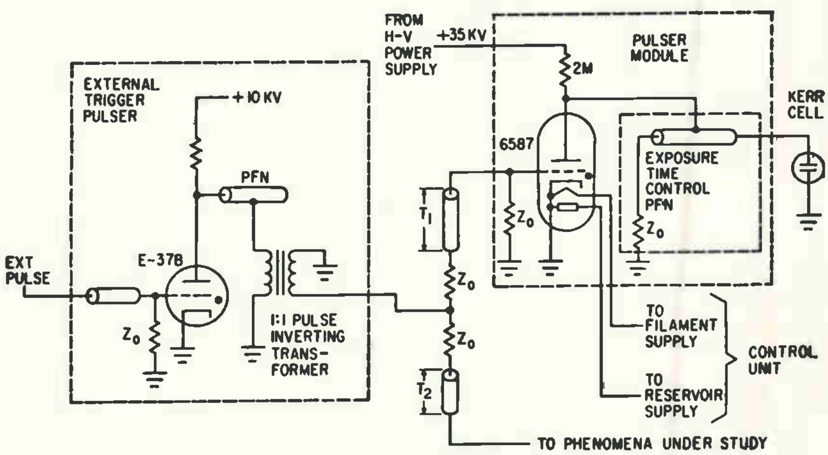

FIG. 3—Simplified diagram of Kerr-cell camera system showing high-voltage Kerr-cell pulser and parallel triggering synchronization

nitude and is proportionately less self-luminous. The phenomena under study include experiments in plasma and magnetohydrodynamic physics, and in high-mach-number low-gas-density aerodynamic flow, and can last between several microseconds and several milliseconds.

For the latter case, triggering requirements are modest since triggering jitter and delay are relatively unimportant. For example, a 300-volt trigger pulse with a 0.1-μsec rise time applied to the thyratron pulser grid will give a switching delay on the order of 0.1 μsec and with a jitter in firing between 0.01 and 0.025 μsec. The variation is due largely to the age and condition of the thyratron.

For high-energy density experiments, such jitter in triggering can render the advantages of 5-nsec exposure capability useless, while the triggering delay can make it difficult if not impossible to obtain photographs in early stages of the phenomenon, particularly if the phenomenon itself triggers the Kerr-cell shutter action. Experience has shown[5] that triggering delays can be reduced to 0.05 μsec and triggering jitter can be reduced below 0.001 μsec by using trigger pulse voltages above 2.5 Kv from low inductance and impedance lines. To benefit from such jitter-free operation, coaxial cables provide delays in the initiation of the Kerr cell shuttering action without serious degradation of these large trigger-pulse amplitudes.

The Kerr cell used with this camera system is shown in Fig. 2B, with the enclosure containing polarizer and analyzer removed. It incorporates a canted electrode design to allow a versatility in operation with a minimum of optical vignetting. The smaller or entrance aperture is 0.8 $\times$ 1.5 inches and the exit or larger aperture is 1.2 $\times$ 1.5 inches. The cell is hermetically sealed and provided with an integral expansion bellows to allow for variations in liquid volume with ambient temperature. Optical resolution through the Kerr-cell shutter is 1:10,000 which corresponds approximately to 70 line pairs per mm in the focal plane of a 6-inch lens.

The spectral transmission of standard nitrobenzene-filled Kerr cells extends from 4,200 A on the short wavelength end, where the cell is totally absorbing, to approximately 2 microns. When used with dichroic Polaroid polarizers, the open transmission ranges from 12 to 25 percent and the closed transmission from 10^{-6} to 10^{-4}, depending on the materials used. By going to crystal polarizers such as Glan-Thompson prisms, the open transmission in the passband will exceed 40 percent.

Of considerable interest in high-speed photography is the recent determination[6] of liquids that extend the open transmission bandwidth down to optical wavelengths as short as 2,400 A and also provide useful apertures at available pulse voltages. By combining Kerr cells filled with such liquids with recent pulsing techniques described, a whole new spectrum of phenomena can be studied by means of nanosecond high resolution photography. An example of where this added capability is rapidly finding application is that of transient spectrographic studies with nanosecond time resolution. With the higher electron temperatures being reached in controlled thermonuclear reaction studies, the near-ultraviolet Kerr cell will also prove a useful and versatile tool for examining plasma instability kinetics. The relative immunity of the Kerr-cell triggering and pulsing circuits from spurious triggering due to the extreme r-f fields developed during the megampere currents flowing in the plasma circuits is an added asset in such studies. The Kerr cell is also finding application as a sharp cutoff optical impulse generator for studying photo-induced minority carrier lifetimes in solid state and phosphorescence and fluorescence decays in organic chemical systems.

Versatility can be extended by multiple framing techniques, and at least two groups have taken Kerr-cell photographs at frame rates of 10^8 per second. Zarem and Associates[7] used a number of separate Kerr-cell shutters and a single recording camera with electronic delays for achieving the required framing rates. More recently, Goss[8] used a single Kerr-cell shutter and recording camera in conjunction with a series of optical delay lines for achieving at least six frames at about 10^8 per second.

Shock front generated by breakdown of a coaxial sparkgap (12 Kv, 30 μf) in 100 microns of air. The front is shown at 60 cm downstream from the gun, taken at various exposure times: 1 μsec, with a 20-μsec delay at station 1;

500 nsec, with a 21.5-μsec delay;

and 100 nsec, with a 25-μsec delay. Speed of front, Mach 100; tube diameter, 3 inches; discharge at 125,000 amperes. Pictures taken on shock tube built under direction of Hans Liepmann, Dept. of Aero Eng., Calif. Inst. of Technology, using a KSC-51 Kerr-cell camera

REFERENCES

(1) D. Erway, Final Report on WADD Contract AF33(616)-6310, Electro-Optical Systems, Inc., Pasadena, Calif., Apr 20, 1961.

(2) Zarem, Marshall and Poole, *Trans Am Inst Elec Engrs*, 68, 1, 1949.

(3) J. W. Woodford, Jr., and E. M. Williams, *J Appl Phys*, 23, 722, 1952.

(4) N. Chase, N. Hankin, and F. Webb, Instrumentation for Exploding Wire Research, ELECTRONICS, p 43, July 1, 1960.

(5) Zarem, Marshall and Hauser, *Rev Sci Inst*, 29, 1049, 1958.

(6) S. M. Hauser, Final Report on WADD Contract AF33(616)-6669, Electro-Optical Systems, Inc., Pasadena, Calif. June 15, 1960.

(7) A. M. Zarem and F. R. Marshall, *Rev Sci Instr*, 21, 514, 1950.

(8) Willis C. Goss, *J of the Soc Mot Pict & Television Engr*, 69, 889, 1960.

Generating Random Forcing Functions

Statistically random functions are produced within a predetermined frequency spectrum using a gas-discharge tube and analog computer arrangement

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Goodyear Aircraft, Akron, Ohio

CONVENTIONAL designs of networks, control loops and communication systems are usually tailored to yield satisfactory response to signals fabricated by the designer rather than signals encountered in a natural environment. Such artificial signals are either sinusoidal, or simple aperiodic waveforms like impulse and step functions. In applications, forcing signals are only statistically describable; therefore, the output can be predicted only in statistical terms.

In the airborne guidance field, the signals are random functions that can be defined only by their probability distributions. An analytical expression for this distribution is generally required for the computation of the power spectrum of the signal. On the basis of this expression, design of optimum controls and compensators can be undertaken. Often the power spectrum of the environmental disturbances for a system is known; an example is the effect of wind gusts on the flight path of an airplane. Therefore, it is useful to have an electrical input signal of the same power spectrum as the problem spectrum if the loop optimization problem is to be attacked by simulation. This is particularly true when the system includes nonlinearities that render the analytical approach difficult.

Precisely known forcing functions are also indispensable in human psychomotor response studies, where predictability of the signal should be ruled out and use of sinusoidal inputs is therefore impractical. The signal source for human psychomotor studies must have an exact power spectral density, and the source should be stationary so that once the statistics are selected they will not vary with time.

Present electronic function generators usually depend on either the random component of current emitted from an incandescent cathode or the random atomic particles emitted during the decay of a radioactive substance. Although the probability distributions in these random processes are known from theoretical considerations, the generators suffer from uncertainty caused by component changes with time.

The random function generator described eliminates these problems by providing a reliable source of random signals within the desired spectrum.

The random signals that are used as system-forcing functions originate at a grid-controlled gas-discharge tube as shown in Fig. 1 and arise from fluctuations in the dense layer of positive ions near the cathode. The bursts and drops of current superimposed on the average plate current have amplitude variations that are distributed according to the gaussian density function. This analytical form, however, is immaterial to the immediate problem. The frequency beyond which the noise energy begins to fall off varies inversely with the atomic weight of the gas. A magnetic field must be applied transversely to the current between the vacuum tube elements to suppress natural preferred oscillation frequencies of the ions. The noise component of the gas tube plate voltage is fed through a capacitor to the computer circuit shown in Fig. 2 to produce the periodically stepped voltage wave of Fig. 3. This transformation is essential for securing spectrum invariance as analyzed

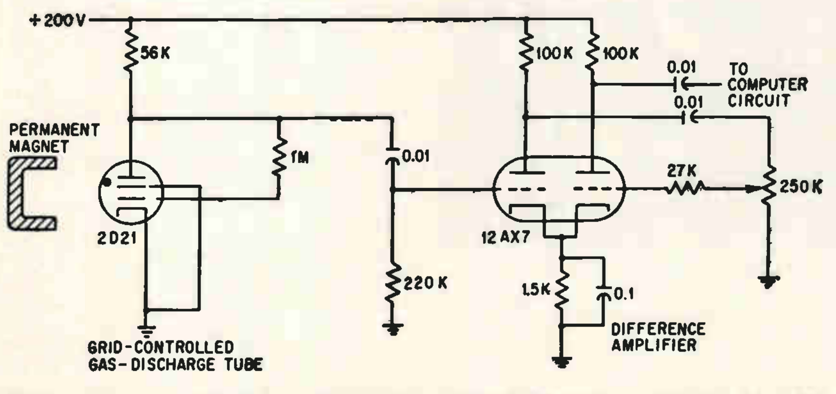


FIG. 1—Source circuit for the random signal. Signals originate in grid-controlled gas discharge tube at left

QUARTER-SQUARE MULTIPLIER, NETWORK ACCURACY

$e_{in}(v)$	$e_{exp}(v)$	$e_{th}(v)$
0	0.0	0.0
7	1.1	1.0
12	3	2.9
18	6.5	6.5
25	12.4	12.5
35	24.5	24.5
45	40.7	40.5
47	44.1	44.2
50	50.0	50.0

For Control-System Simulation

at the right of this page.

In accordance with Eq. 21, such an invariance requires fulfilling two necessary and sufficient conditions: the raw signal must be sampled periodically at constant time intervals, τ_o; and the standard deviation, σ, of the signal after sampling must be monitored and kept constant.

The required units include: a threshold unit that will clip the raw noise signal and subtract from it the portion necessary to maintain the standard deviation of the stepped voltage wave constant; a sampling unit that will generate the stepped wave $V(t)$ and also measure the magnitude of its jumps; a squaring and averaging unit that will compute the average value of the jumps squared, σ^2; and a feedback arrangement which will continuously compare this value σ^2 to a constant reference v and lower or raise the threshold setting to keep the $(\sigma^2 - v)$ equal to zero. The implementation of these operations using the operational amplifiers of an analog computer is shown in Fig. 2.

Raw noise from the gas tube circuit is amplified in amplifier 10 and fed into the threshold circuit that includes diodes D_1, D_2 at the input of amplifier 9 and the diode biasing arrangement made up of two potentiometers fed by amplifiers 7 and 8. Bias voltages $\pm E$ are set by a constant voltage input to amplifier 7 (+200 v) and by the control component that represents the difference $(\sigma^2 - v)$ from amplifier 6. Thus, only the part of the raw signal that exceeds the $\pm E$ threshold level appears at the output of amplifier 9 and is presented to the sampling unit.

This unit in turn generates not only $V(t)$ but also the magnitude of its successive jumps. A constant-speed d-c motor drives the drum of a commutator that periodically and alternately closes two sets of contacts, C_1 and C_2. When C_1 is closed, operational amplifier 1 is connected as a time-delay element with a short time constant and as such

TRANSFORMATION FOR SPECTRUM INVARIANCE

Design of the present spectrum-invariant random function generator is made possible by the transformation of the gas tube current into the stepped voltage waveform of Fig. 3. Advantage is taken of the analytical equivalence between power spectrum and autocorrelation function. The autocorrelation function of the stepped signal $V(t)$ yields the corresponding power spectrum.

The function $V(t)$ is first written

$$V(t) = \overline{V} + V_v(t) \qquad (15)$$

where $V_v(t)$ is the variable part of $V(t)$ about its mean value $\overline{V}$. Therefore,

$$\overline{V_v(t)} = \lim_{T\to\infty} \frac{1}{T}\int_0^T V_v(t) = 0 \qquad (16)$$

Since the autocorrelation function of $V(t)$ is $R(\tau) = \overline{V(t)V(t+\tau)}$ and for the forcing function generator, $V(t) = 0$

$$R(\tau) = \overline{V_v(t)V_v(t+\tau)} \qquad (17)$$

Assume that $V(t)$ is obtained by perodically sampling the gas tube plate voltage; the sampling period being τ_o, and that sampling is performed in a linear manner during a short portion of the period ($0.04\tau_o$).

If a_n is the magnitude of a particular step of $V_v(t)$, then $V_v(t) = a_n$, from $t = n\tau_o$ to $t = (n+1)\tau_o$. The magnitude of these steps has some probability distribution $p(V_v)$, which means that the probability that a_n lies between V_v and $V_v + dV_v$ is

$$P(V_v < a_n < V_v + dV_v) = p(V_v)dV_v \qquad (18)$$

In terms of the second probability distribution, the autocorrelogram is

$$R(\tau) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} V_{v1}C_{v2}p_2(V_{v1},t_1;\, V_{v2},t_2)dV_{v1}dV_{v2} \qquad (19)$$

where $p_2(V_{v1},t_1;\, V_{v2},t_2)dV_{v1}dV_{v2}$ is the probability that $V_v(t)$ lies between V_{v1} and $V_{v1} + dV_{v1}$ at the instant t_1, and between V_{v2} and $V_{v2} + dV_{v2}$ at the instant t_2 (or at a distance τ from t_1).

Since the amplitude variations of the raw noise from the gas tube are much faster than the sampling frequency, $V_v(t_2)$ is completely independent of $V_v(t_1)$. This is a sufficient condition for the second probability distribution to be equal to the product of the first distribution by itself. When this is true the integral of Eq. 19 defining the autocorrelation function yields

$$R(\tau) = \begin{cases} \sigma^2\left(1 - \dfrac{|\tau|}{\tau_o}\right) & \text{for } |\tau| \leqq \tau_o \\ 0, & \text{for } |\tau| > \tau_o \end{cases} \qquad (20)$$

The power density spectrum corresponding to this correlation function is

$$\phi(\omega) = \int_{-\infty}^{\infty} R(\tau)\cos\omega\tau\, d\tau$$

$$= 2\sigma^2\int_0^{\tau_o}\left(1 - \frac{|\tau|}{\tau_o}\right)\cos\omega\tau\, d\tau$$

$$\phi(\omega) = \sigma^2\tau_o\left(\frac{\sin\frac{\omega}{2}\tau_o}{\frac{\omega}{2}\tau_o}\right)^2 \qquad (21)$$

This power density spectrum has the property that the only source of variation possible, σ, appears as multiplication factor that is easily monitored and taken into account. This is true regardless of any variations in the gas tube circuit due to aging, supply variations, mechanical vibrations or temperature effects

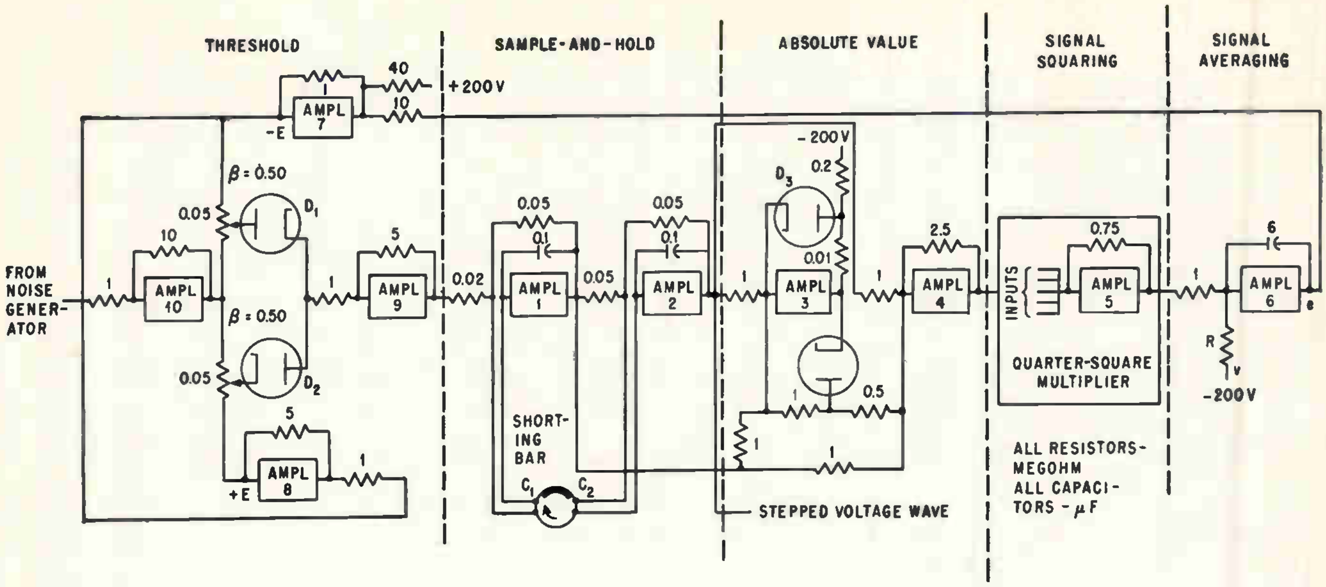


FIG. 2—Computer circuit with feedback arrangement produces periodically stepped voltage waves

samples the noise voltage. This sampling takes place during the short portion of the sampling cycle, τ_o, during which contacts C_1 are bridged by the commutator shorting bar. When C_1 is interrupted, the amplifier becomes an integrator, keeping the sampled voltage value stored. Amplifier 2 is connected identically to amplifier 1 except that sampling through switch C_2 is performed halfway between the samplings through C_1. Thus amplifier 1 generates the present step, a_n, of $V(t)$ while amplifier 2 holds the value of the preceding step, a_{n-1}.

The absolute difference between the successive steps of $V(t)$ is then computed by the operational rectifier implemented by amplifiers 3 and 4. The circuit of this unit, shown in Fig. 2, is a conventional analog computer arrangement.

This difference, in turn, provides the input to the quarter-square multiplier represented by amplifier 5. For economy, the multiplier was arranged to accept only a positive polarity signal, like the output of the absolute value unit, and designed to perform the operation

$$e_o = k_o e_{in}^2 = k_o \mid a_n - a_{n-1} \mid^2 \quad (1)$$

The multiplier is equivalent to a deterministic function generator receiving an input voltage and giving out the square of this voltage. The input range was selected as

$$0 \leq e_i \leq 50 \text{ volts} \quad (2)$$

and that $e(50) = 50$ volts, which immediately establishes $k_o = 0.02$.

The squaring function of Eq. 1 was approximated by seven straight-line segments with end points at $e_{in} = 0, 5, 10, 15, 20, 30, 40, 50$ v, and slopes of 0.10, 0.30, 0.50, 0.70, 1.00, 1.40 and 180, plotted in Fig. 3B. This was accomplished through a group of input diodes in series with input resistors, R_4, and biased by a constant voltage, E_b, as shown in Fig. 4A for one segment only.

On the basis of the input-output relationships shown in Fig. 4 A and B, and the parameter values in Fig. 3B plus the condition $E_b = -50$ v, these settings of voltage dividers were calculated

$$R_2/R_1 = 0.10, 0.20, 0.30, 0.40, 0.60, 0.80 \quad (3)$$

corresponding to the last six segments in ascending order. On the basis of these values and the value of the feedback resistor selected at $R_5 = 0.75$ megohm, the various input resistors in the same ascending order were

$$R_4 = 3.401, 3.125, 2.885, 1.442, 1.172, 1.042 \text{ megohms} \quad (4)$$

The final circuit is shown in Fig. 4C. The degree of accuracy obtained through this setup is shown in the table. Following the squaring operation only time averaging of the signal of Eq. 1 is required to obtain the variance σ^2. This function is assigned to the integrator amplifier 6 which, if fed by the multiplier output only, would have yielded an output

$$e = \frac{k_o}{\sigma} \int_0^t \left| a_n - a_{n-1} \right|^2 dt \quad (5)$$

where the factor $\frac{1}{6}$ is the contribution of the feedback capacitor to the gain of the integrator. For $t = T$, this will result in

$$\sigma^2 = \frac{1}{k_o T} \lim_{t \to T} (e) \quad (6)$$

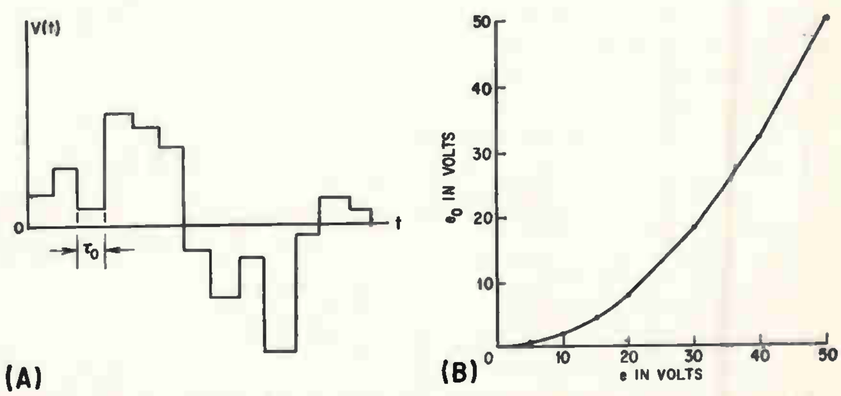


FIG. 3—Stepped voltage wave, output of circuit in Fig. 2, is shown in (A); approximated squaring function for input range 0-50 volts is plotted in (B)

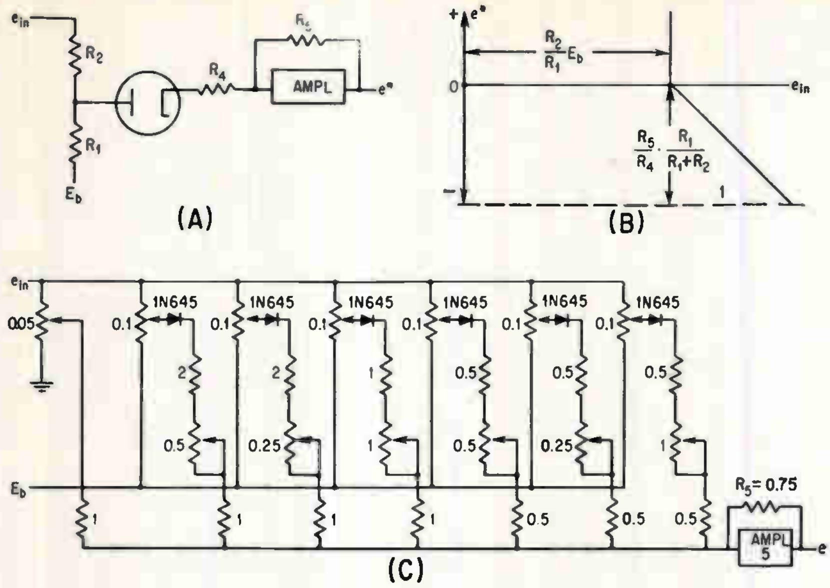


FIG. 4—Basic element of the squaring circuit, (A); input-output relationship for element, (B); diagram of quarter-wave multiplier network, (C)

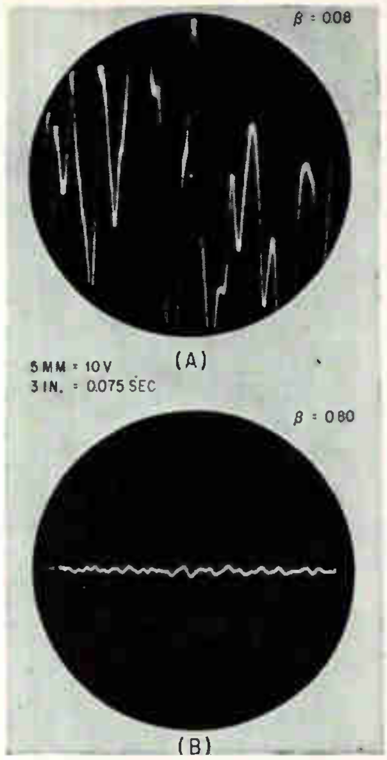


FIG. 5—Raw noise at the output of amplifier No. 9 in Fig. 2, for extreme settings of threshold control, β = 0.08 in. (A) and 0.80 in. (B)

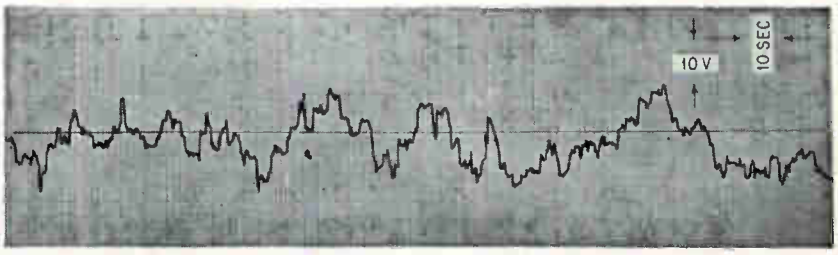


FIG. 6—Signal after being passed through the low-pass filter, with filter transfer function of Eq. 14

Thus, the output of the integrator provides a continuous check of the standard deviation σ of the signal steps. Speed of the sampling motor and the gear train was selected to produce a sampling period of τ_0 = 0.07 sec with sampling duration equal to 0.04 τ_0. At the output of the rectifier, the emerging voltage was 2.50 $|a_n - a_{n-1}|$; therefore, after squaring according to Eq. 1.

$$e_o = 0.125 \, | a_n - a_{n-1} |^2 \qquad (7)$$

Combining Eq. 5 and 7 gives

$$e = \frac{1}{48} \int_0^T \left| a_n - a_{n-1} \right|^2 dt \qquad (8)$$

hence

$$e = \frac{1}{48} T\sigma^2 \qquad (9)$$

Voltage $|a_n - a_{n-1}|^2$ is opposed at the integrator input by a voltage v. The net input will be

$$V = e - \frac{1}{6R} \int_0^T v \, dt$$

$$= e - \frac{v}{6R} T \qquad (10)$$

where the factor $1/R$ represents the integrator gain associated with the input v. Hence, from Eq. 9 and 10,

$$V = \frac{1}{48} T\sigma^2 - \frac{v}{6R} T \qquad (11)$$

This voltage is fed back to the threshold unit to change the average squared value of $(a_n - a_{n-1})$ in such a way as to pull V toward zero. Thus, v establishes the variance as

$$\sigma^2 = 8v/R \qquad (12)$$

For $v = 200 \, v$ and $R = 35$ megohms

$$\sigma = 6.76v \qquad (13)$$

Performance of the spectrum-controlled random function generator is demonstrated by recordings of the signals that appear around the control loop. Figure 5 shows the raw noise component at the output of amplifier 9 for two extreme settings of the threshold control, $\beta = 0.08$ and $\beta = 0.80$, at the same 'scope gain where β is the common setting of the potentiometers following amplifier 10. In Fig. 6 the step-like signal is shown, after having been subjected to a low-pass filter, the filter transfer function being

$$Y(s) = 15/(3s + 1) \qquad (14)$$

The analysis and experimental results show that the design objectives of the spectrum-controlled random function generator are attainable as described.

The signal obtained will suffer from some attenuation of its lower frequencies because of the feedback branch between the variance monitor and the threshold units. However, proper selection of the integrator time constants and loop parameters will make this attenuation insignificant within the bandpass of interest for a particular application.

REFERENCES

(1) Henry Low, "Use of Noise & Statistical Techniques in Analog Computation Handbook of Automation, Computation & Control," Edited by E. M. Grabbe, S. Ramo, D. E. Wooldridge, 2, Chap. 26, John Wiley & Sons Inc., 1959.

(2) R. T. Harnett, A Quarter-Square Electronic Multiplier, Unpublished Report Aeronautical Research Laboratory, Wright Air Development Center.

(3) D. T. McRuer and E. S. Krendel, Dynamic Response of Human Operators, WADC Tech. Rep. 56-524. Wright Air Development Center, 1957.

Analog Computer Problem Connector

Matrix for analog computer problems uses punched cards and air pressure to establish contacts directly. No relays or other magnetically operated switches are needed. Special electrical networks used with the connector include digital potentiometer

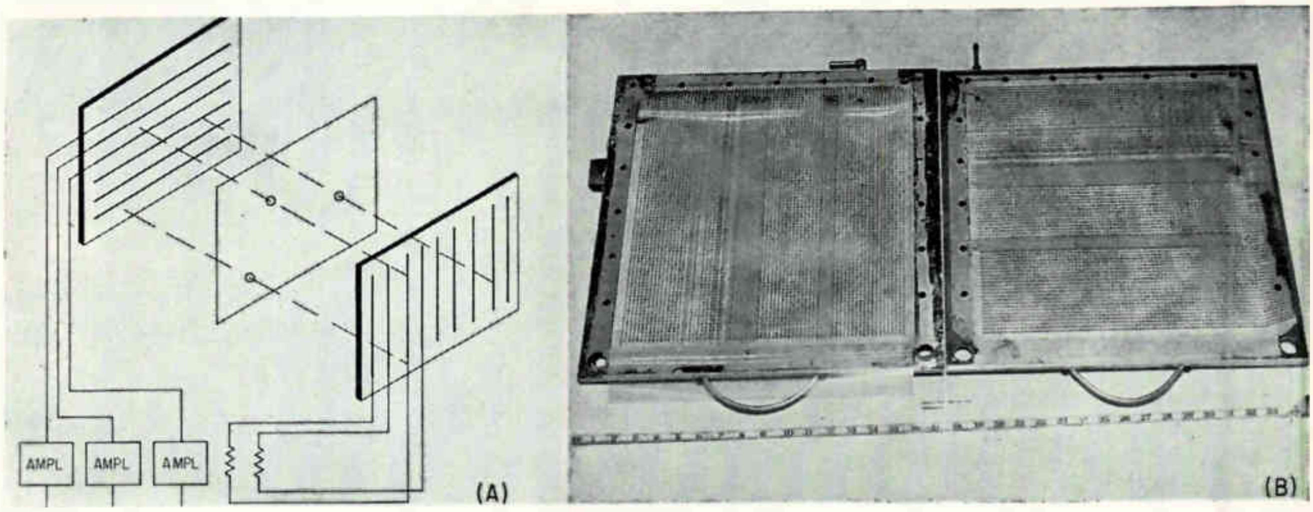


FIG. 1—Crossbar matrix for connecting computer problems (A) uses matrix connector cardset shown open in (B)

PROBLEMS in analog computers are now connected with hand-wired patch boards. Since such boards are expensive and bulky, many efforts have been made to develop systems using tape or cards as the memory.

One class of such systems energizes relays by the tape or cards and connects the problem by the relay contacts. Although feasible, such systems are expensive and require long runs of wire. The wires have high capacitance to ground.

A second kind of punched-card connector is the crossbar matrix shown in Fig. 1A. Certain computer conductors are connected to the first grid of parallel buses, and other conductors are connected to the second grid overlying the first grid at right angles. At each crossover, means are provided for connecting the first grid bus to the second grid bus.[1]

The difficulty with the crossbar matrix is the numbers of contacts. Automatic problem connection is valuable chiefly for large problems in large computers where cost is high for either storage or repatching. Here the number of crossover points in the matrix is large. A 42-amplifier computer needs 50,000 points even after intensive matrix arrangement design. A crossbar matrix is practical only if it can be built at low installed cost per connection point. This has been achieved in the matrix connector shown in Fig. 1B.

In this matrix, the crossbars are printed-circuit conductors. The assembly is a sandwich consisting of a printed circuit, a punched card and another printed circuit. Contacts are made through holes in the punched card when air pressure is applied to press the sandwich together. No relays are used. The manufacturing techniques used make possible low cost per contact. Digital potentiometers and other special networks have been developed to take advantage of the connector.

The matrix in Fig. 1B contains 72 buses in one grid and 74 buses in the crossing grid. The crossovers are on $\frac{3}{16}$ inch centers, so the working area is about 14 inches square and contains slightly over 5,000 connection points.

Each grid of buses is a printed circuit with a substrate of 0.005-in. epoxy fiber glass, and is flexible. The buses are printed-circuit conductors. The contacts are electroplated onto the buses.

The printed circuits are supported by aluminum plates to which they are bonded along the edges. The plates are bolted together, with spacers to make room for the card. Bolts and spacers are omitted from one edge to provide a card access slot; the spacers on the other three edges provide a card-posi-

Employs Punched Card and Crossbar

By LAWRENCE J. KAMM, Design Specialist,
General Dynamics/Astronautics,
San Diego, Calif.

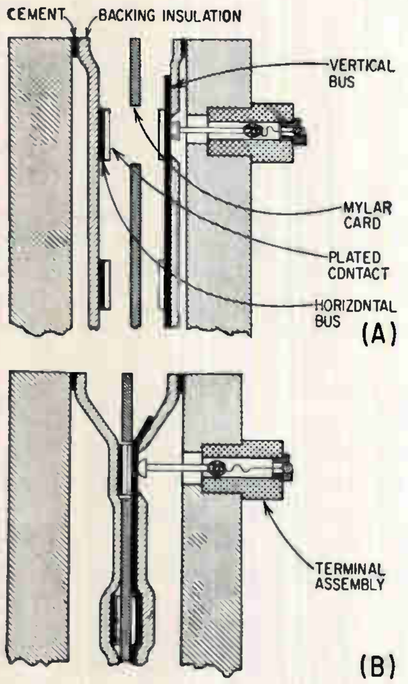


FIG. 2—Contact operation with air pressure off (A) and on (B)

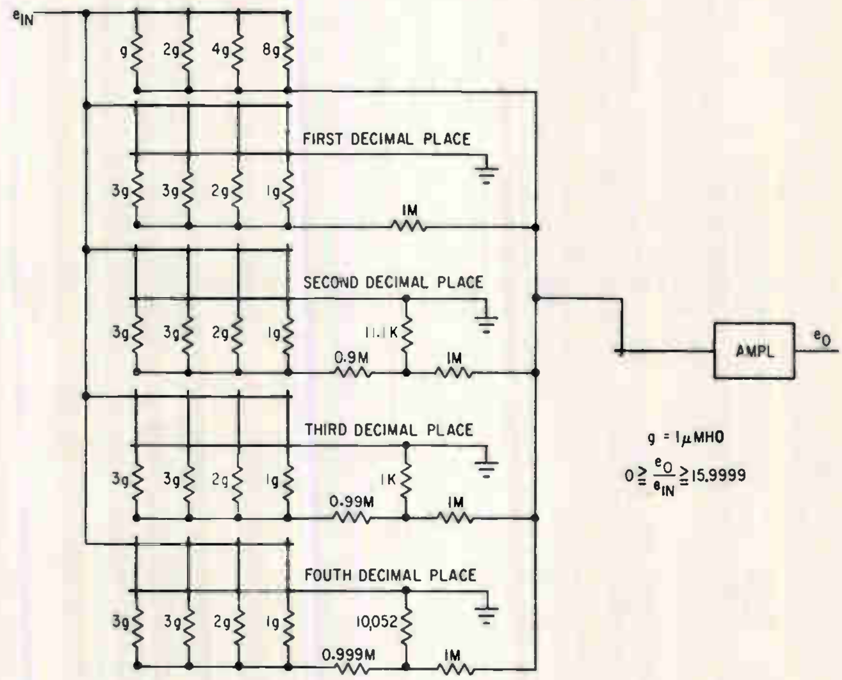


FIG. 3—Coefficient pad provides increments of 0.0001

tioning nest. The card, a sheet of Mylar, is inserted between the circuits as shown in Fig. 2A. Air pressure is applied between the aluminum plates and the fiber-glass printed circuits. This pressure tightly sandwiches the card between the flexible circuit boards. Wherever there is a hole in the card, the corresponding contacts on the boards are pressed together; elsewhere they remain insulated from each other (Fig. 2B).

The contacts are electroplated disks half the thickness of the 0.005-in. card. When the surfaces of two contacts touch through a card hole, their buses are flush with the surface of the card and there is no bending of the backing insulation. When a pair of contacts are held apart by the card, the backing insulation sheets bend away from the card to accommodate the thickness of the contacts.

The buses are stripes 1/16 in. wide on 3/16 in. centers. The contacts are 1/16 in. diameter, 0.0025 in. thick, and have either gold or rhodium surfaces. The punched hole in the card is 5/32 in. diameter so that there is 1/32 in. of card material between adjacent holes.

Using 100 psi air, there is approximately 3½ pounds of force for each contact. If half this force is supported by the edge of the punched hole and the remaining half is applied to the contact itself, contact force is 1¾ pounds or approximately 800 grams. Contact forces in relays are usually on the order of 10 grams.

The total force produced by the air pressure in the deck is 30,000 pounds. Calculations and tests have demonstrated that ⅜ in. thick aluminum backing plates bolted along three edges and supported along the top edge by steel reinforcing bars withstand this load. The same force is applied to the printed circuits and punched card, but since it is a squeezing force against their thickness, there is no damaging effect.

If a matrix were established merely by connecting each wire now going to a plugboard to one X bus and also to one Y bus, then any wire might be connected to any other wire at one of the X, Y crossovers. However, for a 1,000-wire computer a 1,000 × 1,000 matrix would be needed and 10^6 connection points would be costly and cumbersome. A study has reduced the number of crossovers by about two orders of magnitude.

To produce practical computer circuits it is often necessary to divide the full length of a bus into several short buses, end to end, with a separate electrical connection to each. Consequently a large number of connections may be made to a single bus deck. There is no room for all of these connections to

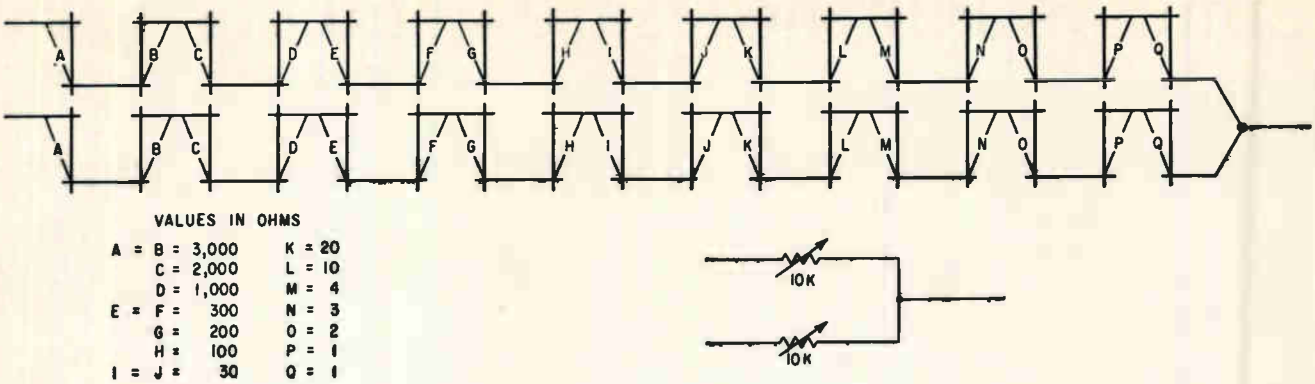


FIG. 4—Digital potentiometer has constant total resistance of 10,000 ohms

be extended to connectors at the edge of the printed circuit. Therefore connections are provided through the backing metal plate and through the under surface of the printed circuit substrate to the bus segments. Terminals for these connections are shown in Fig. 2.

The assembly of two sheets each bearing 5,000 contacts, two backing plates each having dozens of terminals and a card having 5,000 hole positions is manufactured so that each contact is precisely aligned with its mating terminal, contact and card hole. The assembly can be made inexpensively by methods to be described in a future article.[2]

The digital coefficent pad developed for use with the connector is an improvement over the digital coefficient potentiometer. The pad provides any coefficient between 0.0000 and 15.9999 in increments of 0.0001 with no changes in amplifier gains. In comparison, the slide-wire potentiometer has a range of 0.0000 to 1.0000.

Figure 3 shows the network. Five parallel paths, one for each decimal digit, exist between e_{in} and the summing junction. This arrangement has binary coded decimal switching. However, the first path is shown coded in pure binary to extend the range from 9.9999 to 15.9999.

Associated with each resistor of the pad are two connections. Value of each digit is set up by punching card holes for the upper connections. For each resistor not having the upper connection hole punched, the lower hole is punched. Thus for each resistor only one card hole is made.

Consider the portion of the network for the first decimal digit. Sum of all the conductances extending from the common node of all the resistors is $3 + 3 + 2 + 1 + 1 = 10$ where the fifth conductance is that of the 1-megohm resistor fixed to the summing junction which is at ground potential. Let G be the total conductance connected to e_{in}, that is, the value of the first decimal digit. Then the voltage at the node (e_n) is

$$e_n = Ge_{in}$$

Current into the summing junction from this network path is

$$\frac{e_n}{1\,M} = \frac{G}{10} \times \frac{e_{in}}{1\,M}$$

This is the current that should flow into the summing junction when the first decimal digit is G.

The second, third and fourth decimal digit paths are similar to the first path, except that the 1-megohm resistor to the summing junction is replaced by a T network. This T network looks to the node like a 1-megohm resistor to ground, but the T divides its input current between ground and summing junction. This division is 10 to 1 for the second digit, 100 to 1 for the third and 1000 to 1 for the fourth. These circuits achieve their effect without any resistors larger than 1 megohm.

The four resistors that correspond to the digits to the left of the decimal point each contribute their corresponding currents directly to the summing junction.

No unusual tolerances are required of the network resistors. An error analysis indicates that many of them may have broad tolerances and may be film type instead of wire wound.

This coefficient pad has a high input impedance. The worst case is when all four decimal digits are zero; then the input impedance is 25,000 ohms as compared to 10,000 ohms for a slide-wire potentiometer. If any digit is not zero, the input impedance is even higher.

For certain applications a true potentiometer is needed. This is obtained as shown in Fig. 4. There are two 10,000-ohm resistor chains in series, with means to short out each individual resistor. The potentiometer arm is the node between the chains. For each resistor shorted out in one chain, the corresponding resistor in the other chain is not shorted out, so the total resistance is always 10,000 ohms. Two holes are used to short out each resistor so that the resistor need be wired to only one grid.

Other networks include a diode function generator, improved feedback selection scheme for operational amplifiers and guard circuit to prevent starting the computer unless all cards are in their proper slots.

Digital networks led to the packaging of these networks' fixed resistors, capacitors and diodes directly adjacent to their matrix connector contacts. Such packaging eliminates much of the cabling extending to the patch board and reduces both capacitance and cost.

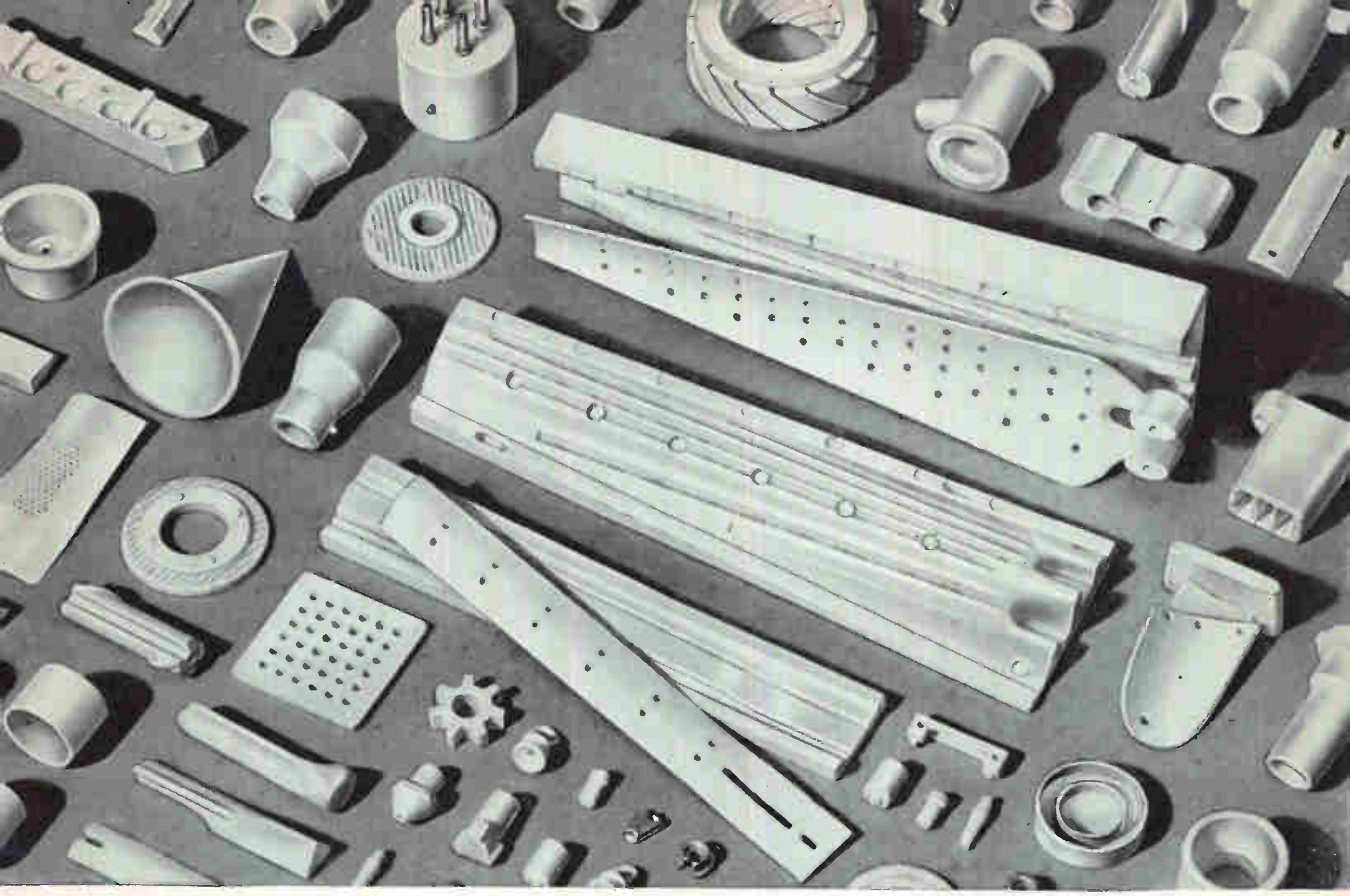
REFERENCES

(1) Dynamic System Synthesizer, WADC Technical Report 56-22, Astia Document AD 110687.

(2) To be published in ELECTRONICS Aug. 25, 1961.

BIBLIOGRAPHY

Reports from Graphik Circuits Division of Cinch Manufacturing Corp. to Glen L. Martin Co. (Denver Division) Contract AF 04(645)-56, Oct. 1956—April 1957.



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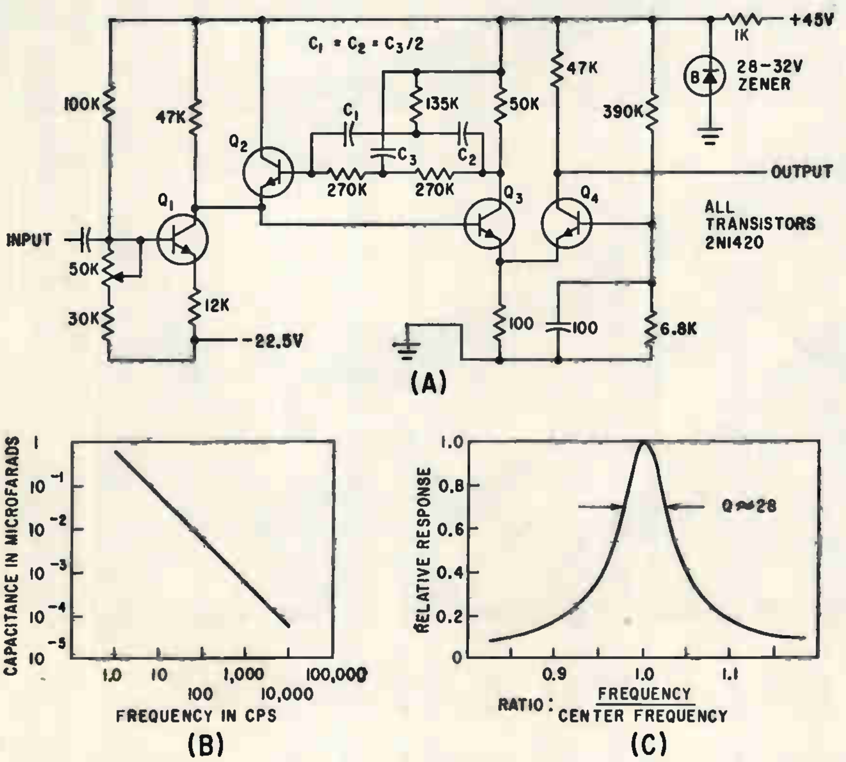
Narrow Pass-Band Amplifier With Parallel-T Network



Parallel T network provides selective feedback (A) to give frequency response (B) that has the peaked characteristic (C)

Frequency range is 1 cps to 10 Kc. Amplifier was designed for frequency-dependent noise measurements, with constant Q value of 28

By R. E. HOBSON
L. CALCAGNO,
Rheem Semiconductor Corporation,
Mountain View, California

CHARACTERISTICS OF the parallel-T R-C network for band-rejection filters are well known[1], but little hardware exists using this principle in a negative feedback loop to obtain a pass-band response.

The amplifier described employs the parallel-T to provide a nearly-constant Q at all frequencies. It permits closer examination of lower frequencies than high-pass/low-pass networks, or heterodyne methods allow.

Battery power eliminates line hum and permits portability and complete shielding. Transistors eliminate microphonics and allow compactness with low battery drain. Silicon diffused mesa transistors are specified for their high gain and low leakage, permitting high impedances where required and providing operating point stability.

The circuit is shown in A. Interstage direct coupling allows operation to below 1 cps.

A symmetrical parallel-T R-C rejection filter is the heart of the amplifier. The passband is obtained by placing the network in the negative feedback loop of the amplifier. Symmetrical response is maintained by matching source and load impedances to the network according to the equation $Z_S Z_L = R^2/2$ where Z_S is the source impedance, Z_L is the load impedance and R is the series resistance.

Input to the filter is from the collector of Q_3; the filter source impedance is therefore the collector load of Q_3.

The load impedance of the filter must be high. This condition is satisfied by the base impedance of Q_3 being multiplied by emitter follower Q_2, thus completing the feedback loop.

Transistor Q_1 provides high input impedance and isolates the input from the feedback loop. Transistor Q_4 isolates the output from the feedback stage, and provides gain if desired. A zener diode stabilizes the battery voltage, as variations will influence the shape of the passband.

The network capacitors must be selected so that $C_1 = C_2 = C_3/2$ within 1 percent[2]. Values of these capacitors determine the pass frequency, as shown in B. The network resistors must also be selected for 1-percent accuracy.

Normalized response of the amplifier is shown in C. The effective Q is nearly constant at about 28, the gain at center frequency is about 5, and maximum output is about 5 v rms. The useful frequency range of the amplifier is approximately 1 cps to 10 Kc.

REFERENCES

(1) Laurence G. Cowles, The Parallel-T Resistance Capacitance Network, *Proc. IRE*, 40, p 1712, Dec. 1952.

(2) "Reference Data For Engineers" Fourth Edition, p 270.

Ultrasonic Transducer Design Cuts Losses

By HARVEY L. MORGAN,
Consulting Engineer, Phoenix, Arizona

UNUSUAL design is used in magnetostrictive transducer to reduce eddy current and conductor losses. The basic principle can be used in several variations of the transducer, and an unusual approach to cooling high-power units seems feasible.

The conventional magnetostrictive transducer at the top of Fig. 1 provides useful output from the logarithmically tapered mechanical transformer attached to one end. The transformer, usually mounted a quarter wavelength from the junction with the transducer, increases output amplitude and matches load and transducer impedances. Transducer output is somewhat reduced because the ends are not excited, although excitation nearer the center is more important. Restricted winding space makes large currents necessary, and copper losses are substantial. Cooling of high-power units is inconvenient because of the winding.

The transducer at the bottom of Fig. 1 consists of magnetostrictive tape (vanadium permadur with positive magnetostrictive coefficient) and insulating material wound into a cylinder. The tape functions as part of both the electrical and the magnetic circuit. Maximum magnetostrictive effect in perpendicular to the rolling direction.

Cross sectional area of 7-mil tape 3 inches wide is about 30 times that of #18 wire, and the lower conductivity of vanadium permadur cuts copper losses by a factor of about 6 for the same number of turns. All of the magnetostrictive material is excited, compared to about 70 percent in the transducer at the top of the figure. Turns are added to increase power output but the increased inductance tends to keep current constant.

The tape can probably be much thicker at a given frequency than laminations of a conventional transducer. Decreasing lamination thickness cuts eddy current losses, the conditions for eddy currents are different in the new transducer. Although there is some fringing at the ends, the magnetic field is always radially symmetrical, so that there are no axial components of eddy current. Also, because adjacent turns are insulated, there can be no circulating eddy currents in the plane perpendicular to the transducer axis.

The induced emf associated with this conductive shielding opposes generator emf. The net effect is an increase in effective resistance over d-c resistance, since generator current is distributed unequally over the length of the transducer with a peak at the middle. The fringing effect can be greatly alleviated by providing a low-permeability return path for the magnetic fields, greatly reducing the radial component. With this structure, circulating currents would be induced in a conductive mechanical transformer that was not laminated parallel to its axis.

Some of the high-permeability ferrites appear suitable structurally for use in the transducers. They can be obtained with practically no eddy current or hysteresis loss below 100 Kc. The magnetic return path could be a ferrite cylinder or magnetic metal laminations parallel to the transducer axis. An air gap would be required at the free end to prevent mechanical damping. Magnetic bias could also be pro-

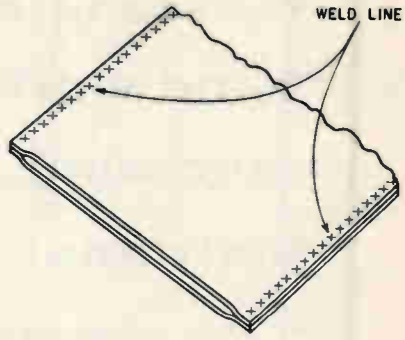


FIG. 3—Welded strips form tubing that could be cooled by liquid in high-power transducers

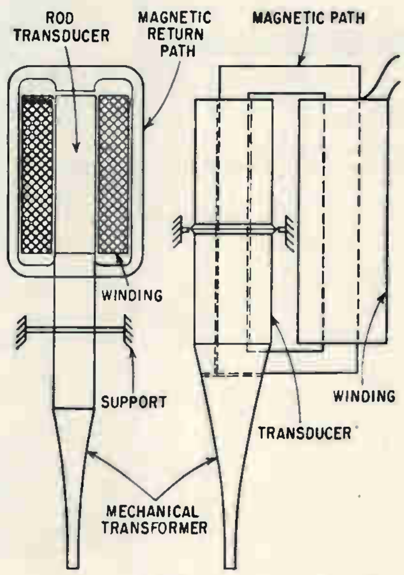


FIG. 2—Solid cylinder at left or hollow cylinder at right provide the same relationship of current and magnetic field

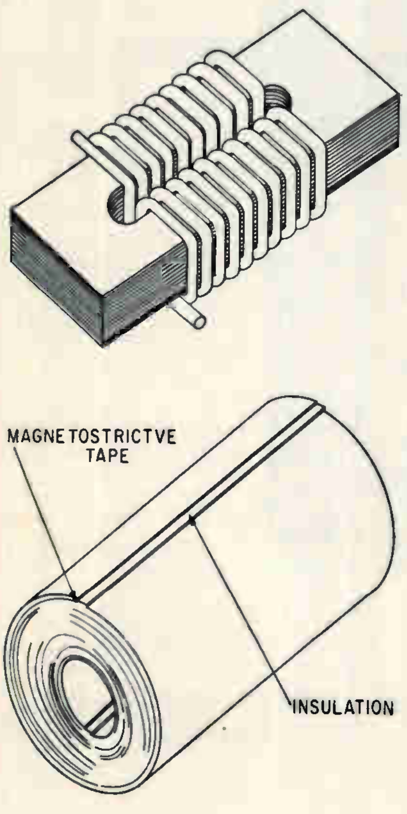


FIG. 1—Eddy current and conductor losses of conventional transducer at top are greatly reduced in magnetostrictive transducer below

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2N709 CHARACTERISTICS

	Min.	Typ.	Max.	Condition	
C_{ob}	....	....	3.0 pf	($V_{CB}=5.0$ V; I	$=0$ mA)
C_{TE}	....	....	2.0 pf	($V_B=0.5$ V; I_C	$=0$ mA)
f_T	....	800 mc	....	($V_C=4.0$ V; I_C	$=5.0$ mA)
τ_s	....	3.0 ns	6.0 ns	($I_B=I_B=I_C$	$=5.0$ mA)
h_{FE}	20	....	120	($I_C=10$ mA; V_{CE}	$=0.5$ V)
BV_{CBO}	12 V	....	....	($I_C=10$ μA; I	$=0$)
I_{CBO}	....	....	100 mμA	($V_{CB}=5.0$ V; I	$=0$)

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vided by a ferrite rod permanent magnet oriented coaxially with the hollow cylinder transducer.

A solid cylinder of electrically conductive magnetostrictive material in the variation of the transducer at the left in Fig. 2 again provides both the electrical and the magnetic path. Current is induced in the cylinder from a winding of many turns of ordinary insulated wire. This configuration should make possible a high Q resonator. If the cylinder were hollow, as at the right in Fig. 2, it would become a transformer secondary. It would be coupled to a separate winding by a magnetic core. This variation has advantages of high Q and ease of fabrication.

To cool high-power transducers, two tapes might be welded together at the edges as in Fig. 3 and then inflated by gas or liquid pressure to form a tube. The tube would be wound to form a transducer cylinder and coolant circulated through the tube opening. A loosely wound cylinder might also be inflated after winding. This technique has been used with other materials.

In the prototype, nickel sheet was cut and soldered to form a strip, which was wound with thin insulation into a hollow cylinder. The transducer was fastened to a mechanical transformer with an insulating cement. The prototype was substantially more efficient than several transducers that had been fabricated using conventional design. Output was greater for a given input, eddy current and conductor losses were reduced and a much higher Q was obtained.

In addition to the conventional mounting at the left in Fig. 4, several alternate arrangements are possible with the new transducer. One reason for making conventional transducers a half wavelength long, to increase the ratio of winding space to transducer size, is unnecessary in the new transducer. At low frequencies and power levels, the quarter wavelength transducer at the right in Fig. 4 provides reductions in length, weight and cost.

The transformer-coupled hollow cylinder can also be a quarter wavelength and mounted at the end that is attached to the mechanical transformer. Although it could be mounted at one end and attached to the mechanical transformer, me-

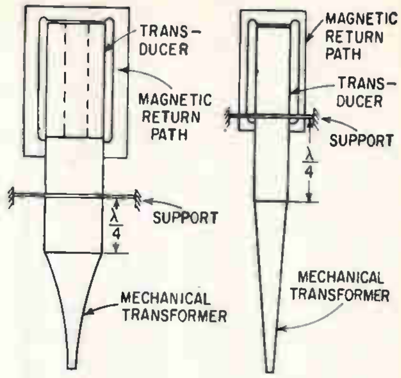


FIG. 4—Conventional mounting at left or mounting for quarter wavelength transducer at right can be used

chanical loading would reduce mechanical Q so much that no advantage would be obtained from resonance.

The author acknowledges the cooperation of Elmer Bomar, Phoenix, Arizona, a manufacturers representative and amateur lapidary who developed the transducer for ultrasonic gem cutting.

Function Generator Solves Nonlinear Equations

NONLINEAR equations can be solved by a device developed to simulate the performance of jet engines unvarying operating conditions. It is now in the operational prototype state and a patent is being sought for the development.

The new device is called a three-dimensional function generator. It was developed at the Transport division of Boeing Airplane Co.

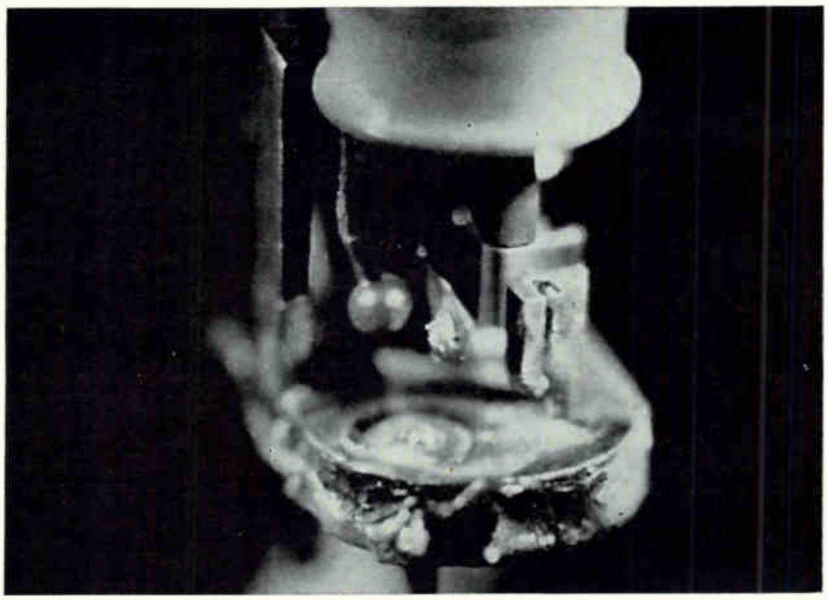
The reason given for developing the three-dimensional function generator is that existing simulators lacked the required accuracy to deal with such variables as air temperature and pressure, the rate of fuel consumption and operating speed, all of which affect performance of the jet engine. Several of the three-dimensional function generators can be used simultaneously as components in a simulator system.

In operation, each variable of the particular problem is represented by an analogous voltage. When two of these analog voltage signals are fed to the function generator, it selects electronically a mathematically related output, such as thrust, from information previously set up in a storage system.

Catastrophic Relay Failures

THE CAUSE: DISCHARGE TRANSIENTS

By CHARLES P. NUNN
REINHOLD HOLBECK,
Filtors, Inc., Port Washington, N. Y.



An example of the destruction caused by an arc discharge between the relay contacts and the header. Notice that one fixed contact has actually vaporized.

MICROMINIATURE RELAYS are designed and tested to withstand at least 1,000 volts between contacts and case. Yet when many of these relays are grounded in many types of circuits, and are used to switch a-c power loads as low as 50 volts, a breakdown occurs within 2,000 operations, destroying the units.

The cause and prevention of this phenomenon were the subjects of a study undertaken by Filtors, Inc.[1]

It has always been good design to place grounded-case relays after the load to reduce the potential on the contacts to the lowest possible level. Experience has shown that relays actually explode while switching power loads. The explosion was attributed to glow discharge. However, the design engineer cannot always place relays on the low side of the load.

The Military Electronics Division of Motorola, in Scottsdale, Arizona, has records of eight system failures attributed to a discharge transient while switching a-c power loads and having the relay cases at ground potential. This led to the investigation of the malfunction by Motorola.[2] This detailed investigation by D. Saewert may have been responsible for establishing that this type of relay malfunction was a design limitation for many of the sealed miniature and crystal case relays on the market today. Saewert's findings indicated that this type of discharge could be predicted. And circuit designers were supplied with reliable figures for the maximum permissible limits of voltage and current. With this background, supplied by Saewert, Filtors instituted a program on the cause and cure of catastrophic relay failures.

After a preliminary investigation, it was realized that the nature of this phenomenon affects the reliability of many types of power switching circuits where a potential difference is encountered between relay contacts and case.

A uniform testing procedure was established to determine the point at which various relays failed. The procedure cycled relays in the test circuits shown in Fig. 1. The majority of the relays tested at room ambient were in the sealed condition to assure uniformity of atmosphere and to minimize the effects of atmospheric contaminants. Since the current in the grounding circuit was monitored with an oscilloscope, the current peaks could be determined. When relays were used to switch 2-ampere loads (2 amperes at 26.5 volts or 115 v a-c), discharge transients reaching peak values of 160 amperes for periods as long as 50 milliseconds were observed. This type of discharged transient completely destroys the relay (see photo).

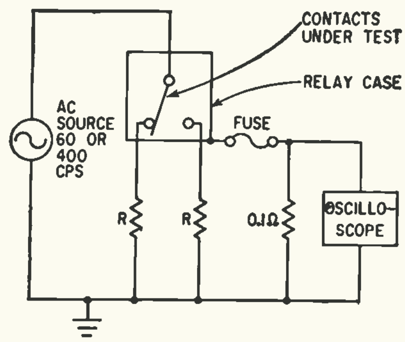


FIG. 1—Test circuit employed for determining relay performance limitations switching one and two ampere loads at 115-v rms, a-c

Since no attempt was made to synchronize the peak a-c current with the relay operation, the range of operations before breakdown varied. On any of the 15 different types of miniature or crystal-case relays tested, no unit was capable of operation more than 2,000 times without a discharge occurring. This survey represented tests on over 100 different relays. The speed at which the relays were cycled did not appear to have a marked effect on the occurrence of the arc discharge transient. Operating rates from 10 to above 400 operations

EX-CELL-O

Contour Projector Used To Aid Nuclear Research

Engineers for the Enrico Fermi Atomic Power Plant used an Ex-Cell-O Model 30 Contour Projector to determine the maximum load that could be applied to a "dimple"!

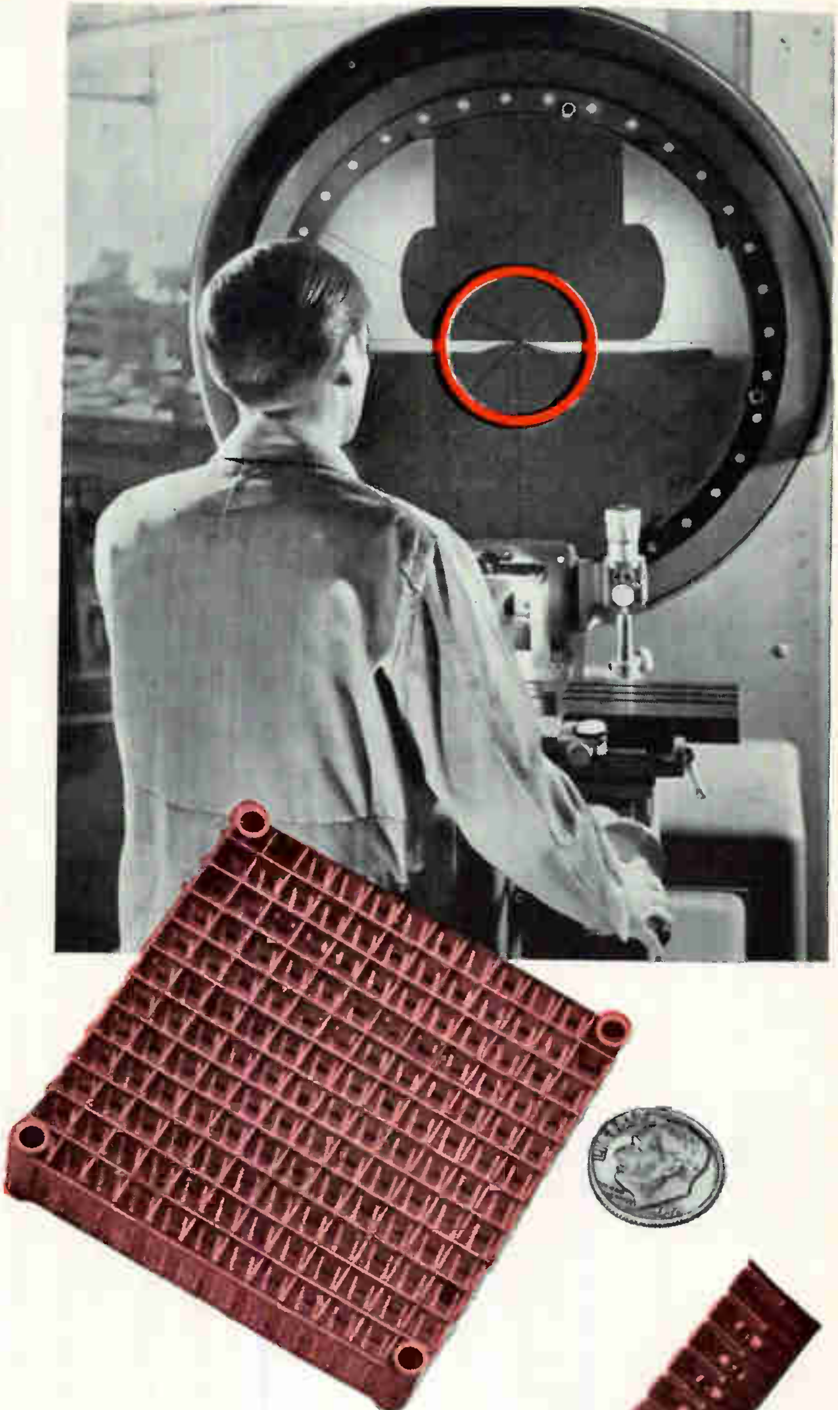
The uranium rods comprising the fuel elements in a reactor core are held vertically in "egg crate" assemblies. Each strip contains precision stamped "dimples" to provide necessary support and accurate alignment.

> *The problem was how to determine the maximum load that could be applied to these "dimples" before permanent set took place.*

Simple with an Ex-Cell-O Model 30 Contour Projector! The workpieces were mounted in a holding fixture and stress applied in increments of one pound. Under 100X magnification the deflection in movements of .0001 inch or less was easily seen on the projector screen! With the highly accurate vertical measuring micrometer and dial indicator, standard on the Ex-Cell-O Model 30 Contour Projector, the actual deflection was measured and recorded with great precision! Successive readings were plotted up to and including the yield point.

This is not an unusual inspection application for Ex-Cell-O Contour Projectors. They are helping in hundreds of different ways to speed production and bring about greater accuracy in the fields of electronics, nuclear research, and travel in space!

If you have similar difficult inspection problems . . . if your inspection is taking too much time . . . or if you need greater accuracy . . . an Optical Gaging Products man can help you. We will gladly send you our new booklet "43 Reasons Why Ex-Cell-O Contour Projectors are the First Choice of Industry."



Stainless steel "egg crate" assembly built up from 26 interlocking strips and designed to carry uranium fuel rods in compact formation. "Dime" shows relative size. The Model 30 Ex-Cell-O Contour Projector above shows inspection of "dimple" on single strip at right.

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per minute were tried.

By reducing the voltage and current that the contact switched, a correlation between the load parameters and the arc discharge transient to the case was determined. This threshold point (below which no discharge transient was encountered) was empirically determined to be (on the majority of relays tested) close to the minimum arc current and voltage values of the contact materials. The values ranged from 0.25 to 0.5 ampere and 30 to 50 volts rms. Figure 2 depicts the conditions under which arcing will and will not occur; the marginal region is the area where some relays, because of their configuration and contact material, will arc. The conditions under which a particular relay will arc can be established within very narrow limits. For example, no arc to the relay case was encountered with 0.25 ampere 115 v rms, or 2 amperes and 30^{v} rms. Both the current and voltage parameters had to be satisfied at the same time. To emphasize this point, the current had to exceed a point in the range of 0.2 to 0.5 amp *and* the circuit voltage also had to exceed a point in the range of 30 to 50 v rms.

Tests were also conducted switching d-c loads. These test results were fairly consistent with the a-c load tests. The d-c tests showed that the life of the arc between separating contacts had to be greater than 0.5 millisecond for the discharge to take place.

It is evident that the breakdown mechanism is not due to field emis-

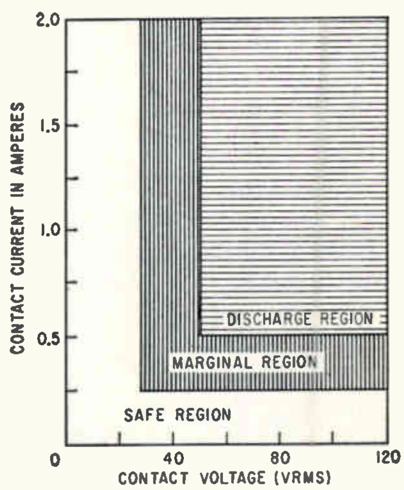


FIG. 2—Conditions under which arcing will occur between relay contacts and case

sion of electrons between the relay contacts and case because: the majority of relays tested can withstand potential differences of 1,000 volts rms between contact and case for over one minute, *when the contacts are not switching a load*; and and a rough calculation of the *average* electric field strength indicates values of 3,000 volts/rm.[3] Field emission is usually noted to take place in electrostatic fields of the order of 10^5 to 10^7 volts/cm. This is probably well above the maximum encountered in the non-uniform electric fields found in relays.

Basically, the breakdown is similar to that encountered in common discharge tubes, such as microwave tr tubes with keep-alive.[4] The arc is assumed to be acting as the cathode and the relay case as the anode. The arc is a source of metallic vapor and electrons and ions. The metallic vapor emitted into the surrounding atmosphere due to the heat generated by the arc and can greatly reduce the ionization potential between the relay contacts and the case.

The region surrounding the arc is composed of ionized gases, metallic vapor, and electrons. By lateral diffusion[6] of electrons and ions from the arc, it is possible for some high-energy ions or electrons (as can be expected from a Maxwellian distribution of energy) to cause further ionization of the surrounding atmosphere. These electrons and ions obtain their energies from various arcing phenomena such as high pressures, thermal and potential gradients, and elastic and inelastic collisions. As described by J. C. Devins and A. H. Sharbaugh,[7] an electron avalanche can occur. Once an avalanche of electrons has occurred the discharge can become self sustained.[8]

REFERENCES

(1) C. P. Nunn and Reinhold Halbeck, "A Study of Discharge Transients In Relays with Grounded Cases," Filtors Relay Research Monograph ER55, Filtors, Inc., Port Washington, New York.

(2) D. Saewert, Motorola, Inc., Private Communications, Military Electronics Division, Scottsdale, Arizona.

(3) V. D. Cobine, "Gaseous Conductors, Theory and Engineering Applications," p 118, Dover Publications, Inc., New York, 1958.

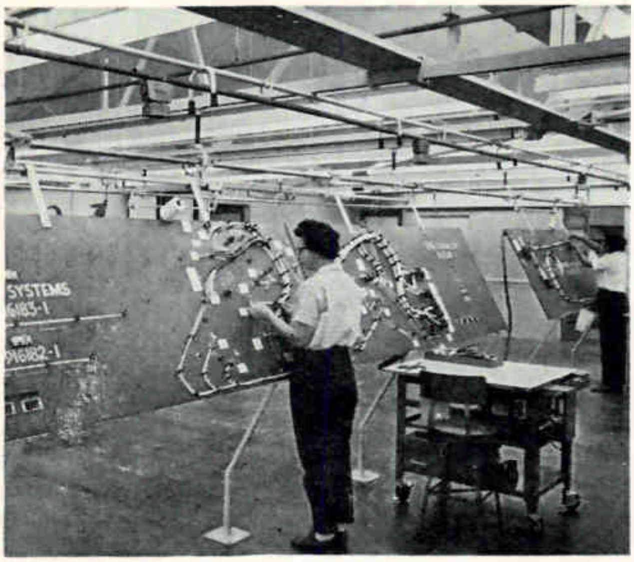
(4) L. D. Smullin and C. G. Montgomery, "Microwave Duplexers," McGraw-Hill Book Company, Inc., 1948.

(5) F. Llewellyn Jones, Arcing Phenomena at Electrical Contacts As Used In Communication Engineering, *Nature*, 157, p 306, 1948.

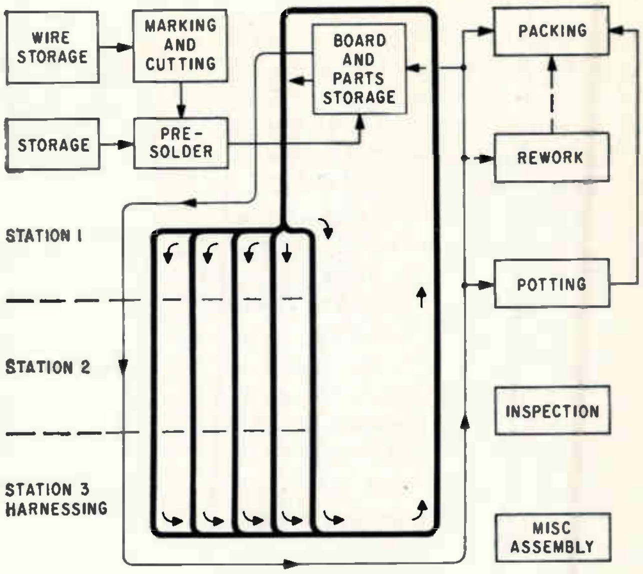
(6) Op. cit. Ref. 5, p. 311.

(7) J. C. Deuins and A. H. Sharbaugh, The Fundamental Nature of Electrical Breakdown, *Electro-Technology*, p 105, Feb., 1961.

(8) Op. cit. Ref. 5, p 305.



Portion of progressive harnessing line



Simplified diagram of harnessing area layout

Conveyor Line Speeds Harness Assembly

PRODUCTION AREA specifically designed to turn out wiring harnesses in short order has recently been installed at Rohr Aircraft Company's plant in Chula Vista, Calif. It is engineered for a progressive assembly system.

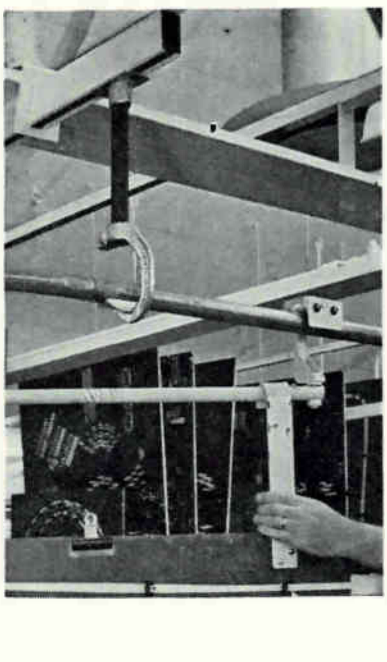
Among the uncommon features is a series of monorail conveyors, from which boards are hung during harnessing. Women harnessers, with a gentle push, can move cumbersome boards—eight or 16 feet long—along the line. Harness boards ride the conveyors in a full circuit (see sketch), carrying parts and materials from one station to the next. The conveyor can be automated by addition of motors and controls.

The main conveyor divides into a series of parallel lines. Work is assigned each line according to the time required to produce the harness. Line 1, for example, handles harnesses requiring two to five hours; line 2, harnesses requiring five to eight hours, etc. Each line has three stations, for the following general operations: routing and lacing, a hold station, and soldering. The board is then passed on to inspection, potting or rework if needed, and board removal and packaging.

All subsidiary operations, such as wire preparation, presoldering, ultrasonic cleaning of plugs, junction box assembly, analyzer assembly, inspection, rework, potting, packaging and personnel instruction, are grouped at locations convenient to the conveyor line. The sketch shows these schematically, not in detail.

Harness components are kitted, numbered and placed in baskets in the parts storage section in the circuit. The baskets ride on the boards. Heavy parts and production aids are also numbered and routed along with the boards, on carts.

Boards are fitted with steel straps formed into a hook at the upper end. The straps are hung on pipes. The pipes are hung from swivel rollers, which ride on the round tube forming the conveyor track. Transfer junctions, curved tube sections which rotate 180 degrees to switch conveyor lines, are located



Two conveyors meet at transfer junction

Harness and conveyor hangers. Board storage is in background

at conveyor divider points.

The conveyor track is supported by C-shaped bracket holders. The holders fit into slotted unistrut sections which are fastened to the building I-beams. The holders clamp into the unistrut sections under spring tension, so they can be removed readily. The entire conveyor can be dismantled and relocated in hours.

While assemblers are working on the harnesses, boards are steadied by adjustable stanchions. Large boards are made maneuverable by dividing them into standard sections eight feet long, connected by butt hinges reworked to permit quick release. The hinge pin is ground down and notched. A groove is milled in the pin retainer and a spring is inserted. The spring lifts out the pin when turned.

Parts are kitted in baskets

One of the subassembly areas (wires to plugs)

The harnessing area is air conditioned to prevent dust and corrosion. All parts carriers are covered with plastic free of sulfur contaminants. Harnesses are checked for wiring faults and leakage resistance by circuit analyzers made by Rohr.

Ultrasonic Cleaner Recondense Solvents

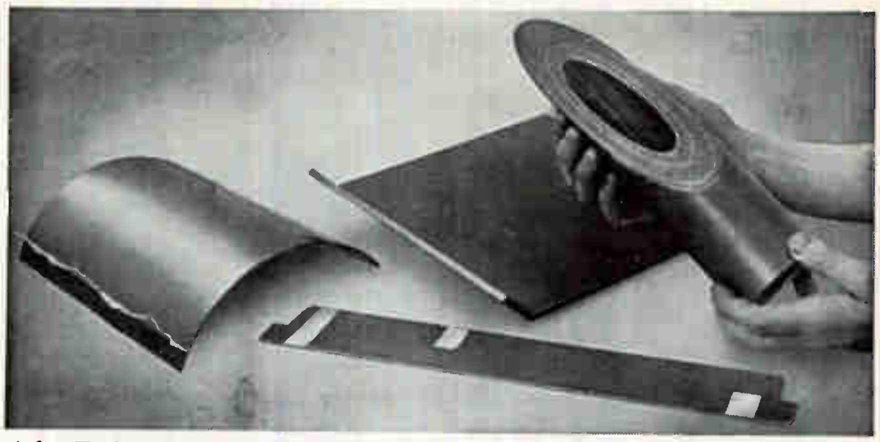
AUTOMATIC ULTRASONIC cleaning machine recently introduced by Autosonics, Inc., Philadelphia, Pa., uses a series of wheels to move parts through wash, rinse and dry cycles. The solvent used (Freon, du Pont) is conserved by condensation.

In the machine heated air is circulated counter-current to the moving parts. The air absorbs evaporating solvent and carries it through chilled coils, which condense the solvent and return it to a rinse sump. The sump overflows into the immersion tank. Contaminated solvent in the immersion tank is periodically replaced and may be cleaned by distillation. The machine can be integrated with parts fabrication machines, it is reported.

Stainless Steel Atop Epoxy Stops Corrosion

Stainless steel jacket over epoxy encapsulant provides low-cost corrosion resistance equivalent to an all-stainless shell. To encapsulate motors, Epoxylite Corp. forms two-mil foil shell slightly larger than product ad pours resin between the two. A temporary mold prevents weight of the liquid resin from rupturing the foil

Important facts to know about laminated plastics



A few Taylor composite laminates (left to right): copper-clad section; sandwiched copper component; Taylorite vulcanized fibre-clad part; laminated tube, copper inserts.

Composite Laminates Open Up New Design Opportunities

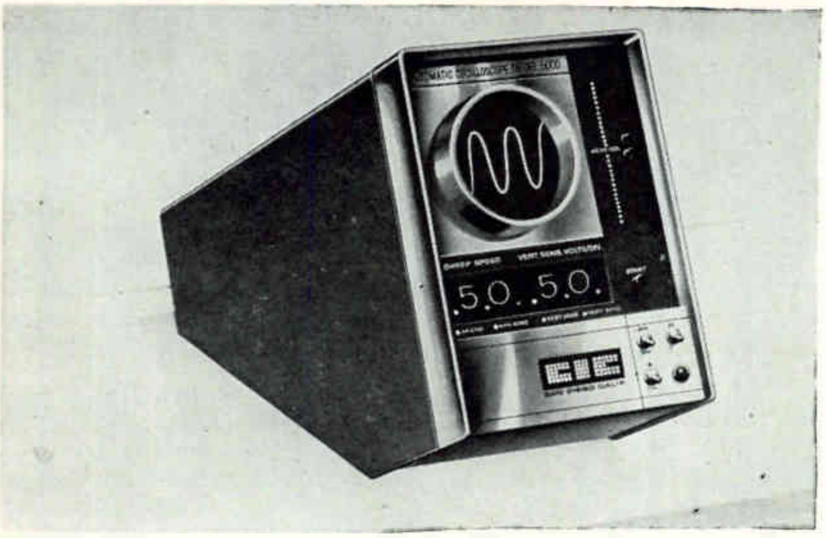
While the great variety of commercially available laminated plastics satisfy most electrical and mechanical requirements, there are applications that can benefit from the combination of properties provided by composite laminates. Recent advances in bonding techniques have made it possible to bond virtually any compatible material with a laminate. These can be supplied as clad or as sandwiched materials. And they can be molded into many shapes to fit design requirements. Taylor is presently supplying to order the following composite laminates:

- **Copper and laminated plastics.** Clad for printed circuits and formed shapes. Sandwiched for special applications.
- **Taylorite® vulcanized fibre-clad laminates.** These combine the high strength of laminated plastics with the superior hot-arc-resistance of vulcanized fibre. They are being used in both high and low-voltage switchgear applications. Also in applications where the high impact strength of vulcanized fibre may be advantageous.
- **Rubber-clad laminates.** Almost any type of natural or synthetic rubber may be used as the cladding material. These laminates are widely used for condenser tops in wet condensers to protect the laminate against highly alkaline electrolytes. They also have application in any part where sealing or chemical resistance is needed.
- **Asbestos-clad laminates.** For applications where high heat- and arc-resistance are required.
- **Laminate-clad lead.** Lead sheets sandwiched between Grade XX paper-base laminates have been used for X-ray shields. The laminate provides strength and contributes to the high shielding properties of the lead.
- **Aluminum-clad laminates.** These have been used extensively for engraving stock. They also offer possibilities as printed-circuit material and as plate holders for X-ray machines.
- **Beryllium copper-clad laminates.** Beryllium copper is nonmagnetic and a good conductor—properties that give these laminates possibilities in many applications.
- **Stainless steel-clad laminates.** Applications where nonmagnetic properties are required. Also in certain corrosive environments where the resistance of stainless steel to attack is an asset.
- **Magnesium-clad laminates.** These laminates have been produced in 108-in.-long sheets for use as screens for X-ray operators. Weight was a factor.

Our design and production engineers are constantly developing new materials, new applications, and new procedures for fabricating laminated plastics. Our experience is yours for the asking. And if you have a problem requiring assistance or more information on composite laminates, write us. Also ask for your copy of Taylor's new guide to simplified selection of laminated plastics. Taylor Fibre Co., Norristown 40, Pa.

Taylor
LAMINATED PLASTICS VULCANIZED FIBRE

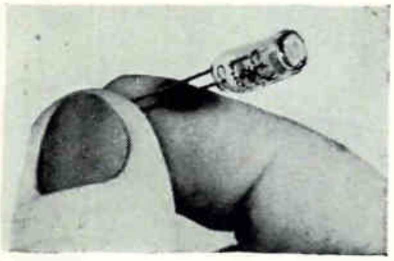
New On The Market



Automatic Oscilloscope
WITH DIGITAL READOUT

SOLID-STATE, 10 Mc oscilloscope automatically displays sized and positioned picture of waveform regardless of input voltage magnitude, frequency or d-c offset. Vertical sensitivity, horizontal sweep d-c offset are presented digitally. Features include automatic triggering and provision for external sync. Price is approximately $1,500, delivery in 30 days, from California Instruments Corp., 3511 Midway Dr., San Diego 10, Calif.

CIRCLE 301 ON READER SERVICE CARD



Photoconductive Cell
HUMAN EYE RESPONSE

MINIATURE photoconductive cell that approximates the human eye is announced by Clairex Corp., 8 West 30th St., N. Y., N. Y. Cadmium sulphide cell measures tungsten or daylight over a wide range of color temperatures. Series will contain six types for various impedances, in both side and end-view versions. Applications include picture brightness and contrast control, photographic exposure meters, streetlight switches.

CIRCLE 302 ON READER SERVICE CARD

TV Camera For Dark
LOW LIGHT LEVELS

TRANSISTORIZED camera for battlefield surveillance is announced by Admiral Corp., 3800 Cortland St., Chicago 47, Ill. With low light level tube, the camera can observe objects several hundred yards away in virtually total darkness. The picture is observed on a standard tv monitor set. Image orthicon camera can also be used for plant, base and battlefield security in conjunction with portable radar set.

CIRCLE 303 ON READER SERVICE CARD

Small Generator
WEIGHS ONE GRAM

TYPE 201 is a size 2 (0.25 inch diameter) solid state generator whose output voltage is a sine function of the angular position of its shaft. The device can be used as an error sensor, function generator, tachometer, modulator. Max speed is greater than 10,000 rpm, frequency range is d-c to 50 Kc. Type 501 is a size 5 version. Delivery is two weeks, from The Omnite Co., P. O. Box 491, Westminster, Calif.

CIRCLE 304 ON READER SERVICE CARD

Miniature Recorder
SEVERAL VERSIONS

RECORDER is a rugged unit that can be used as a portable device or built-in component. It is suitable for recording voltage, current, pH, temperature, pressure and other variables. Two basic meter movements measure a wide range of d-c and a-c without amplification. Pressure-sensitive paper feeds at

up to 15 inches per hour. Manufacturer is Amprobe Instrument, 630 Merrick Rd, Lynbrook, N. Y.

CIRCLE 305 ON READER SERVICE CARD

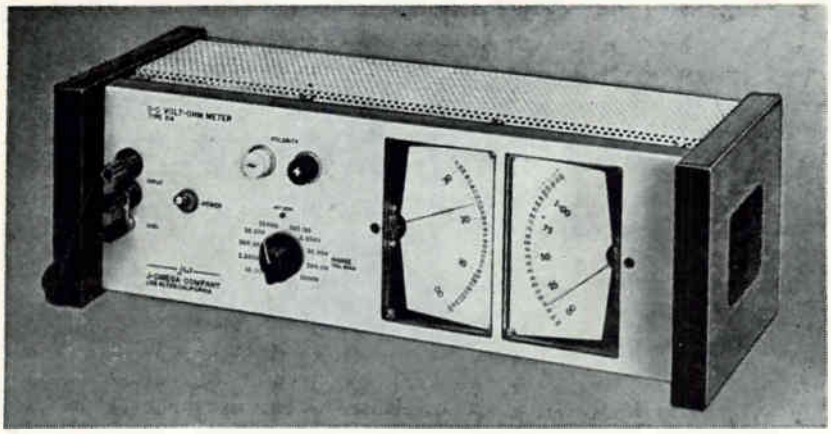
Direct-Reading Wavemeter
HIGH ACCURACY

DIRECT-READING wavemeter provides readout to ± 0.05 percent, without correction tables or charts. The frequency scale is a slightly sloping

line on a long tape, which moves behind a curved index line. Model

3102 covers 900 to 2,100 Mc; model 3103, will cover 2,350 to 3,750 Mc. Manufacturer is General Communication Co., 677 Beacon St., Boston 15, Mass.

CIRCLE 306 ON READER SERVICE CARD

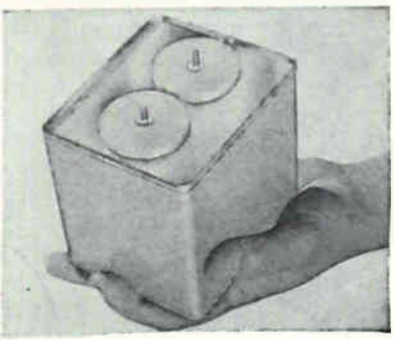


Semi-Digital Volt-Ohmmeter

DIGITAL PLUS ANALOG

TYPE 21A solid-state volt-ohmmeter combines analog and digital readout. Left hand meter is digital indicator, calibrated in 32 steps; right hand analog meter has 100 parts to one step of the digital meter. Readout gives two figures from left and two from right indicator. Color coded lights indicate voltage polarity. Price is $650, delivery from stock, from J-Omega Co., Los Altos, Calif.

CIRCLE 307 ON READER SERVICE CARD



Capacitors

HIGH-VOLTAGE

DEARBORN ELECTRONIC LABORATORIES, INC., P. O. Box 3400, Orlando, Fla. The Hi-Var h-v capacitors feature low space saving terminal height with long, heavy, horizontal creepage path minimizing corona yet permitting h-v ratings in very small compact circuitry. Units are ideal for potted and oil-immersed circuitry from sea level to 100,000 ft. Capacitance values range from 0.1 μf to 15.0 μf with tolerances as low as ± 5 percent in voltages from 400 to 12,500 v d-c.

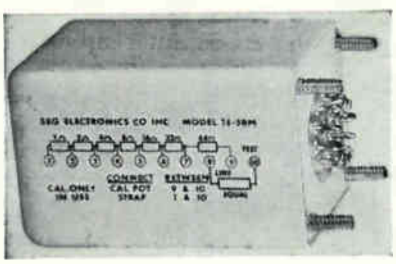
CIRCLE 308 ON READER SERVICE CARD

3-Phase Transformers

VOLUME OF 0.53 IN^3

SMALL, 3-phase transformers by Titan Transformer Co., 229 Binney Street, Cambridge, Mass., are one by one by 17/32 inch, for a volume of 0.53 cubic inches. Series SX subminiatures are hermetically sealed, manufactured to MIL-T-27 A, Grade 5, Class R; primary windings to 200 v at 400 cps; secondaries up to 200 v at 2 watts output.

CIRCLE 309 ON READER SERVICE CARD



Line Equalizers

DELAY DISTORTIONLESS

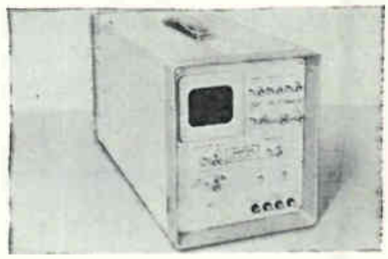
SEG ELECTRONICS CO. INC., 12 Hinsdale St., Brooklyn 7, N. Y. The TEM series of delay distortionless line equalizers use new techniques for equalizing for both amplitude and delay in a single unit. The compact units (a few cubic inches) are adjustable for any desired length of transmission line up to 25 miles.

CIRCLE 310 ON READER SERVICE CARD

Digital Computer

FLEXIBLE, SMALL

MNEMOTRON CORP., 47 S. Main St., Pearl River, N. Y., announces the CAT digital computer for the study of on-line calculation of four different variables, simultaneously. It may be used for many purposes



by the biological scientist—calculating brain response, nerve potentials, retinograms, cardiological data, phono cardiograms, autonomic functions, pupil responses, and other biological variables.

CIRCLE 311 ON READER SERVICE CARD

Logic Modules

THREE SERIES

COMPUTER TECHNIQUES INC., 3300 Northern Blvd., L. I. C. 1, N. Y. Encapsulated logic modules in collector gated 1200 series, general purpose 2100 series, and NOR/AND 3000 series are available. Features are the wide temperature range (−54 C to 85 C) of the 1200 series, load handling ability of the 2100 series, and ability of the 3000 series to optimize many parallel type digital systems. Frequency range is

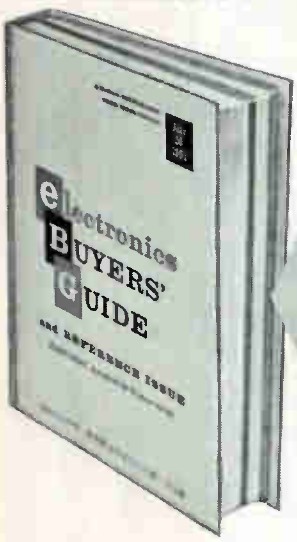
E I C **solid-state power supplies meet critical requirements**

Custom-designed and standard EIC solid-state power supplies meet your most demanding requirements for frequency and voltage regulation, size, and performance. Prototypes can often be delivered within two weeks, and production runs in any quantity can follow immediately.

Standard models include a broad range from subminiature static units to kilowatt supplies for ground support equipment and automatic controls. Prices are very competitive. Write for data on standard models, or describe your requirements. We welcome an opportunity to serve you.

ELECTRODYNAMIC INSTRUMENT CORPORATION
Subsidiary of Reed Roller Bit Company
1841 Old Spanish Trail Houston 25, Texas

CIRCLE 201 ON READER SERVICE CARD



Seen the new IDEA INDEX IN EBG?

The INDEX to the editorial articles in electronics magazine, previously published annually in a December issue, now appears ONLY in the EBG. Another original EBG idea that saves time and trouble for users! Keep your EBG copy on your desk!

EXTRA!

Also in the EBG are condensed ABSTRACTS of *all* the editorial feature articles which have appeared to date in 1961. Another reason why EBG is used more by all four – men in research, design, production and management.

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ACTUAL SIZE
(versus ordinary commercial servo-type motor)

EAD 60 CYCLE MINIATURE SIZE 15 SERVOMOTORS

Design *instant response* into your recording instruments and, at the same time, miniaturize your "package" with substantial cost-reductions. EAD 60 cycle, size 15 miniature servomotors are engineered for RESPONSE-*ability* . . . the ability to produce rapid acceleration and reversing without over-power and over-size.

These 60 cycle, size 15 servomotors, now available for commercial applications, have the same precision RESPONSE-*ability* as EAD's military versions . . . your assurance of high performance and reliability.

TYPICAL PERFORMANCE DATA

MODEL	S2HBZ7-*	S2HAX7-*
Voltage	115 volts	115 volts
Frequency	60 cycles	60 cycles
Stall Power/Phase	6.0 watts	6.0 watts
Stall Current/Phase	70 MA	70 MA
Time Constant	.0052 Sec.	.00915 Sec.
Reversing Time	.0089 Sec.	.0155 Sec.
Rotor Inertia	4.0 gm cm^2	3.3 gm cm^2
No Load Speed	1500 RPM	3000 RPM
Stall Torque	1.7 oz-in	1.6 oz-in

*Basic models. Mechanical modifications available to customer requirements.

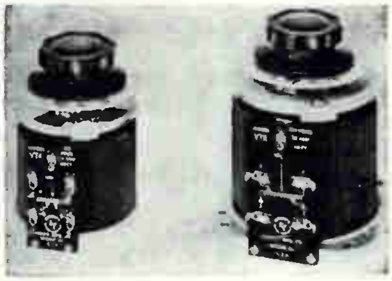
If *your* responsibility is improved recorder design, look first to EAD for the servomotor line that meets all your RESPONSE-*ability* requirements. Call your nearest EAD representative or write about your specific needs.

Rotation Is A Science At
EASTERN AIR DEVICES, Inc.
A SUBSIDIARY OF NORBUTE CORPORATION
397 Central Ave., Dover, New Hampshire

CIRCLE 87 ON READER SERVICE CARD

200 Kc for the 1200 and 2100 and 100 Kc for the 3000.

CIRCLE 312 ON READER SERVICE CARD



Transformers
UL APPROVED

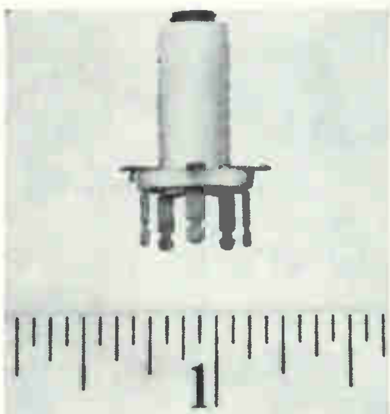
OHMITE MFG. CO., 3682 Howard St., Skokie, Ill. Series VT4 and VT8 variable transformers are UL approved. The VT4's are rated 3.5 amp nominal with overvoltage feature; 4.75 amp without overvoltage. The VT8's are rated 7.5 amp nominal with overvoltage; 10.00 amp without overvoltage.

CIRCLE 313 ON READER SERVICE CARD

Solid State Relay

AUTRONICS CORP., 180 N. Vinedo Ave., Pasadena, Calif. Static relay latches in either position and holds "on" position when contact load is lost.

CIRCLE 314 ON READER SERVICE CARD



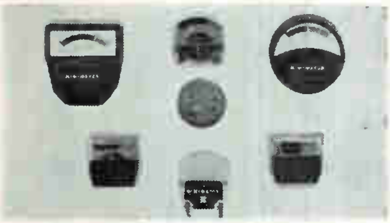
Ceramic Coil Form
VERTICALLY-MOUNTED

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. Ceramic coil form, No. 2501, is for p-c work and other space-saving applications. It is silicone-impregnated and internally threaded for tuning cores. Coil form is available

with four different powdered iron tuning cores having overlapping frequency ranges that cover a total range from 0.2 Mc to 150 Mc.
CIRCLE 315 ON READER SERVICE CARD

VTVM

B & K MANUFACTURING CO., 1801 W. Belle Plaine Ave., Chicago 13, Ill. Automatic vacuum-tube voltmeter has direct reading scales, includes d-c current ranges.
CIRCLE 316 ON READER SERVICE CARD



Level Meters
MINIATURIZED

THE MURA CORP., 777 Northern Blvd., Great Neck, N. Y., announces a line of miniature level meters and tuning eyes for use in tape recorders and stereo equipment. Meter movements range from 100 μa to 1 ma with zero left or zero center. Sizes range from 1 in., 1½ in., and 2 in. with compact construction behind panel taking up only ½ cu in. Mounting is accomplished by use of slip-on metal grip and/or screws.
CIRCLE 317 ON READER SERVICE CARD

Fixed Attenuator
HIGH POWER

RLC ELECTRONICS, INC., 805 Mamaroneck Ave., Mamaroneck, N. Y. Model A-500 can be supplied in attenuation values from 0 to 20 db. Attenuator accuracy is ½ db. Vswr with type N connectors is 1.2 maximum from d-c to 1 Gc. Power rating is 50 w average, 50 Kw peak. Units are calibrated at 0.95 Gc; can be supplied with type N, C or HN connectors.
CIRCLE 318 ON READER SERVICE CARD

CIRCLE 89 ON READER SERVICE CARD

PRODUCT BRIEFS

PULSE HEIGHT ANALYZER multichannel. Radiation Counter Laboratories, Inc., 5121 W. Grove St., Skokie, Ill. (319)

DELAY LINE magnetostrictive. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, L. I., N. Y. (320)

LASER STIMULATOR high energy. Edgerton, Germeshausen & Grier, Inc., Boston, Mass. (321)

SYNCHRO operates without slip rings. Harowe Servo Controls Inc., Mount Road, Lenni Mills, Pa. (322)

SILICON PLANAR TRANSISTORS high reliability. General Instrument Semiconductor Division, 65 Gouverneur St., Newark 4, N. J. (323)

MINIATURE CHOPPER 83 deg nominal phase-lag. The Bristol Co., Waterbury 20, Conn. (324)

ULTRASTABLE CRYSTAL for frequency standard use. James Knights Co., Sandwich, Ill. (325)

VERSATILE SCOPE DOLLY low cost. Metal Dynamics Corp., 9430 State Road, Philadelphia 14, Pa. (326)

NONMAGNETIC CONNECTOR for space instrumentation. Hermetic Seal Corp., Pasadena, Calif. (327)

MATCHED SSB FILTERS less than 3 db ripple. Systems, Inc., 2400 Diversified Way, Orlando, Fla. (328)

WIRE-WOUND RESISTORS for p-c applications. Reon Resistor Corp., 155 Saw Mill River Road, Yonkers, N. Y. (329)

TEMPERATURE DETECTOR ribbon-type. Control Indicating Corp., Bradley Field, Windsor Locks, Conn. (330)

TUNNEL DIODE AMPLIFIERS gallium antimonide. Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N. J. (331)

GLASS SEAL CONNECTORS uniform impedance. General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass. (332)

CIRCULATOR SWITCHES at L-band. Hyletronics Corp., 185 Cambridge St., Burlington, Mass. (333)

Literature of the Week

D-C AMPLIFIER & POWER BOOSTER Ridgefield Instrument Group, P. O. Box 337, Ridgefield, Conn., is offering technical literature on its all solid state differential operational amplifier model A-2 and power booster model G-2. **(334)**

PRECISION POT George Rattray & Co., 101 New South Road, Hicksville, L. I., N. Y. A catalog sheet illustrates and describes model 200 CEUS, a 2 in. precision pot suitable for the simulator field. **(335)**

MINIATURE PUSH BUTTONS General Electric Co., Schenectady 5, N. Y. Bulletin GEA-7127A includes new forms added to a complete line of industrial, miniature, oil-tight push buttons. **(336)**

GLASS-EPOXY LAMINATES Taylor Fibre Co., Norristown, Pa. Fireban 600, a flame-retardant glass-base, epoxy-resin laminated plastic, and Fireban 600E, the copper-clad version, are described respectively in bulletins 51.5.20 and 51.5.21. **(337)**

D-C POWER SUPPLY Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif. A 2-page bulletin describes a d-c power supply designed for solid state computer and other digital system applications. **(338)**

SERVO REPEATER Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin DPS/A6 describes the SR-112 servo repeater which, used with an appropriate synchro-transmitting unit, indicates in digital form the angular position of a remote shaft. **(339)**

CURRENT PROBE SYSTEMS Tektronix, Inc., P. O. Box 500, Beaverton, Ore. Specification sheet details characteristics of two systems for observation and measurement of current waveforms. **(340)**

MOTOR-DAMPING GENERATOR Kearfott Division, General Precision, Inc., Little Falls, N. J. Reference sheet P820-001 describes a size 10 short length motor-damping generator combination. **(341)**

TESTER-CALIBRATOR Consolidated Airborne Systems, Inc., 900 Third Ave., New Hyde Park, L. I., N. Y. Specification sheet TF 20-461 covers an instrument that permits testing and calibration of liquid quantity systems and components, in-place or on bench. **(342)**

TIMER Technology Instrument Corp., Space Instrumentation Division, 533 Main St., Acton, Mass. A brochure entitled "Micro-Adjustable Timing" covers the model 4-23 sequence timer. **(343)**

H-V COMPONENTS & EQUIPMENT Universal Voltronics Corp., 17 S. Lexington Ave., White Plains, N. Y., has published a catalog describing high voltage components and equipment. **(344)**

TRANSISTOR HEAT SINKS Invar Electronics Corp., 1723 Cloverfield Blvd., Santa Monica, Calif. Technical bulletin 202 describes transistor heat sinks based on the Invar HS 229 extrusion. **(345)**

WIRE-WOUND RESISTORS Reon Resistor Corp., 155 Saw Mill River Road, Yonkers, N. Y. Bulletin describes a line of ultraminiature encapsulated wire-wound resistors for microminiature circuitry in industry and the military. **(346)**

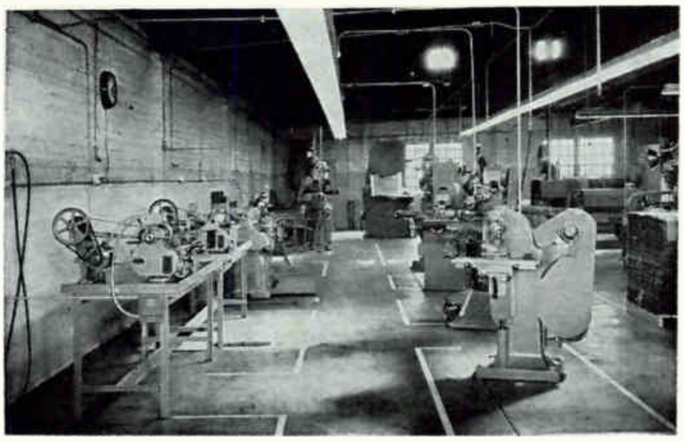
RECTIFIER HOUSINGS Advanced Vacuum Products, Inc., 430 Fairfield Ave., Stamford, Conn. Technical bulletin AV-100 describes ceramic-to-metal housings for high-power high-current semiconductor rectifiers. **(347)**

PANEL METER Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif., has released a data sheet covering the style 42 (4½ in. rectangular) panel meter. **(348)**

TERMINALS & SPLICES AMP Inc., Eisenhower Blvd., Harrisburg, Pa. Catalog enables user to select proper terminal or splice by computing circular mil area of wire. **(349)**

TRANSISTORS Electronic Transistors Corp., 9226 Hudson Blvd., North Bergen, N. J. An eight-page catalog contains detailed specifications of 452 types of germanium transistors. **(350)**

BELLOWS Avica Corp., Box 180, Newport, R. I. Bulletin 611-B illustrates and describes bellows for pressure seals, flexible joints and vibration dampers. **(351)**



Synthane-Pacific Gets New Facility

INSTALLATION of complete facilities (partial view shown) for fabrication of laminated plastics for electronic, electrical and industrial applications has been completed by Synthane-Pacific, Glendale, Calif.

Synthane-Pacific was recently established by Synthane Corp., Oaks, Pa., a manufacturer and fabricator of industrial laminated plastics, to offer complete service to West Coast customers. The Los Angeles, San Francisco, San Diego, Tucson and Phoenix areas will be served by the new facility.

Thirty-four pieces of precision equipment, selected especially for fabrication of intricate and close-tolerance parts for aircraft, spacecraft, electronics and other industries, have been installed at the Glendale plant. District sales offices and a warehouse for quantity storage of laminated plastic sheets, rods, tubes and fabricated parts are also located at the site.

Synthane-Pacific is a wholly-integrated operation and the first branch plant established by Synthane Corp.

Bert C. Kibre is manager of the West Coast plant, with Charles F. Reustle in charge of fabricating operations.

G-D/Electronics Names Green

CHARLES R. GREEN has been appointed chief engineer of the Communications Laboratory in General Dynamics/Electronics' Military Products Division, Rochester, N. Y. He comes to G-D from the Admiral Corp., Chicago, Ill., where he was chief engineer of the communications and countermeasures branch.

Appoint Hazebrook Section Manager

HARRY HAZEBROOK has been promoted to the position of engineering section manager at Electro-Mechanical Research, Inc., Sarasota, Fla.

Since joining EMR in 1959, Hazebrook has been a senior engineer engaged in the design and development of pulse-code-modulation airborne and ground-based telemetry equipment. In his new position he assumes major responsibility for the development of EMR's product line in the area of airborne digital equipment.

Announce Formation Of New Company

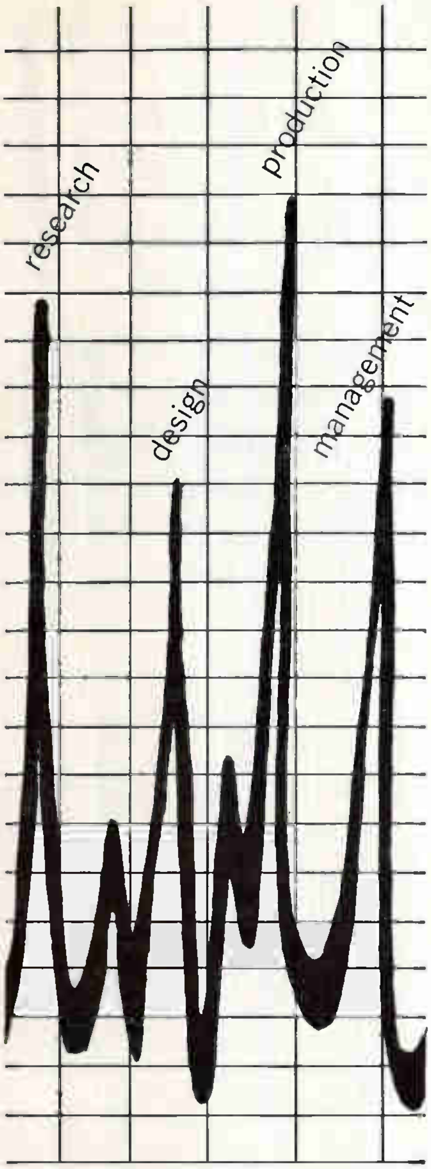
COMREX CORP., Sudbury, Mass., has been formed to design and manufacture high-frequency transistorized communications equipment. The company expects to apply advanced state of the art knowledge and techniques to the production of high quality, practical equipment which can be operated by nontechnical personnel.

WacLine Meters Hires Ross

AL ROSS joins WacLine, Inc., Dayton, O., as chief engineer of its meter division. He comes from Standard Electrical Products Co. of Dayton where he has been vice president and chief engineer for the past 14 years.

IFI Promotes Lockwood To Executive V-P

ROBERT C. LOCKWOOD, former vice president of Instruments for Industry, Inc., Hicksville, N. Y.,



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2 new H-K Logic Module Series to choose from

125°C.•5 MC... Plus a new economical packaging advance... Harman-Kardon

Flexi-Card

Here's two way flexibility... to provide the exact encapsulated digital logic assembly you need, at substantial savings:

1. Three compatible H-K module series...**125°C.• 5 MC.• 250 KC.**
2. *Flexi-Card*—the new circuit card assembly that lets you specify the exact circuit assortment needed—delivered quickly and economically by Harman-Kardon.

No need to pay for more flip-flops, gates, drivers...than you need. Harman-Kardon's new approach to card assemblies provides custom utility at stock prices. Get the facts on this doubly good news! Write for details on the expanded range of encapsulated digital logic modules... and *Flexi-Card*—Harman-Kardon's new versatile circuit card assembly.

D→ S→ D→ →H-K

Data Systems Division

harman kardon

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FREE

HANDY POCKET GUIDE TO BOOLEAN ALGEBRA!

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developer of electronic countermeasure systems, precision potentiometers and related components, has been named executive vice president.

Lockwood, who is also a director of the company, joined IFI in 1953 as vice president in charge of engineering and has been in charge of the over-all direction and planning of the company's development programs. Before joining IFI, he was an engineer with the General Electric Co. and Airborne Instruments Laboratory, Inc.

Cannon Electric Appoints Witting

CANNON ELECTRIC CO., Los Angeles, Calif., has named Edward G. Witting as manager of research and new products. Witting leaves the post of Deputy Assistant Secretary of the Army (Research and Development) to assume the new position.

Dunn Engineering Hires Kilham

ROBERT E. KILHAM, former manager of computer projects of the National Co. and of Remington Rand, has joined Dunn Engineering Corp., Cambridge, Mass., as manager of its new digital systems department.

The department was organized recently to design and apply digital

computer techniques to instruments produced by Dunn Engineering, and to develop custom equipment on contract. Company is a developer-manufacturer of electronic systems and inertial guidance and other missile test equipment.

John Weaver Forms New Corporation

INFONETICS CORP., Van Nuys, Calif., was recently formed by John H. Weaver, president and general manager, to design, manufacture and market peripheral equipment devices for automatic data processing systems.

Weaver was one of the original founders of Telecomputing Corp. in 1947 and until recently was vice president and general manager of its data instruments division.

PEOPLE IN BRIEF

C. Daniel May, Jr., formerly with the Defense Dept., joins IBM's federal systems division as head of tactical communications systems. *James G. Callaghan* of the Ford Motor Co.'s Aeronutronic division advances to manager of the space systems operations staff. *King H. Dendy* transfers from Microsecond Electronics to PCA Electronics as vice president. *Herman A. Affel, Jr.*, leaves Philco Corp. to become vice president of Auerbach Electronics Corp. *Francis T. Koen* promoted at Itek Electro-Products Co. to director of manufacturing. *Robert L. Anderson*, formerly with Hertner Electric Co., named project manager at Designers for Industry, Inc. *Albert Haselman* and *Robert Lewis* of Prodelin, Inc., elected to the board of directors. *Maj. Gen. John A. Barclay* retires from the Army Ordnance Missile Command to join Lionel Corp. as vice president for research and development. *Dean Arden* of the MIT computational staff appointed to the board of directors of Harvey-Wells Electronics. *Dave Gerstein* of the Siegler Corp. moves up to vice president of government and industrial operations for the Olympic Radio and Tv div. *Leonard J. Linde* promoted to director of engineering for the industries group, Allis-Chalmers Manufacturing Co.

EMPLOYMENT OPPORTUNITIES

electronics

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3. Notice the key numbers.
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6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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COWIN ASSOCIATES Garden City, New York	248*	4
ERIE ELECTRONICS DIVISION Erie Resistor Corp. Erie, Pa.	98	5
ESQUIRE PERSONNEL Chicago, Illinois	246*	6
GYRODYNE CO. OF AMERICA INC. St. James, L. I., New York	98	7
I B M CORPORATION Lexington, Kentucky	100	8
INSTRUMENTS FOR INDUSTRY INC. Hicksville, L. I., New York	246*	9
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LOCKHEED California Division Burbank, California	13*	11
MANSON LABORATORIES INC. Stamford, Connecticut	241*	12
MERONEY & ASSOC., A. H. Chicago, Illinois	248*	13

(Continued on page 98)

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

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NAME ....

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CITY......................... ZONE...... STATE...........

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PROFESSIONAL DEGREE(S)...................................

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

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- ☐ Aerospace
- ☐ Antennas
- ☐ ASW
- ☐ Circuits
- ☐ Communications
- ☐ Components
- ☐ Computers
- ☐ ECM
- ☐ Electron Tubes
- ☐ Engineering Writing
- ☐ Fire Control
- ☐ Human Factors
- ☐ Infrared
- ☐ Instrumentation
- ☐ Medicine
- ☐ Microwave
- ☐ Navigation
- ☐ Operations Research
- ☐ Optics
- ☐ Packaging
- ☐ Radar
- ☐ Radio—TV
- ☐ Simulators
- ☐ Solid State
- ☐ Telemetry
- ☐ Transformers
- ☐ Other ....
- ☐ ....
- ☐ ....
- ☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Join the winning team!

career openings in

MANAGEMENT

ENGINEERING

ADMINISTRATION

THESE ARE GYRODYNE ROTORCYCLES!

The Grand Prix trophy, shown in the inset, was won by a Gyrodyne Rotorcycle for its competitive performance at the International Air Show, Le Bourget, Paris, France on June 1, 1961. The Rotorcycle was developed under a U. S. Navy contract for the Marine Corps. An advanced engineering design of this helicopter—the Gyrodyne Drone—is now being produced for the U. S. Navy's ASW DASH Program. DASH consists of pilotless, weapons carrying helicopters, electronic flight control equipment on destroyers and complex support activities.
These and other challenging projects are creating career openings for highly qualified administrative and professional personnel experienced in the following fields:

ENGINEERING

DESIGNERS
Transmission
Airframe
Powerplant Installation
Equipment Installation
Electrical

ANALYTICAL
Aerodynamicists
Stress Analysts
Helicopter
Stability and Performance

DRAFTSMEN
Layout
Detailers
Mechanical Design Checkers

TEST ENGINEERS
Flight Test
Structural Test
Static and Dynamic

MANUFACTURING ENGINEERS
Tool Design
Tool Design Checkers
Shop Liaison
Vendor Liaison

AVIONIC SYSTEMS ENGINEERS
Autopilot
Digital Data Link
Radar Tracking
Ground Control Equipment

CONTRACT ADMINISTRATION ENGINEERS
Electronic Systems
Electronic Components
Electronic Support Equipment

PRODUCT SUPPORT ENGINEERS
Publications
Electronic Equipment
Field Service
Training

ADMINISTRATION—MANAGEMENT

ACCOUNTING—Cost • Audit • Property
CONTRACTS—Administration • Proposals
FINANCE—Corporate • Legal
PERSONNEL—Recruiting • Training • W & S
PLANNING—Facilities • Manufacturing
SYSTEMS—Procedures • Forms • Data Processing

Applicants interested in the possibility of becoming associated with a progressive organization located in one of the most beautiful suburban residential areas on Ling Island, are requested to submit confidential resumes to our Personnel Director, Dept. E, Gyrodyne Company of America, Inc., St. James, L. I., N. Y.

★ **Gyrodyne** ★
COMPANY OF AMERICA, INC.
An equal opportunity employer.

RESISTOR ENGINEER

Progressive manufacturer of Metal Film Resistors located near Chicago needs an experienced engineer to take charge of their precision resistor line. Must be experienced on Mil type resistors. Excellent opportunity for the right person to manage this division.

CENTRAL RESISTOR CORP.
507 Factory Road Addison, Illinois
National S-9332

TRANSFORMER ENGINEER

With experience in the design and development of Hi-Frequency and Pulse transformers for commercial and military applications.

Ideal opportunity for ambitious man to develop full potential of present small department. Salary—open. Location—Erie, Pa. Call or send resume to Chief Engineer

Erie Electronics Division
Erie Resistor Corporation
645 West 12th Street Erie, Pa.
GL 6-8592

POSITION VACANT

Medical Electronic Sales Manager or Consultant-Rare opportunity for the right man in New York City. Write about your background and experience to the President of the Interstate Mfg. Corp., 190 Boston Post Road, Orange, Connecticut.

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

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* These advertisements appeared in the 8/11/61 issue.

ELECTRONIC ENGINEERS & PHYSICISTS

REPUBLIC AVIATION NEWS

NEW RECONNAISSANCE ROLE FOR "ELECTRONIC PLANE"

NEW PRIME CONTRACT AWARDED REPUBLIC CREATES DEMANDING ASSIGNMENTS FOR EE's & PHYSICISTS

The development of a reconnaissance capability for Republic's F-105D marks the first "marriage" of an all-weather reconnaissance system with an all-weather airborne weapon system. The one-man F-105D has already earned the title of the "world's first electronic plane," because its integrated complex of electronic systems permits it to be almost fully automatic. Flight control, navigation, target seeking, identification and tracking, fire control for diverse weapons are all automatically controlled.

With the addition of a sophisticated reconnaissance system the F-105D becomes a flying electronic platform. System design and analysis of the new reconnaissance package and its aerospace ground support present stimulating new challenges to electronic engineers and physicists. Optimum integration of the whole electronic complex offers unique problems.

SENIOR & INTERMEDIATE POSITIONS NOW OPEN TO ENGINEERS (EE) AND PHYSICISTS, TO PERFORM SYSTEMS DESIGN, ANALYSIS, TEST AND RELIABILITY ENGINEERING ON:

- Radars (front & side looking)
- Infrared Systems
- Antennas, Radomes
- Data Links
- Digital Computers
- Flight & Fire Control Systems
- High Speed Tape Recorders
- Optical Systems
- Aerospace Ground Support Equipment

These opportunities are at 2 Republic locations: Mineola and Farmingdale, Long Island. For further information, write in confidence to:

Mr. George R. Hickman
Technical Employment Manager,
Dept. 11H-2
Republic Aviation Corporation
Farmingdale, Long Island, New York

Mr. Paul Hartman
Technical Employment, Dept. 11H-2A
Missile Systems Division
Republic Aviation Corporation
223 Jericho Turnpike
Mineola, Long Island, N.Y.

All Republic programs are backed up by the new Paul Moore Research & Development Center, an integrated complex of eight laboratories dedicated to the advancement of all aspects of aerospace technology.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

REPUBLIC
AVIATION CORPORATION

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

•

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.40 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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• See Advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

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Audited Paid Circulation

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Advertising Sales Manager

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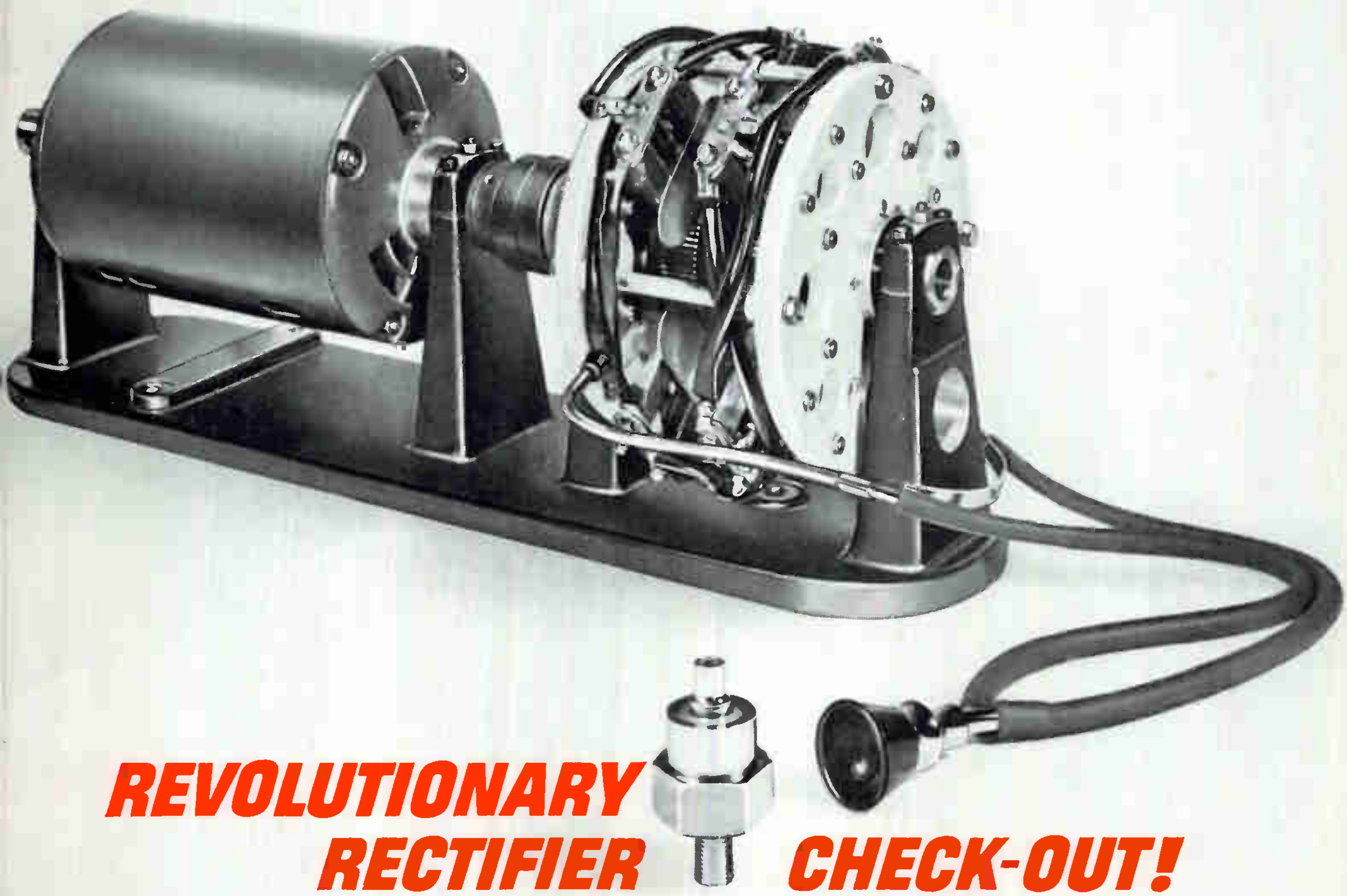
...Blazing new trails in component reliability!



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New synchronous switch gives more dependability . . . lower initial cost, lower operating cost!

HERE is just what you need to test **large numbers** of semiconductor rectifiers under rated conditions of forward current and peak-inverse voltage—without dissipating the large power required by normal full-wave rectifier circuits. The forward current and peak-inverse voltage are applied for a larger portion of the cycle (170°) than test circuits using thyratrons, ignitrons, or relays.

The switch also includes these operating features: voltage drop less than 1 volt at maximum current rating (which is 100 amperes average through each bank of rectifiers in full wave circuit) . . . generation of destructive transients is non-existent . . . rectifiers may be tested in series on each side of circuit . . . 2 thermal cutouts, which operate at 200° F, can be used in breaker control or alarm circuits . . . unit furnished with enclosure and blower.

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THE DAVEN COMPANY, Livingston, New Jersey

A SUBSIDIARY OF GENERAL MILLS

General Mills

SWITCHES

TODAY, MORE THAN EVER, THE DAVEN Ⓓ STANDS FOR DEPENDABILITY