September 9, 1960

electronics

Television camera (below) overcomes transistor low-frequency noise problems, permits variation in characteristics. *See p 72*

Design of a practical high-speed magnetic-film memory. *See p 78*

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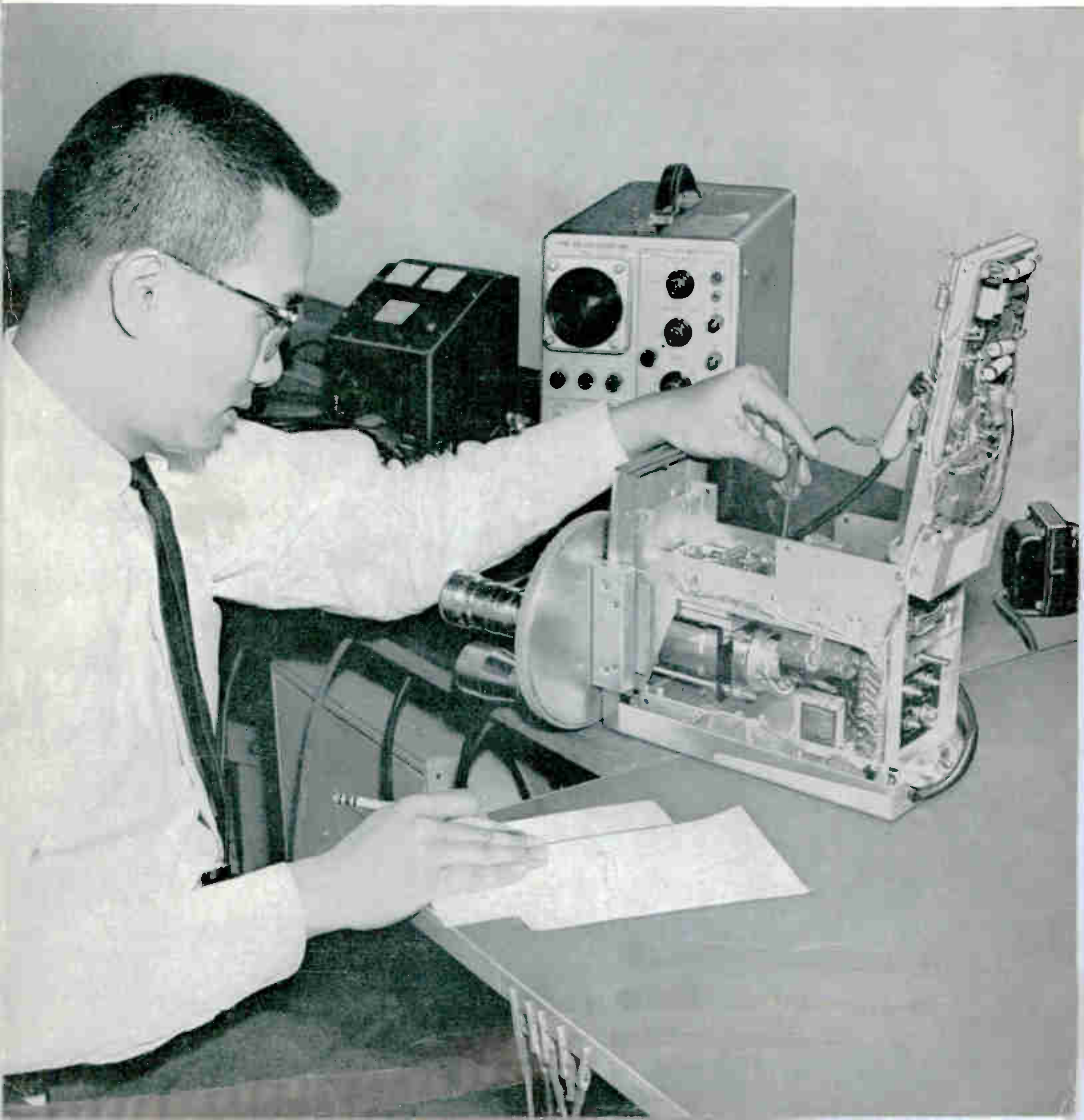
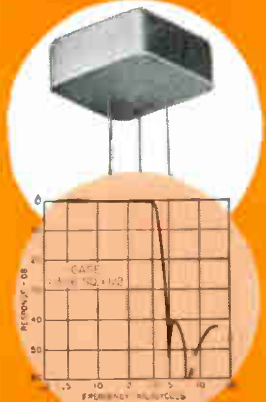
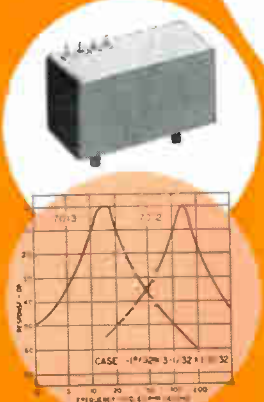


SPECIAL FILTERS

TO YOUR REQUIREMENTS

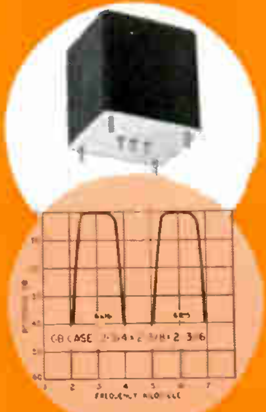


Miniaturized 3.5 KC low pass filter. 10K ohms to 10K ohms. Within 1 db up to 3500 cycles. Greater than 40 db beyond 4801 cycles.

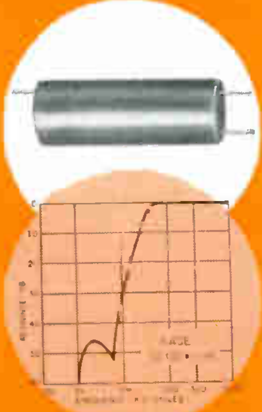


Fifteen cycle and 135 cycle filters for Tacan 600 ohms to high impedance. Extreme stability —55° C. to + 100° C.

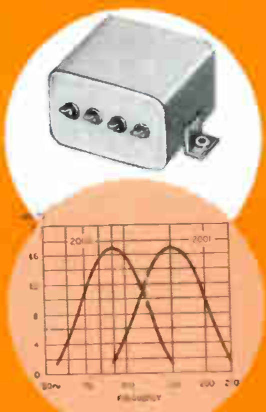
Almost thirty years of experience in the design and production of special filters have resulted in UTC being a first source for difficult units. Present designs incorporate a wide variety of core structures, winding methods, and capacitors to provide maximum performance, stability, and reliability. The 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.



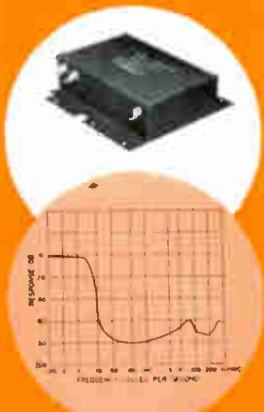
Three KC and 6 KC flat top band pass filters 400 ohms to 20K ohms MIL-T-27A: each filter 1.7 lbs.



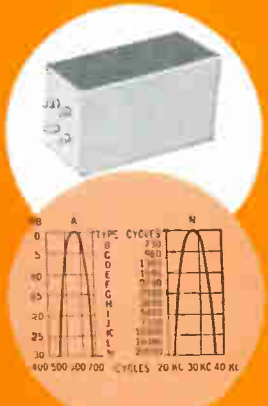
High frequency Mini filters, 33 oz. MIL-T-27A Grade 5. 150 KC High Pass 3 db to 150 KC, down 45 db below 85 KC. 7500 ohms.



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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September 9, 1960

electronics

A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, Editor

BUSINESS

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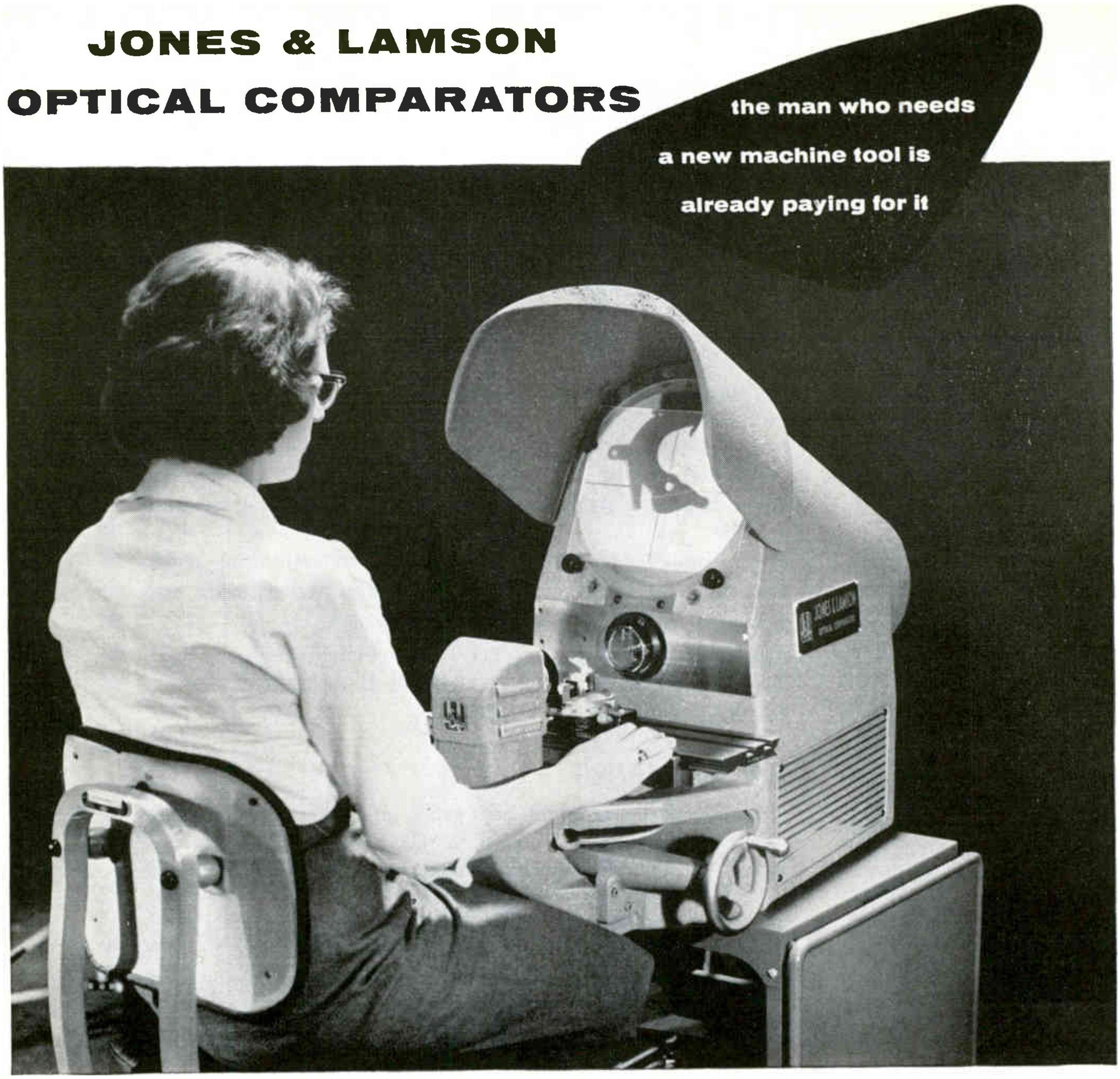
JONES & LAMSON OPTICAL COMPARATORS



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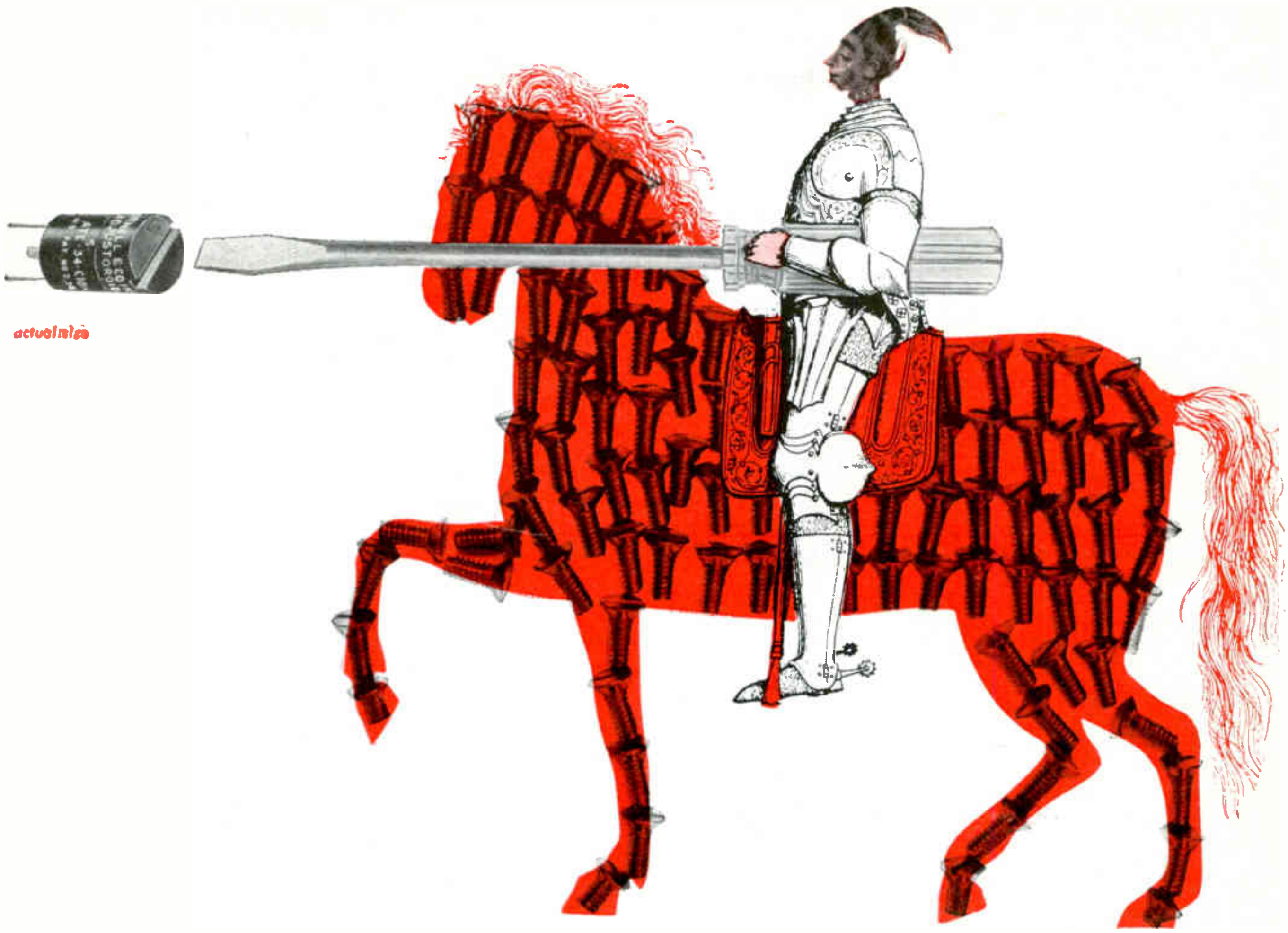

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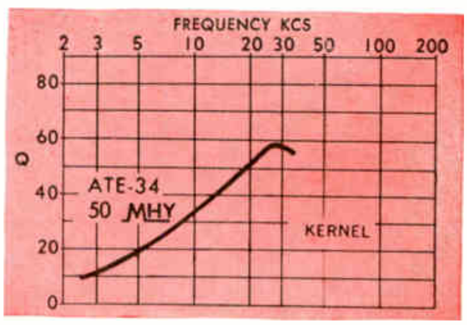

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CROSSTALK

electronics

Sept. 9, 1960 Volume 33 Number 37

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

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

Subscription price U. S. and possessions $6 per year; single copies 75¢, Buyers' Guide $3. Other countries, and longer periods, on request. Subscriptions solicited only from those actively engaged in the field of the publication and in a manner served by its contents; position and company should be indicated.

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REFLEX KLYSTRONS. This issue brings another in a series of informative articles by K. Ishii of Marquette University on the subject of reflex klystrons. In this his latest ELECTRONICS article, which begins on p 82, Ishii analyzes the behavior of the QK-295 reflex klystron as a millimeter-wave regenerative detector.

Previous articles by Ishii, who is an assistant professor in Marquette's electrical engineering department, have dealt with reflex klystrons in X-band receiving amplifiers (p 202, April 1955 and p 56, Jan. 8, 1960), in M-band amplifiers (p 71, Mar. 18, 1960) and reflex klystron amplifiers with hybrid-T coupling (p 64, June 10, 1960).

COMMUNICATIONS. Technological progress sometimes means new life to some and doom to others. The invention of the locomotive killed the stage coach business outright. The communications satellite, however, is not expected to leave much bankruptcy in its wake. The expanded facilities provided by these orbiting microwave relay stations will be used up by the normally expanding need for communications. Some changes in equipment are nevertheless inevitable. Gear developed as weapons systems— ballistic missiles and radar—will move into the communications field. And much existing communications equipment will be converted. Progress in many specific areas is urgently needed. Associate Editor John Mason reports on p 40 how the communications satellite will affect the communications equipment maker.

LONG-STANDING THORN in the side of FCC and some broadcasters has been the operation of unlicensed booster stations that take television signals off the air for the benefit of communities isolated from conventional reception. The Commission's latest move is to authorize establishment of vhf-tv translator stations. In the past, FCC tried to deal with boosters by approving uhf translators. (These stations receive vhf broadcasts and transmit them on a uhf channel.) Since many boosters were already operating on vhf frequencies, there was no great stampede to adopt the Commission's uhf plan, although many boosters did change over. Remaining to be seen now is whether or not the vhf translators will win the boosters over, and what, if any, interference problems will arise. For news in this area, see Associate Editor Emma's story on p. 42.

Coming In Our September 16 Issue

MICROWAVE TELEMETRY. Measuring the acceleration of a projectile being fired is a central problem of interior ballistic instrumentation. Telemetry systems for this task are subject to special requirements imposed by accelerations over 10,000 g's and by the high cutoff frequency of the gun barrel.

Next week, W. M. Kendrick and L. A. Peters of Ballistic Research Laboratories, Aberdeen Proving Ground, describe a technique for using a microwave beam to transmit data up the gun barrel from a projectile during firing. A ferrite modulator within the projectile modulates the externally generated beam; the modulated signal reflected from the projectile is then demodulated in the ground station to recover the information.

IN ADDITION. The variety of interesting feature articles scheduled to appear next week includes: A sensitive capacitance intruder alarm by S. M. Bagno of Kidde Ultrasonic & Detection Alarms.

COMMENT

Electronics Probes Nature

(Ref. "Electronics Probes Nature," special report on p 53, July 29 . . .)

I was very glad that I was able to contribute to your coverage of this most important area.

The report was very well done, demonstrating a masterful editorial effort. I should imagine that the material in the article represents the consolidation of a considerable mass of literature, comments, reports, and so forth. The article accomplished what I believe you intended it to: that is, to establish a framework which shows the related nature of several important scientific areas with a small indication of what is going on in each.

I do, however, have one criticism to make. There wasn't enough of it, which is understandable when publication space is at a premium. Therefore I would like to make a suggestion. Using the present article as a guide, further develop each section so that you can present a full comprehensive report of one part in each issue of ELECTRONICS.

I would like to further suggest that in each part, a section be devoted to the geopolitical aspects of that particular part. I do not restrict this facet of an area to the short-range international scene, but refer to the long-range effects.

As an example, what will be the long-range effects of the knowledge we are accumulating about the oceans? What will happen in agriculturally poor countries when food reaped from the oceans will be plentiful? What technical steps are being taken now to make the most of these opportunities? Science-fiction? No, a glimpse into things to come based on wellfounded guesses.

Again, thank you for . . . the article. I sincerely believe it was well done, timely, and with about as much content as the space would permit.

JOHN H. NEWMAN

DAYSTROM INC.
POUGHKEEPSIE, N. Y.

I do not have time to write you a full letter of comment on "Electronics Probes Nature" at the present moment . . .

From my perusal of the articles so far, I was very much impressed with both the high quality of the technical writing (I except my own contribution) and the comprehensive nature of the information.

ROBERT A. FROSCH

COLUMBIA UNIVERSITY
DOBBS FERRY, N. Y.

Researcher Frosch need not except his own contribution, which certainly helped make the report the excellent thing we feel it is.

Reader Newman's suggestion would be difficult to implement, and might take us far afield from our proper concern, which is electronics. There are many subjects of scientific interest that we would like to present, and sometimes we let our eclectic nature carry us away—but always we return to the point that a cobbler is a flop unless he sticks to his last. Electronics, rather than agronomy (for instance), is our business. But we're happy to promise that developments in the various areas covered in the special report will be reported as they occur.

Help Wanted

We are trying to find out the present whereabouts of International Scientific Industries Corp., which was located at 3101 E. 42nd St., Minneapolis, several years ago. An inquiry to the Minneapolis Chamber of Commerce bore no fruit.

If this company has gone out of business, we would like to be able to contact one of the principals; therefore if any of your readers know—or *are*—any of the principals, we would appreciate hearing from them.

Hope you can help. Perhaps you could print this letter in your Department of Missing Companies.

GERALD SHIRLEY

ALDSHIR MFG. CO.
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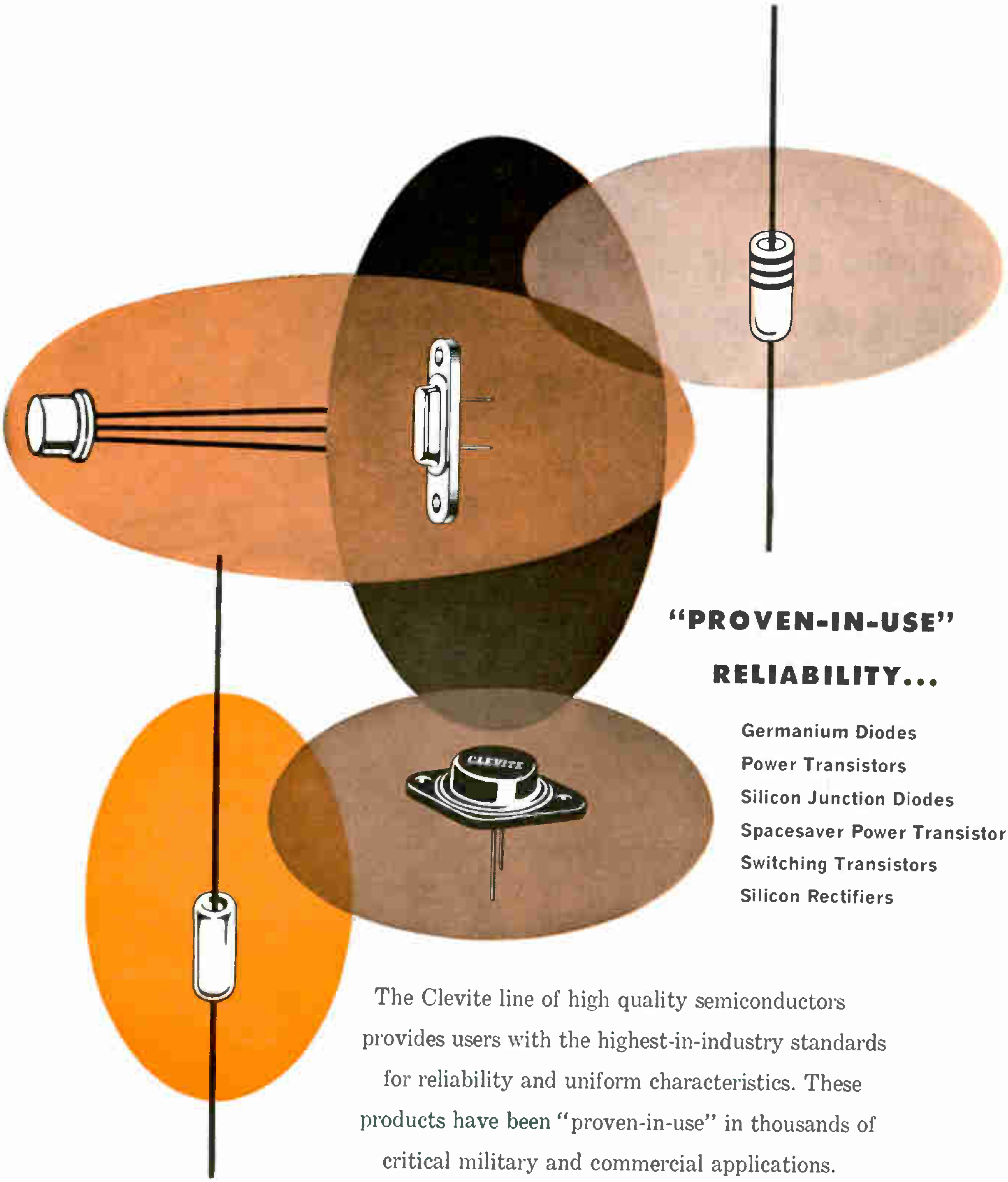
Inquiries directed to our several records and files of such data also bore no fruit, and we hope that someone in our readership will be able to help reader Shirley find his missing company.



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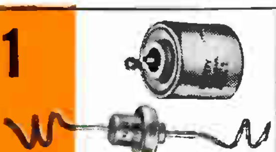

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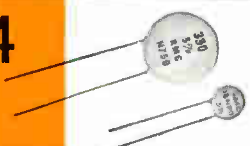

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ELECTRONICS NEWSLETTER

Bank Check Sorter Prints Electrostatically

NEXT THURSDAY an electronic sorter with visual print out at 1,560 lines a minute and a magnetic tape output for computers will go into operation at the First Pennsylvania Banking and Trust Co., Philadelphia. Input to the Burroughs equipment is from MICR (Magnetic Ink Character Recognition) characters imprinted on the checks. The equipment produces magnetic tapes for off-line use with model 220 computers.

The unit also uses four electrostatic printers, two with 27-character lines, two with 17-character lines. The printers are all solid state. Print out is on plastic-coated paper tape. An electron beam deposits a charge pattern on the tape; the tape picks up rosin-based ink powder that is fixed by heat. This is the first commercial application of this printer, although the Signal Corps is using the device for military communications.

Two Electronics Firms Team Up With Jewelry Maker

ELECTRONIC JEWELRY is the term being applied to a line of bracelet charms introduced yesterday in New York City by Sylvania, P. R. Mallory and Marchal Jewelers.

Using the recently developed Sylvania Mite-T-Lite powered by specially designed Mallory batteries, the jewelers have devised such charms as a television set with a glowing screen, tiny sports cars with lighted headlamp, a Statue of Liberty with lighted torch and other designs.

Distribution will be through jewelers who will also carry batteries for replacements. A Sylvania spokesman says the demand for the tiny lamps for jewelry will account for most of those produced for the remainder of this year.

Electronic System to Automate Naval Fleets

SECURITY WRAPS are now off some aspects of Navy's new multimillion dollar tactical data system in which Remington Rand, Collins Radio and Hughes Aircraft have the major shares.

Navy officials say the new system which provides coordinated data processing and communications facilities will permit an entire naval task force to be coordinated almost to the point of operating as one ship against virtually any type of military attack or opposition that may be encountered.

Designed to deal with manned aircraft, guided missiles, submarines and surface vessels, all task force units will share all input data simultaneously. RemRand is providing the computing systems, Collins Radio's Alpha division is providing the data transmission and communications gear, and Hughes is developing the data display system.

International Investment Firm Plans Being Formulated

NEW INVESTMENT COMPANY is being formed in California, according to West Coast sources, that will aim at international financings.

Formed by C. E. Salik and R. Silberman of Electronics Capital Corp., the new organization will start life with a $25-million underwriting to be handled by Bear, Stearns, New York City as principle underwriters.

The company, to be called Electronics International Capital, Ltd., will be incorporated in Bermuda and will seek controlling interest in privately held electronics companies in Britain, Germany, Japan and other countries.

Thermal Cooling Seen for Trailers

THERMOELECTRIC cooling of trailer trucks looks like one early commercial application of the Peltier effect in semiconductors, at least that appears to be the wager of one semiconductor company.

Transitron, Inc., of Wakefield, Mass., is negotiating acquisition of Thermo-King of Minneapolis, supplier of refrigeration equipment for truck trailers.

Best guess is that Transitron, which has been concentrating on thermoelectric materials for two years, sees the merger as a profitable diversification move, expecting that economically practicable direct-conversion systems will be marketable—if not the day after tomorrow, at least the day after that.

Electronics Hitched to Production Control

ELECTRONIC impulse generators link production control center to machines on factory floor in Productograph system introduced by Farrington Manufacturing Co., Needham Heights, Mass., in New York and at Chicago Machine Tool Exposition and Production Engineering Show.

Data is gathered by photocell, pressure transducer, microphone, decade counter, linear measure or voltage relay. Information is reported to a lamp field and to a linear counter which displays and records running situation, including idle machines and causes for them.

Massachusetts company meanwhile has North American leasing rights, with deliveries taking about six months.

Maser Helps Astronomers Measure Solar System

HARVARD UNIVERSITY'S hydrogen-line maser (ELECTRONICS, Jan. 15, 1960, p. 71) is being used to help astronomers define the scale of the solar system more precisely, particularly the distance from the earth to the sun. Information is crucial for deep space probes. Earth's orbital velocity can be computed by comparing the doppler shift when the earth is travelling toward a radio star with the shift, six months later when it is speeding away from the star.

From these measurements, a computer program can solve the earth-sun distance. At 21-cm wavelength, the maser is also helping to detect the weak magnetic fields in interstellar space. Presently, researchers are looking for weak magnetic fields near Cassiopia, strongest source thus far located.

Announcing
the formation of
AEROSPACE
CORPORATION
a new and vital force
engaged in
accelerating
the advancement
of space science
and technology

WASHINGTON OUTLOOK

AIR FORCE is fighting to put the B-70 project back on a weapon-system basis. This would mean reinstating subcontracts for development of electronic subsystems terminated in last year's economy drive.

The Administration's recent decision to earmark an extra $100 million for the B-70 does not imply resuming subsystem development. Instead, the funds are to be used to get faster delivery of two stripped-down prototype models of the Mach 3 aircraft for flight testing.

But the Air Force would prefer to build just one prototype, using the extra funds for what one Air Force official describes as partial resumption on an austere basis of the subsystems. The $100 million would not go far, however.

Among the subsystems cancelled last year, which the Air Force would like to reinstate: IBM's bombing-navigation; Sperry's auxiliary gyro platform; Westinghouse's defensive subsystem; Motorola's mission and traffic control; and Autonetics' automatic flight control.

In addition, plans were also cancelled last year to build a programmer-comparator; and bomb-nav, defense operator, and flight simulator trainers.

In all, Air Force now has slightly over $200 million for B-70 development this year. This includes the basic development budget of $175 million and applied research funds for the bomb-nav subsystem and money carried over from last year to start production of the second prototype plane.

Congress added an additional $100 million that the Administration so far refuses to release to the Air Force.

Sperry Gyroscope, meantime, has proposed a substantial cut in B-70 costs through use of a modified version of its B-58 bomb-nav system for the Mach 3 aircraft to substitute for development of a brand-new system.

RENEGOTIATION BOARD study of 25 major defense contractors in 1959 shows an average 10.4 percent profit on military sales per company prior to renegotiation. The profit rate ranged from 4.9 percent on contracts with cost plus fixed or incentive fees, 5.3 percent on terminated contracts, 8.8 percent on fixed-price incentive contracts, 10.6 percent on price redetermination awards, to 18.3 percent on fixed-price contracts.

MILITARY PROCUREMENT laws require no legislative changes. That's the conclusion of the Senate Armed Services Committee which recently made a wide-ranging inquiry into defense contracting policies.

The Committee has put the kibosh on enactment of two highly-touted bills pushed during the past session of Congress. One, the Vinson Bill, already passed by the House, is aimed to force the Pentagon into more formal advertised contracting and less negotiated procurement and to put the lid on cost estimates and profit allowances in incentive-type contracts.

The other measure, which the Committee's ranking Republican, Sen. Leverett Saltonstall of Mass., is promoting aims to make it easier for the military to award negotiated contracts, to encourage incentive-type contracts, and to centralize greater weapon development and production powers with prime contractors.

Though supporting the general thesis that more formal advertised procurement is desirable, the Senate Committee conceded that open advertised bidding involves serious problems for contracting officers in many types of weapon projects and pointed out that negotiated contracting does not necessarily mean the absence of price competition among potential suppliers.


Navy & Air Force Bullpup


Air Force Mace


Army Lacrosse

Army Pershing

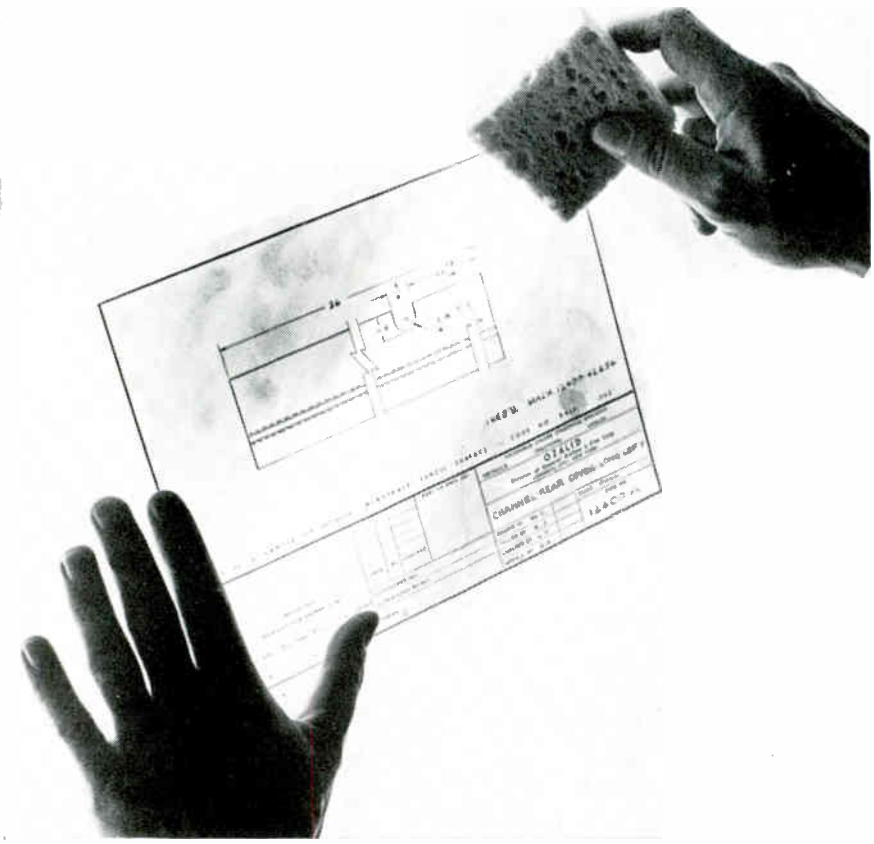
Air Force Titan

Five major U.S. missiles developed and built by Martin

MARTIN

OZALID NEWSLETTER

NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAFTING



A simple sponge with new Duratrace
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New washable, scrubbable Duratrace® gives you indestructible masters you can sponge new!

If ever there was a drafting film that "is forever," Duratrace is it. New Ozalid Duratrace, when used with modern plastic pencils, can be wiped clean and thereby restored to new condition at the sweep of a sponge. Drawings, originally done in regular pencil or India ink, can also be cleaned, although a bit more care might be necessary.

Just combine this cleanability with the fact that Duratrace never yellows or ghosts, and you've got a winner that's hard to match on any count. And how about *this? Duratrace either exceeds or equals any other tracing material as far as dimensional stability is concerned!*

Want even more? Just check Duratrace on acceptability of a pencil image! Never has a drafting film equaled New Ozalid Duratrace on pencil acceptability. But the proof is really in the doing. There are intangibles that exist between a draftsman and his materials that are hard to fully describe. Only your own experience with Duratrace can completely convince you. We think that Duratrace has a certain "feel" that makes it a delight and a joy to work with. Hundreds of draftsmen agree with us. Why not try Duratrace today? Someday, someone might improve on this. Bet we'll be the ones to do it. On every count, doesn't it make sense to try Duratrace?

If you like 'em stacked for speed...

Just check our Ozalid Streamliner 200 Direct Copy Machine.

Fast? A neat 14 feet per minute. Perfect for medium-sized operations and easy feeding.

Wide? A roomy 42 inches that takes four 8½ x 11 sheets in a row, does them as fast as smaller machines do a single sheet.

And the new close-up controls of the 200 cuts operator fatigue; means anyone can learn to operate it in minutes.

New stacking system cuts work time considerably while the new cooling system means greater comfort for everyone in the office.

But these are just the basic facts of operation. How about versatility? The Streamliner 200 is specifically designed as a double-duty unit equally suitable for both engineering and general office work.

Just invest in one Streamliner 200 and get both an engineering *and* an office unit in one. You get the benefits of engineering speeds and width in your technical work *plus* a super high-efficiency unit for office copying and order invoicing.

One last plug. The Streamliner 200 costs a lot less than you would imagine. It costs less to operate and virtually nothing to maintain. Sold? Just contact your local Ozalid representative for a demonstration.

***Ozalid,** Johnson City, New York. A Division of General Aniline & Film Corp.*

Transitron

introduces

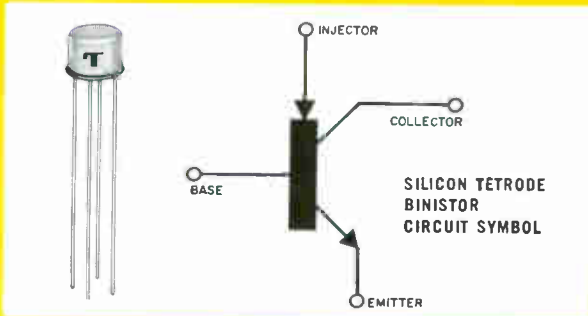
an exciting new device for simpler, more reliable, more economical switching circuitry

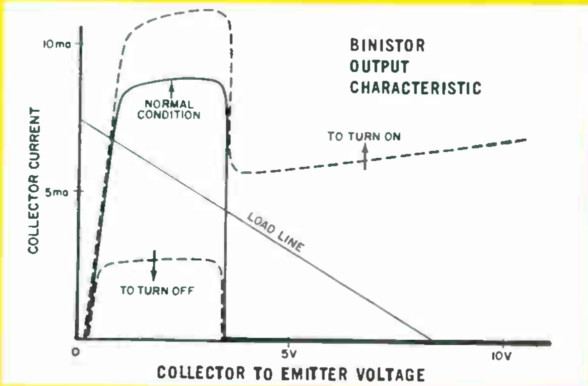
BINISTOR

(BY'-NIS-TOR)

The Silicon NPN Tetrode binistor is a new component and a new concept for the circuit designer! The key parameters of this bi-stable, negative resistance device are determined by external circuitry in contrast to existing devices. The significant reduction of peripheral circuitry results in outstanding savings in cost, space, weight and solder connections. For example, a typical flip-flop requires at least 13 components versus only 4 in an equivalent binistor stage. Very large current and voltage gains are realized in both on and off directions. Inputs and output are compatible in level with typical transistor and diode circuits. The tetrode binistor can operate from −80°C to +200°C.

To learn more of this important new development — THE BINISTOR — and how it works — write for Bulletin No. TE-1360.





CONDENSED SPECIFICATIONS TRANSITRON BINISTOR

Typical Turn-off Current Gain	50 @ 15ma Collector Current
Operating Collector Current Range	50μa to 15ma
I_j critical	0.5ma @ 5ma Collector Current
Operating Temperature Range without Temperature Compensation	−65°C to 150°C

Transitron

electronic corporation

wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO

New Mergers Emphasize Diversity

Minnesota Mining and Manufacturing and **Warner-Lambert Pharmaceutical Co.**, Morris Plains, N. J., report they are engaged in negotiations to combine the two companies. W. L. McKnight, 3M board chairman, and E. H. Bobst, Warner-Lambert chairman, emphasize that the respective boards and stockholders of the two companies will be consulted before any plans are finalized. The two men commented that the mutual interest both firms have in chemical and other products, plus marketing and distribution facilities owned by each, would be of mutual benefit to both companies.

Consolidated Electronics Industries Corp., majority owner of **Philips Electronics and Pharmaceutical Industries Corp.**, announces plans by its Philips subsidiary to acquire **Columbus Pharmacal Co.**, Columbus, O. In the same announcement, P. van den Berg, Consolidated president, said net sales of the parent company for the six-month period ended June 30, 1960, totaled $46,487,749 with consolidated net income of $2,009,811, equivalent to 72 cents per share on more than two million shares outstanding. Net sales for Philips E&P for the same period were $17,385,904. Net income is counted at $851,896, or 43 cents a share on 1,993,275 shares outstanding.

International Telephone and Telegraph Corp. reports acquisition of **L. C. Miller Co.**, Los Angeles manufacturer of vibration test equipment, for an undisclosed amount. An ITT spokesman says the acquisition represents a step in the corporation's intent to grow in the test equipment field. ITT second quarter sales and revenues for this year increased to $203,523,000 from $189,851,000 in the same period last year. Net income in this year's second quarter was $8,383,000, equal to 54 cents a share. In the equivalent period last year, this figure was $7,862,000 or 52 cents a share.

Tenney Engineering Co., Union, N. J., manufacturer of environmental test gear and refrigeration and air conditioning components, announces it has contracted to acquire the assets of **Communication Measurements Labs., Inc.**, Plainfield, N. J. CML produces electronic generators, space instruments and science and industry test gear. S. S. Schiffman, Tenney board chairman, describes the move as an expansion of his company in the electronics field, and expects to add a million dollars a year to company sales volume. The acquisition was effected through an exchange of Tenney stock. CML had been a privately held company.

Laboratory for Electronics, Inc., Boston, Mass., reports acquisition of an interest in the Florence, Italy firm, **Segnalemento Marittmo ed Aereo**. The Italian company was established in 1943 by ar-

25 MOST ACTIVE STOCKS

WEEK ENDING AUGUST 26, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Elec & Mus Ind	1470	7⅝	6½	7⅛
Avco Corp	1395	17⅛	16⅛	16¼
Gen Tel & Elec	1280	30⅛	29¼	29⅝
Univ Controls	1202	18⅛	16⅛	17½
Sperry Rand	1094	23⅜	21⅜	23⅛
Victoreen Inst	926	16½	14¼	15⅛
Ampex	918	33¾	30⅞	31⅜
Avnet Electronics	918	20¾	18⅝	19⅛
RCA	901	65⅛	62⅛	64¼
Bulova Watch	825	23¾	20⅞	23⅛
Westinghouse	581	56¼	54⅝	55⅜
Edo Corp A	557	29¼	26⅝	27⅝
Standard Kollsman	554	26¼	23⅝	23⅞
Int'l Tel & Tel	518	43⅛	41⅝	42
Audio Devices	509	23⅛	20⅜	22¼
Gen Electric	496	85¼	82⅜	84⅜
Philco Corp	395	27¼	25	25⅝
Gen Dynamics	383	46⅝	44⅜	44⅞
Reeves Sndcrft	353	8½	7⅝	7¾
Cenco Inst	328	52¼	48	52¼
National Video A	303	23⅞	21	23⅛
Siegler Corp	303	37	34	36⅝
Fairchild Camera	302	201¾	185¼	185½
Burroughs	271	37⅜	36¼	36⅝
Beckman Inst	260	99⅜	94	97

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

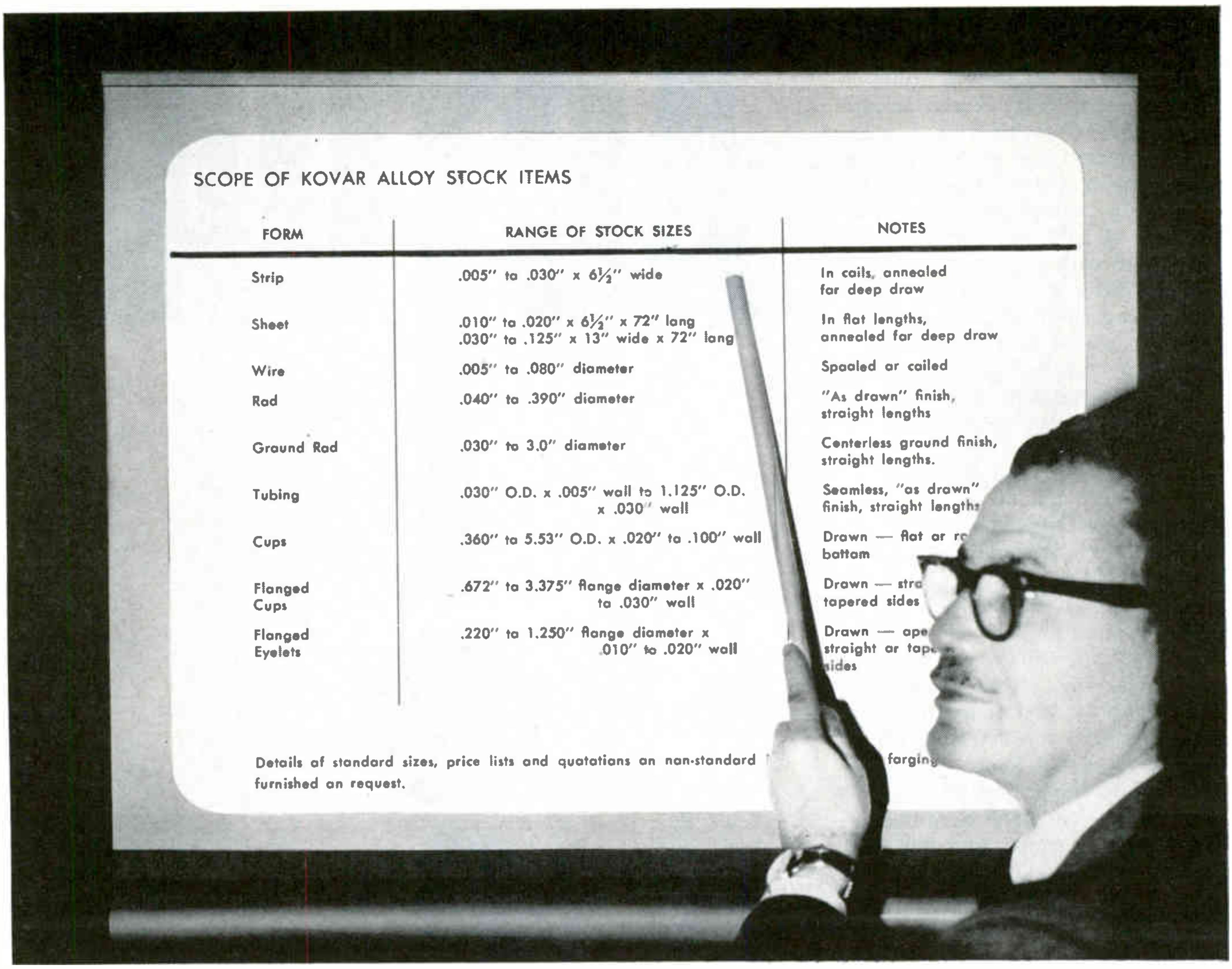
rangement of the Italian Ministry of Defense to produce marine and airborne communications gear. The company now produces navigation radar, infrared devices and signalling equipment. Company officials at LFE say the purchase is in line with a program to step up worldwide marketing and manufacturing facilities. In addition to these plans, LFE stockholders will vote Tuesday on a proposed charter amendment to raise the number of authorized shares of common stock (par value $1 per share) from 750,000 to 1,250,000.

Branson Instruments, Stamford, Conn., reports acquisition of **Colin Campbell Co., Inc.,** Danbury, Conn., through exchange of stock. Also acquired by Branson, by cash payment, is a half interest in **Radionics, Inc.,** Norristown, Pa. The Danbury firm manufactures transformers, toroids and other components for defense and industrial applications. The Norristown company makes gamma radiography thickness gages and flaw detectors.

Transitron Electronic Corp., Wakefield, Mass., and **Thermo King Corp.,** Minneapolis, have arrived at a preliminary agreement to combine. The surviving company name would be Transitron, which would issue nine shares of common stock for each 10 shares of Thermo King stock outstanding. The Minnesota firm manufactures transport temperature control equipment and had a sales volume last year in excess of $18 million.

Nova-Tech, Inc., Manhattan Beach, Calif., manufacturer of two-way aircraft radios and navigation equipment, reports a net profit of $37,413 for the fiscal year ended Mar. 31. Profits equal 14 cents a share on 270,000 shares outstanding, compared with $23,909, or 9 cents a share for the previous year.

Midwest Technical Development Corp., Minneapolis, Minn., announces it has doubled its common stock outstanding with a new issue of 561,500 shares of $1 par value stock. Existing shareholders bought some 75 percent of them.



Engineering hints from Carborundum

Check stock forms of KOVAR® Alloy to simplify production problems

KOVAR®, the original iron-nickel-cobalt alloy for making seals with several hard glasses comes in a variety of forms, sizes and parts available as *stock* items for immediate shipment.

The table above summarizes the breadth of these stocks. It does not, of course, cover the wide range of available sizes. For example, over forty sizes of seamless KOVAR alloy tubing are maintained as stock items. Complete, up-to-date data sheets giving specifications, dimensions, surface finishes, tolerances and other details sent on request.

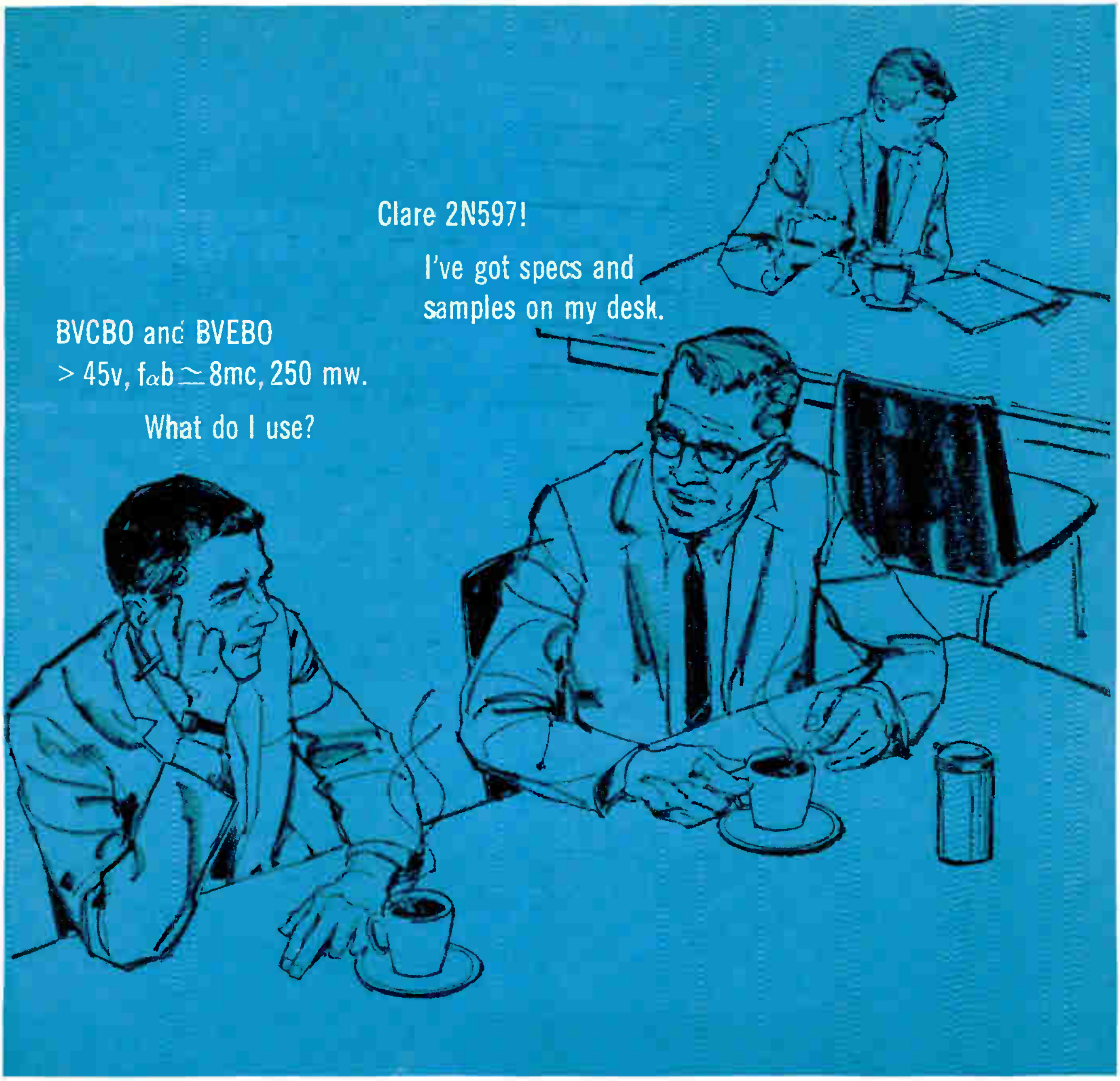
For applications that cannot be served satisfactorily by stock items, specials can be supplied. Complete technical service is offered to help in solving particular processing and application problems. Just write The Carborundum Company, Refractories Division, Dept. E-90, Latrobe Plant, Latrobe, Pa.

FIND OUT ABOUT KOVAR— WHERE IT IS USED AND WHY

Bulletin 5134 gives data on composition, properties and applications of KOVAR alloy. Supplementary technical, dimensional and price data sheets are available to you on specific request.

For permanent vacuum and pressure-tight sealing . . . count on

CARBORUNDUM®



LOW I_{CBO}, MEDIUM FREQUENCY, MEDIUM POWER—these and other characteristics make 2N597-598-599 really valuable to the circuit designer. Prompt delivery in excellent quality, at reasonable prices. Clare talents and production capabilities combined...make these "hard-to-make" PNP germanium alloy devices easy to buy. Get started now...ask for specifications today. Contact your nearest C. P. Clare and Company Sales Office or C. P. CLARE TRANSISTOR CORPORATION, 260 GLEN HEAD ROAD, GLEN HEAD, L. I., NEW YORK.

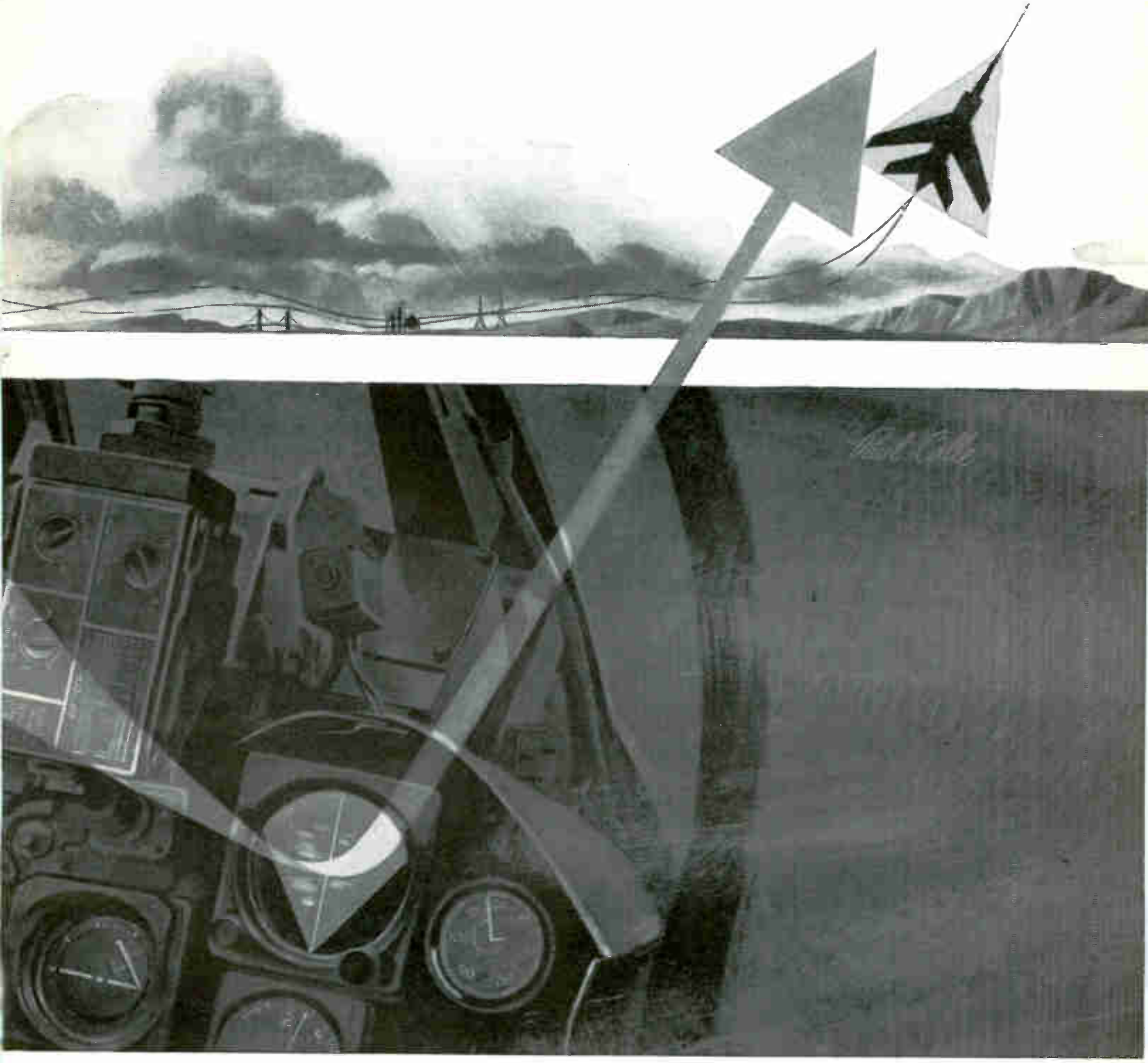
CLARE TRANSISTORS

2N597, 2N598, 2N599—*Characteristics at 25°C*

	fαb min.	fαb typ.	Max. Diss.	Min. H_{FE} $I_C = -100mA$	Max. Rated V_{CB}	Max. I_{CBO} $V_{CB} = -15Vdc$
2N597	3mc	8mc	250mw	40	−45Vdc	−5μA
2N598	6.5mc	10mc	250mw	70	−35Vdc	−5μA
2N599	12mc	18mc	250mw	100	−30Vdc	−5μA

CIRCLE 23 ON READER SERVICE CARD

CIRCLE 24 ON READER SERVICE CARD →



Growing Thermocouple Sales Foreseen

SALES OF THERMOCOUPLE DEVICES are expected to achieve major proportions in the not too distant future, according to industry market researchers who have been studying the market for bismuth telluride, a basic material used in making thermocouples.

These studies show sales of Bi_2Te_3 amounted to 6,000 lb last year; are expected to reach 20,000 lb this year and 300,000 lb in 1965 or 1970. Price of Bi_2Te_3 today is about $350 per lb, but is expected to drop to less than $30 when the 300,000-lb sales level is achieved. Annual sales of the material alone would then be worth $80 to $90 million.

Today it's estimated annual sales of thermocouple devices are between $350 and $300 million, three times the value of the material consumed.

National Aeronautics and Space Administration will spend approximately $600 million in fiscal year 1961 to speed up space exploration, Aerospace Industries Association reports. Actual appropriation is $915 million, but most of funds will be spent in future years on programs still in the research and development stage.

Electronic component vibration and calibration testing equipment sales currently amount to more than $25 million annually and show excellent growth potential, says Frederick H. Gutterman, president of ITT's Industrial Products division.

Capacitor sales will increase 59 percent over the 1959 level by 1965, reports the market research department of Corning Glass Works. Opinions on total value of capacitor sales in 1959 vary between $234 million and $267 million. First figure comes from Business and Defense Services Administration, latter from Electronic Industries Association's Fact Book. Depending on which of the two bases is used, projected 1965 sales come to $372 million or $424 million.

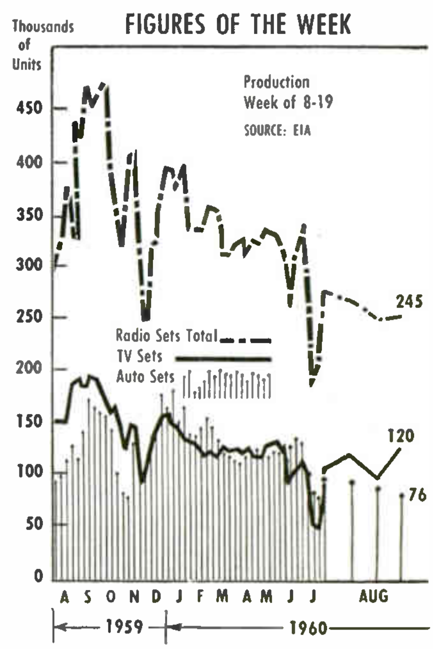
We hear that sales of vitreous enamel capacitors are booming, but sales figures are not available.

Important key to military markets is the right source of information. A guide to defense industry sources of information has been prepared by Edmund J. Richards, manager of market research for Thiokol Chemical Co. The guide lists sources both within the military establishment and industry. Copies of the guide may be obtained from Richards by writing to him at his office in Bristol, Pa.

Association directories are another important market research source tool. The new 715-page Encyclopedia of American Associations is now available. It lists 8,892 national organizations which are grouped in 18 sections.

Here is a sampling of the number of organizations listed in sections of special interest: 2,314 in trade and commerce; 163 public administration, military and legal groups; 293 scientific and technical groups; 2,693 chambers of commerce.

The encyclopedia is published by Gale Research Co., Book Tower, Detroit 26, Mich., at a price of $20.



Model PS4232M
115-325 volts DC out
at 1.5 amp maximum

Model PS4315M
0-36 volts DC out
at 15 amp maximum

NEW

TRANSISTOR - REGULATED POWER SUPPLIES

- *Five-Year Warranty*
- *Transient-Free Output*
- *Exclusive Regulator Circuit*

Two new lines of power supplies — one high and one low voltage line — are available now from POWER SOURCES, INC. Both lines feature the exclusive POWER SOURCES regulator circuit that provides full protection for the transistors *without* DC fuses. Both lines are warranted for *five full years.* Warranty includes all semi-conductor components. Cooling systems of advanced design insure long life and trouble-free operation.

For prices and complete specifications on POWER SOURCES high and low voltage solid state power supplies, write, wire or phone today.

High Voltage Supply Specifications

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

Low Voltage Supply Specifications

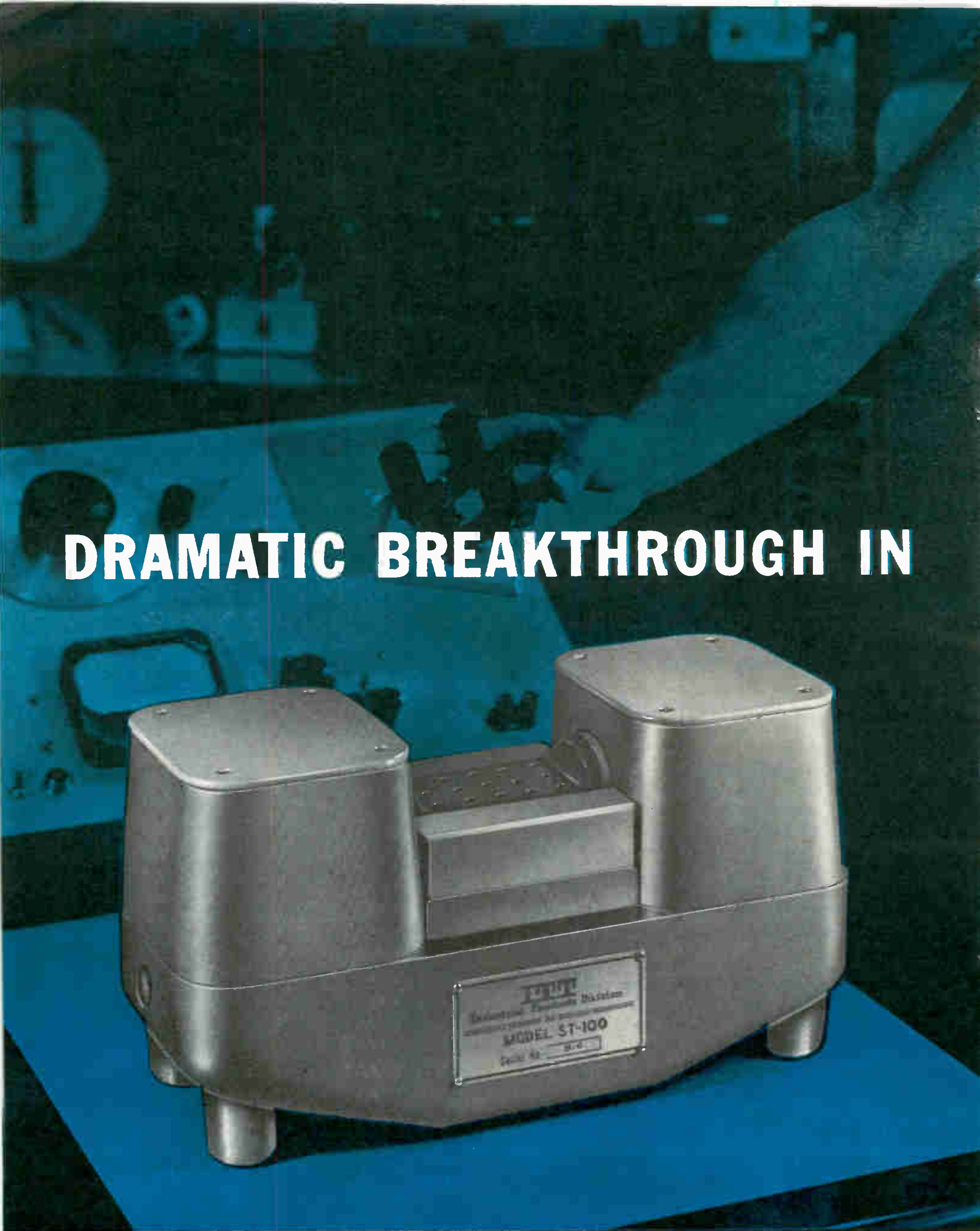
	PS4305	PS4315	PS4330
DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range (whichever is greater)		
Regulation (load)	Better than 0.05% or 5 mv, no-load to full-load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

*400 cps available on order

Specify POWER SOURCES BY

POWER SOURCES, INC. Burlington, Massachusetts

DRAMATIC BREAKTHROUGH IN



ITT Industrial Products Division

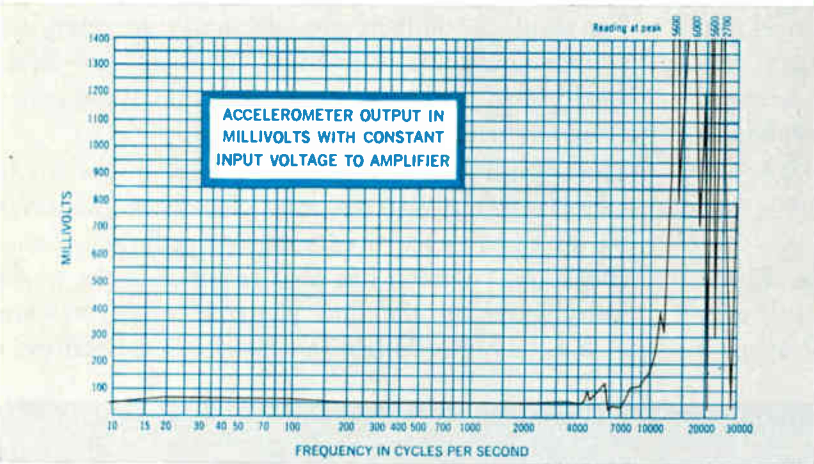
INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION

15191 BLEDSOE STREET • SAN FERNANDO, CALIFORNIA

for vibration testing the ITT Model 1201 is a completely self-contained console built around the ST-100 fifty force pound Vibration Exciter.

for vibration and shock testing the ITT Model 1205 offers all the features of the vibration console, plus shock test equipment. Both systems are particularly suited to accelerometer calibration as is seen in the graph below.

MODEL 1201



MODEL 1205

VIBRATION AND SHOCK TESTING

THE ITT MODEL ST-100 AIR-SUSPENDED VIBRATION EXCITER

- no measureable distortion to 10 KC
- first major resonance above 12 KC
- shock testing to over 3,000 g
- useful frequency range exceeds 50 KC
- 50 force-pound rated output
- handles test samples up to 5 lbs.
- simple to operate—even by unskilled personnel

The ITT Model ST-100 is the first shaker table of its type designed to be used for both vibration and shock testing. In either application, its greatly advanced design and performance features make it ideal, not only for production testing, but as an R & D tool as well. In addition, its "flat" response to 10,000 cps, with negligible distortion, provides *an exact method of accelerometer calibration.*

With the ST-100, force levels at the table are always accurately known. Thus, unnecessary test failures are eliminated and the failure of sub-standard specimens is assured. This, combined with a useful frequency range in excess of 50,000 cps and the simple, one-man operation of the ST-100 greatly expands areas of practicable testing...substantially reduces testing time and expense.

After 7 years of development, the ITT Model ST-100 Vibration Exciter is now available to reliably upgrade your vibration and shock testing results, while it cuts your testing costs.

For complete technical data and applications information, contact your ITT Instruments representative. Or write us direct for Data File E-1291-1.

Check ITT for your other test instrument requirements such as: *Bar Graph Oscilloscopes...Frequency Synthesizers...Large Screen Oscilloscopes and Accessories...Swept Frequency Generators...High Stability Oscillators...Storascope.*

Voltage Regulator and Power Supply Users:

RAYTHEON ESTABLISHES PROGRAM 2020

New Raytheon Standard Voltage Regulator Models include Component Style Units with External Capacitors for convenient upright or horizontal installation on electronic equipment chassis
Apparatus Style Units for use where a completely self-contained installation is desired • Open Style Units (without end bells) • Cord and Receptacle Plate for line applications
Regulator Selection Guide lets you choose from 2,020 different units!

Now, Raytheon provides 2,020 standard magnetic voltage regulator models for AC loads and DC power supply applications with easier selection, faster delivery, lower cost.

It's the easiest, most economical way yet devised to assure you of exactly the voltage regulator you need.

Raytheon's Regulator Selection Guide provides a simple, reliable means of selecting input and output voltages, volt-ampere rating and type of mounting. By using the Guide included in the new Raytheon voltage regulator catalog you can quickly determine size, weight and other pertinent data to aid you in selecting the unit that best suits your requirements. Your selection is made from *2,020 standard voltage regulator models*, all available for prompt delivery.

In addition to their use in countless AC applications, these new regulators provide many significant advantages for the DC power supply designer. Using the Selection Guide, he can readily select the appropriate regulator model directly on the basis of DC output voltage and power requirements.

An extremely wide range of AC voltage ratings is available from 2.3 to 1,055 volts and up to 10,000 volt amperes. Regulation on all models is ± 1% for line voltage variations of ± 15%.

Fill in the coupon and receive your copy of our VOLTAGE REGULATOR SELECTION GUIDE AND CATALOG No. 4-265.

CHECK THESE BENEFITS OF NEW RAYTHEON VOLTAGE REGULATORS

- Lower prices and prompt delivery of 2,020 standard models
- Isolated secondaries on all models
- Negligible external field
- Output stabilization to ± 1%
- No tubes or moving parts to service
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RAYTHEON

Excellence in Electronics

RAYTHEON COMPANY

Power Supply & Voltage Regulator Operations
Keeler Avenue, South Norwalk, Connecticut

Raytheon voltage regulators are also available from your local Raytheon distributor and in Canada through Raytheon Canada, Ltd., P.O. Box 152, Waterloo, Ontario

RAYTHEON COMPANY
Power Supply & Voltage Regulator Operations
Keeler Avenue, South Norwalk, Connecticut

Gentlemen:
Please send by return mail my copy of Raytheon's VOLTAGE REGULATOR SELECTION GUIDE & CATALOG.

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It's a matter of routine . . . when you have talented engineers with lots of experience . . . first quality materials . . . and advanced manufacturing techniques.

Fortunately, The Gamewell Company has all three. When customers' specifications come in, our engineers get busy. The precious metal ring, heart of a Gamewell Rotary Switch, is designed with as many segments as required. Brushes are provided which assure smooth, trouble-free action with either MAKE-BEFORE-BREAK or BREAK-BEFORE-MAKE contacts. Then a highly versatile arrangement of terminals connecting to ring segments is devised for the periphery of the switch housing. And so on, depending on requirements.

The end result is a highly versatile, reliable switching component. Cased in special plastic, it's inherently fungus resistant and stable at high temperatures. It can be used with confidence over a wide range of environmental conditions.

Gamewell is well qualified to design rotary switches for circuit sampling, programming, digital generators and various electronic data processing systems. *Your* specs will receive prompt attention.

Write to THE GAMEWELL COMPANY, 1379 Chestnut Street, Newton Upper Falls 64, Massachusetts. *A Subsidiary of E.W. Bliss Company.*

The Gamewell SG-270 Switch is available with diameters of ⅝", 1¼", 1⅝", 2", 3" and 5" in various mounting styles.

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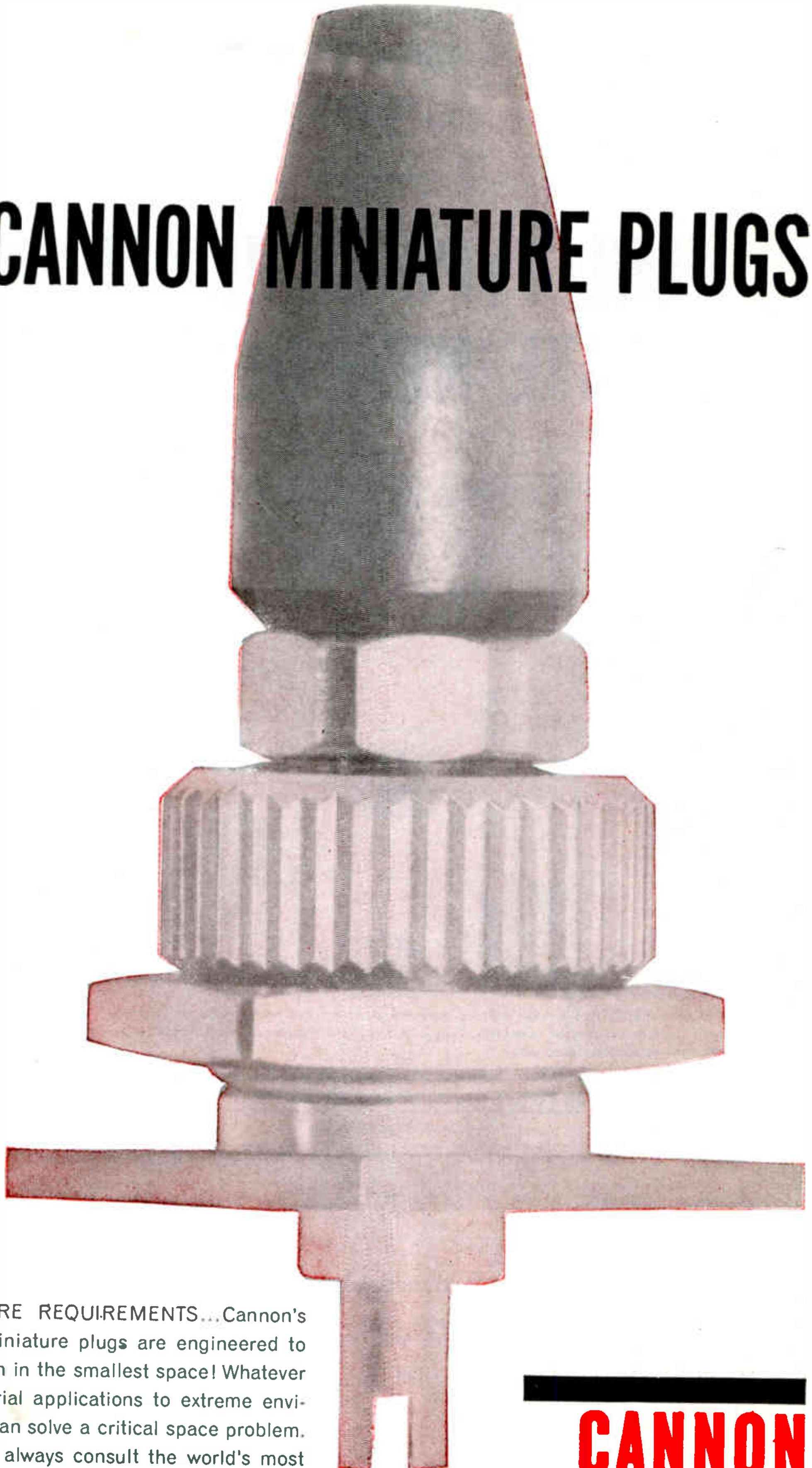
PRECISION POTENTIOMETERS

"INTEGRALS OF HIGH PERFORMANCE"

CANNON MINIATURE PLUGS



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CANNON PLUGS

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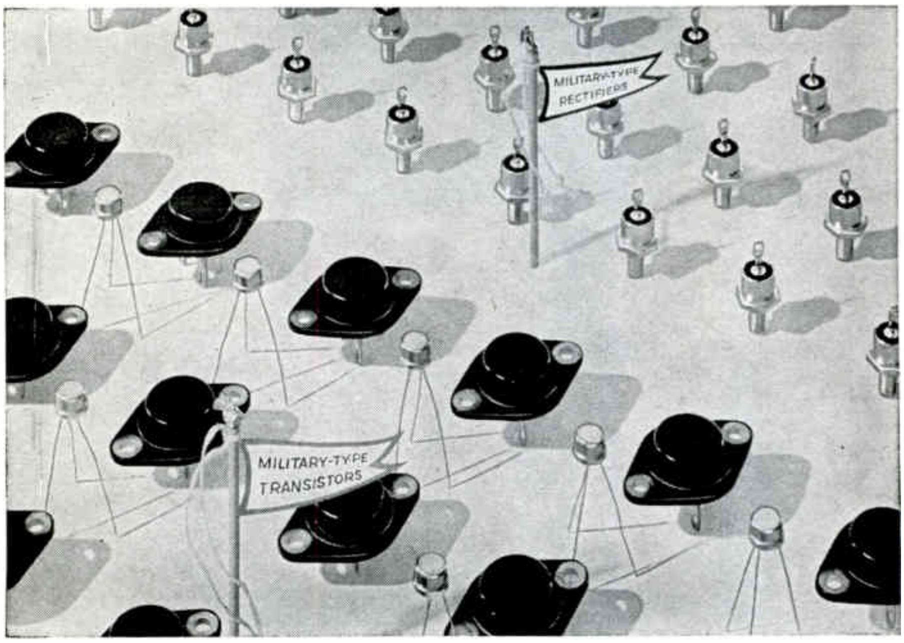
Bendix Bulletin

Up-to-the-minute news about transistors and rectifiers

MIL-TYPE SEMICONDUCTORS CREATE NEW DESIGN FREEDOM



DESIGN ENGINEERS find Bendix military-type power transistors and rectifiers a virtual "parade" of ruggedness and reliability. They also find Bendix engineers most helpful with circuitry and application problems.

MAXIMUM RATINGS AND TYPICAL OPERATION OF MILITARY POWER TRANSISTORS

TYPE NUMBER	MIL-T-19500	MAXIMUM RATINGS						TYPICAL OPERATION	
		Vce Vdc	Vcb Vdc	I_c Adc	P_c W	T_j °C	T storage °C	h_{FE} at	I_c Adc
2N297A	/36A (SigC)	−50	−60	5	35	95	−65 to +95	70	0.5
2N331	/4A	−12	−30	0.2	0.075	85	−65 to +85	50	0.001
2N1011	/67 (Sig C)	−70	−80	5	35	95	−65 to +95	55	3.0
2N1120	/68 (Sig C)	−70	−80	10	45	95	−65 to +95	35	10.0

Ideal for such applications as:
HIGH CURRENT SWITCHING • AUDIO AMPLIFICATION
SMALL MOTOR AND SERVO DRIVERS

MAXIMUM RATINGS OF MILITARY POWER RECTIFIERS

TYPE NUMBER	MIL-E-1	Io at 150°C	PRV Vdc	LIb at 25°C	Epp	LIb at 150°C
1N1614	/1240	5 Adc	200	50 μAdc	140	750 μAdc
1N1615	/1241	5 Adc	400	50 μAdc	280	750 μAdc
1N1616	/1242	5 Adc	600	50 μAdc	420	750 μAdc

Ideal for such applications as:
MAGNETIC AMPLIFIERS • DC BLOCKING CIRCUITS
POWER RECTIFICATION

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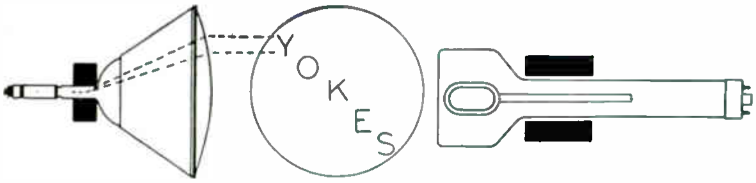

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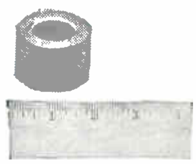

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Active vs Passive Communications

Either way equipment makers for both military and civilian use will have to

By JOHN F. MASON,
Associate Editor

WHEN THE OFTEN-DELAYED Courier active communications satellite finally joins passive communications satellite Echo I in orbit, communications experts will be able to contrast the actual performance of these protagonists of different satellite communications concepts.

Either system will bring big changes to communications equipment makers, both civilian and military. Present equipment is being converted, new gear is on the drafting board and work on new components is proceeding apace.

Least affected by the new era in communications are makers of consumer products. Whether a telephone conversation from New York to London is by undersea cable or satellite will not affect the design of the telephone instrument nor the local telephone network. Transoceanic tv relayed by satellite will still be transmitted to the home screen by the same local transmitters—though eventually, homes may be equipped with directional antennas that can receive directly from a satellite.

The big change lies in the equipment connecting local conventional communications centers. Equipment once alien to communications is now part of that industry. Devices originally developed for weapon systems and for the exploration of space will become standard production-line items for global networks. Long-range ballistic missiles and related equipment will be the construction gear for installing the satellite relay stations in space.

Specific communications equipment to be used in the new global networks depends on the kind of satellite systems ultimately selected.

Present possibilities include low-altitude passive reflectors, like NASA's 100-ft balloon, Echo I, now successfully operating; high-altitude hovering reflectors of various shapes, proposed by NASA; UASF's reflective cloud of orbiting frangible needles; low-altitude delayed repeater satellites, like the Advanced Research Projects Agency's Courier, to be launched Sept. 30; and ARPA's 24-hour equatorial, real-time, hovering satellite, Advent, scheduled for test firings in 1963.

All these systems are scheduled for testing. Staying power of each remains to be seen.

The general feeling at the recent Globcom symposium in Washington seemed to favor active rather than passive satellites. Passive reflectors require larger antennas and more powerful transmitters, thus upping cost and complexity.

"The passive satellite is a highly valuable R&D tool which will provide needed information concerning the near-earth space communications environment," James S. Shaw, Senior Vice Pres., Radiation, Inc., told ELECTRONICS. "The bandwidth or intelligence it can reflect is limited to narrow increments such as a telephone channel. Transmission of very high frequency signal components, such as required by tv, will be subject to phase distortions. This is particularly true of a reflective cloud of needles."

Shaw points out another disadvantage to putting clouds of needles into oribt. "The indiscriminate distribution of needles or chaff in the earth space can reduce present day vhf and uhf communications, including tv and radar, to a modern tower of Babel."

Rome Air Development Center, however, sees a big military advantage in passive satellites. They can't be jammed and the operating frequency can be changed on the ground.

Generally accepted as the ultimate satellite relay station is the active hovering satellite, hanging in a circular, equatorial orbit, 22,400 miles high. Three such satellites—stationary with respect to a point on the earth—could blanket the earth with high frequency radio, telegraph and tv signals.

ITT estimates such a 3-satellite system could be set up, operated for ten years—including satellite replacement every two years—for $180 million.

AT&T has proposed a commercial network of low-altitude, active repeater satellites in random orbit. AT&T's system calls for 26 ground stations, providing 600 telephone circuits between each pair of terminals, at a total cost of $115 million. Adding tv to the network would boost the cost to $170 million.

The keynote for ground equipment is sensitivity, says Walter Glomb, Radio Systems, ITT.

Ground equipment for both passive and active satellites includes high power transmitters, sensitive automatic-scan receivers, multiplex equipment and power supply. (Ground equipment for Courier, ELECTRONICS, p 38, July 22).

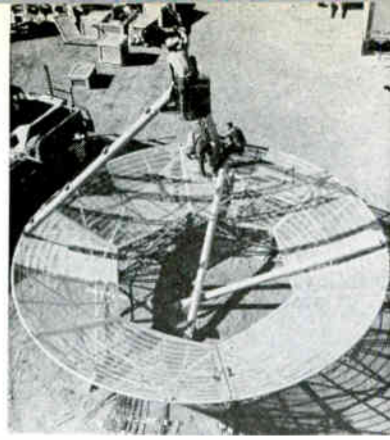
Each ground station for AT&T's active repeater satellite station will consist of two 60-ft dish transmitting antennas, two 50-ft by 50-ft horn reflector receiving antennas, two beacon tracking units for directing the antenna systems, and a standby transmitter and receiver.

Radiation's Shaw says: "The low altitude repeater will require expensive, complex programmed antennas. The high altitude active repeater will require the simplest antenna of all. It may be as small and as inexpensive as a fringe-area tv antenna installation.

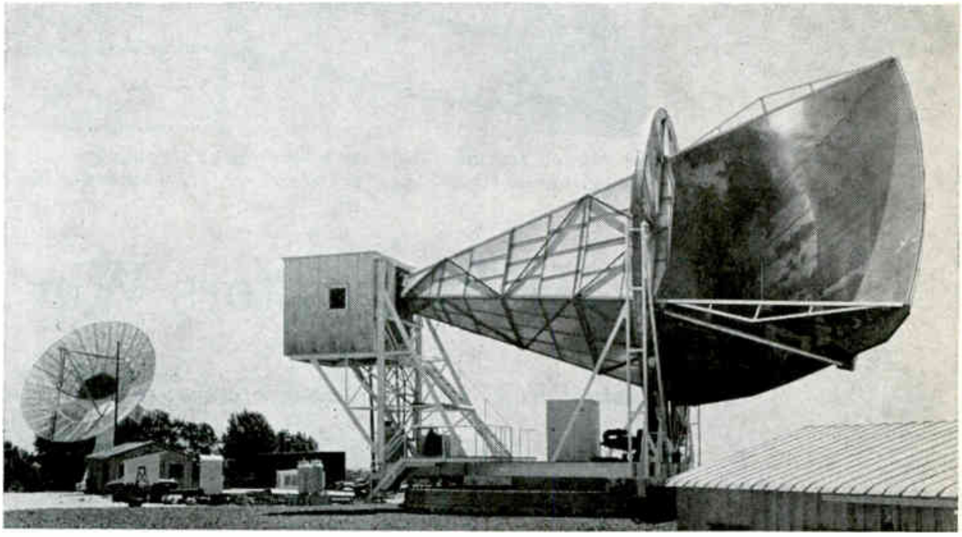
"The high altitude active satellite will require appreciable power aboard for retransmission to earth. High power, however, will result in the ability to relay contiguous bandwidth suitable for video use together with the radical re-

Satellites?

raise their sights towards outer space



Courier's 28-ft tracking and communications antenna, designed by Radiation, Inc., going up in Puerto Rico



Horn reflector antenna, developed by BTL, listens to Echo reflected signals. Left is D. H. Kennedy's 60-ft transmitter dish

duction in receiving antenna complexity and costs," Shaw says.

"Automatic tracking is probably more economical than highly sophisticated programming," Shaw says, "particularly if the higher frequencies are used. This is because the ground antenna beamwidth reduces with increasing frequency to the extent that accurate programming would be necessary. And of course atmospheric bending is 'unprogrammable'."

Passive satellites require greater transmitter power and more highly sensitive receivers than active. Collins used a 10 kw 28-ft parabolic antenna transmitting system to bounce signals off the 1,000-mi high Echo I balloon. A 40-ft dish was used for receiving. Bell Telephone Laboratories used a 50-ft horn-shaped antenna, with a ruby maser amplifier to receive reflected signals.

To bounce a signal off a passive satellite at 22,400 mi altitude, some 16,000 times as much power as that required for Echo I would be required says Glomb.

The satellite payload is a complete relay station in extremely reduced form: Microwave receivers, transmitters, antennas, data storage and power supply equipment. (For Courier's payload, see ELECTRONICS, p. 26, Sept. 2).

Main design goal for satellite payload equipment is reliability, ITT's Glomb says. Unreliable equipment requires a replacement of spares carried in the satellite and eventually the costly replacement of the satellite itself. Miniaturization —weight and size—is also a big requirement. But with more powerful boost vehicles, payload dimensions will become less critical.

Hans Ziegler, Chief Scientist, Army Signal Research and Development Laboratory, Ft. Monmouth, told ELECTRONICS he forsees no functional problems in obtaining satellite communications equipment. An important portion of a satellite system is the series-to-parallel and parallel-to-series converter for rapid transmission of telegraph and facsimile messages.

Greater reliability and longer life will be demanded of microwave generators, Ziegler said. Failure is now resolved by redundancy, "but we will need at least a life time of several years."

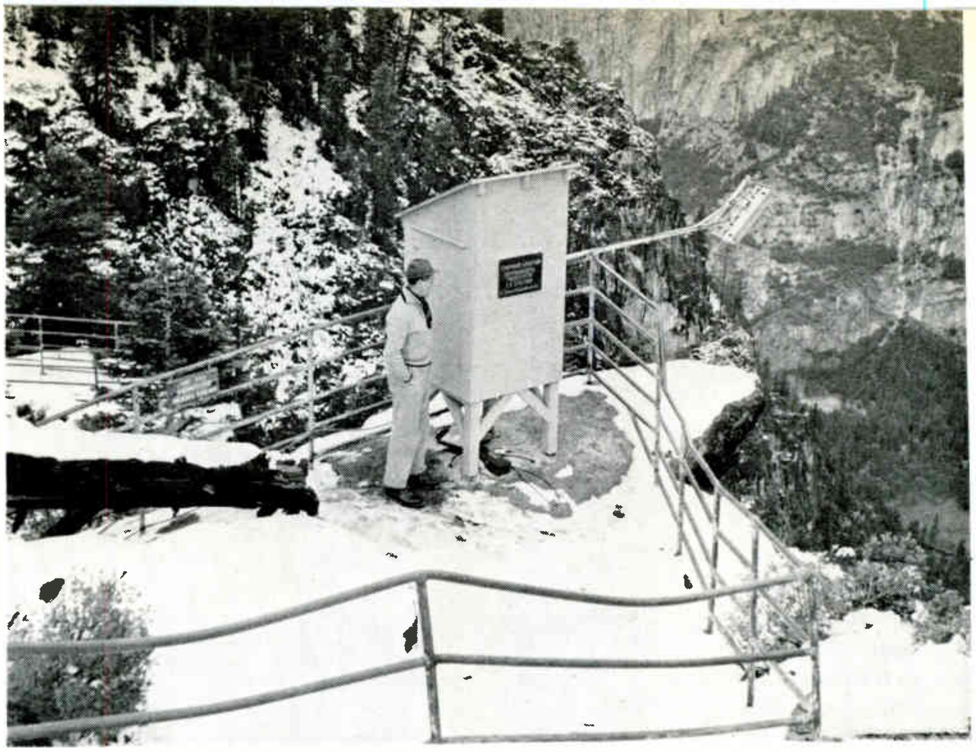
Bell Telephone Laboratories is working on a 1-watt traveling-wave tube with an expected life of 10 years or more. Using such low power is possible by using a broadband modulation method, such as wide deviation f-m and an f-m with feedback receiver.

BTL is also working on a broadband satellite receiver and transmitter made entirely out of long-life solid-state components. Success is dependent on the feasibility of using Esaki tunnel diodes or transistor harmonic generators as 6,000 Mc local oscillators.

Other areas pointed out by Louis Pollack, Space Communications, ITT, include: doppler shift corrective schemes, modulation schemes that make the best use of bandwidth versus information, and large antennas with full theoretical gain at reasonable costs.

Glomb stressed the need for work on low noise amplification: parametric diodes, parametric beam devices, traveling wave tubes, tunnel diodes, and maser devices.

NASA says new methods of information coding and processing are needed which permit compact reliable low-power drain communications links capable of handling much more complex information than at present. NASA is also interested in studying anisotropic passive reflectors and chaff. Ryan Aeronautical has proposed a number of anisotropic designs for passive satellites.



In rugged terrain like this, where an experimental Adler Electronics translator was tested, conventional reception is often impossible

VHF Translators Win Approval

Latest FCC move to block continued operation of unlicensed television boosters is authorization of vhf repeaters to relay on changed frequency

AUTHORIZATION of vhf television translators by Federal Communications Commission becomes effective this week.

The ruling will largely effect mountainous regions in the far west and certain areas of the middle Atlantic states. In many locations, audiences cut off from regular tv stations have been relying exclusively on unlicensed boosters or uhf translators to relay programs into their areas.

FCC has no objection to the operation of properly licensed uhf translators which arrange with local stations to rebroadcast programs on uhf channels. Booster operators, however, who take the station signal off the air and relay it on the same or on some adjacent frequency have long been a problem to the FCC.

For slightly more than two years, booster operators have been urged to exchange their equipment for uhf translator gear. Although some operators complied, others were reluctant to do so because they had viewing audiences equipped with vhf receivers only. Often the translator had power requirements different from the booster.

In an attempt to improve the situation, FCC set up new regulations this July authorizing low-power translator stations in the vhf band providing they meet technical requirements and protect regular tv broadcast stations from interference. Maximum power for the vhf translators is limited to one watt.

Although the effective date of the new ruling is Sept. 6, boosters constructed prior to July 7, 1960 will have until Oct. 31 to identify themselves to the Commission, and until Oct. 31, 1961 to make the changeover.

From the office of Commissioner R. E. Lee, ELECTRONICS learns that no additional FCC field men will be used to enforce the changeover. "We don't anticipate any great resistance to the new vhf rules," commented one spokesman. "A good number of booster groups have been seeking just the legalization that these new rules provide. There are even areas where people have chosen to do without television rather than establish an unlicensed booster operation. We expect full cooperation from such groups."

Informal conversations with Commission personnel reveal, however, that the uhf translator operation is dearer to the official heart than the vhf set-up. Some commissioners are fearful that spectrum crowding in the vhf band will develop if any great number of translators go to vhf frequencies. The largely unused uhf television band, in the official opinion, is a preferred spectrum for translator operation.

Predictions by ELECTRONICS in December 1957 that translators would increase have proven valid. At that time there were about 135 translators in use. Present estimates by Adler Electronics, a major supplier of translator equipment, are about 350.

Although no exact count of booster stations is possible since they are not licensed, their number is guessed to be about 700. The majority of these are vhf installations that will be able to modify their equipment without too much difficulty to meet the new FCC standards of frequency and power. The new rules dispense with the requirement for a licensed operator and require only on-off control from an accessible location and automatic cut-off protection for both vhf and uhf.

While uhf translators must meet prescribed mileage separation from regular tv stations, no equivalent restrictions are placed on vhf translators. The new rules require that the translator be able to transmit identifying call letters.

As in the case of uhf translators, the vhf installations cannot retransmit signals on the same channel as the one on which they receive the station signal. In addition, permission of the station must also be obtained. Power, according to the Commission, will be strictly limited to one watt for the vhf operators. Those who wish to use more power will be allowed to apply for uhf translator operation where the upper limit is 100 watts.

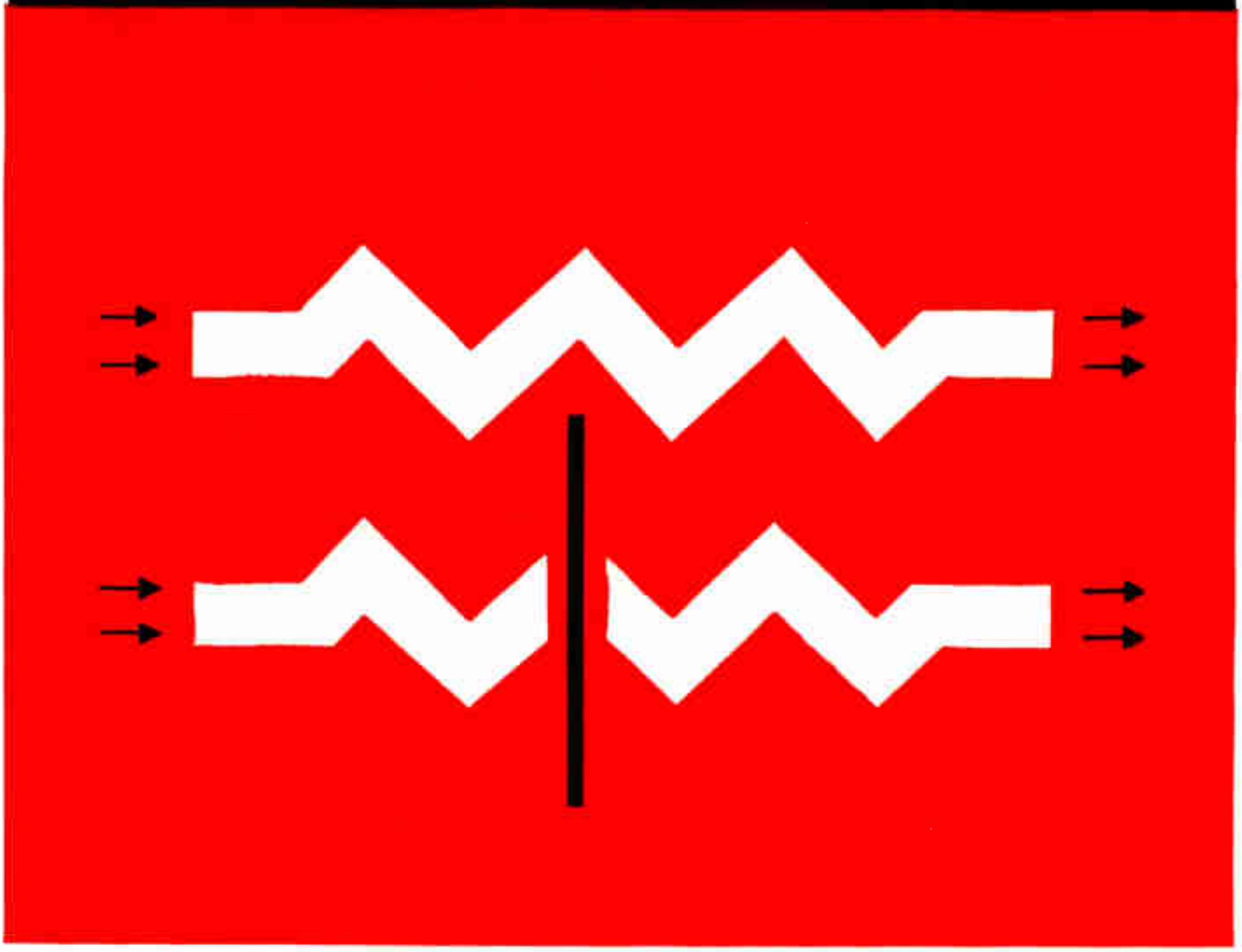
Groups purchasing new translators in preference to modifying existing equipment will be spending about $1,500 for the gear exclusive of buildings and antennas. Equipment manufacturers, who have up to now been producing equipment primarily for the uhf band, say they will have vhf equipment available.

Argentine Output Sales Dip in '59

OUTPUT AND SALE of consumer electronic equipment in Argentina dropped in 1959, the Electronics Division of Business & Defense Services Administration reports. Production of radio receivers declined from 350,000 units in 1958 to 250,000 last year; tv receiver production dropped from 100,000 units to 80,000.

Higher retail prices resulting from increased production costs are blamed for the dropoff, with the price of imported components sharing part of the blame. Despite high duties, 1,381 tv sets were imported by Argentines from the U. S. during the year, and 648 more from Italy. No Argentine consumer electronic products were exported last year.

In POWER WIRE WOUND RESISTORS : **if it's news, expect it first from IRC**



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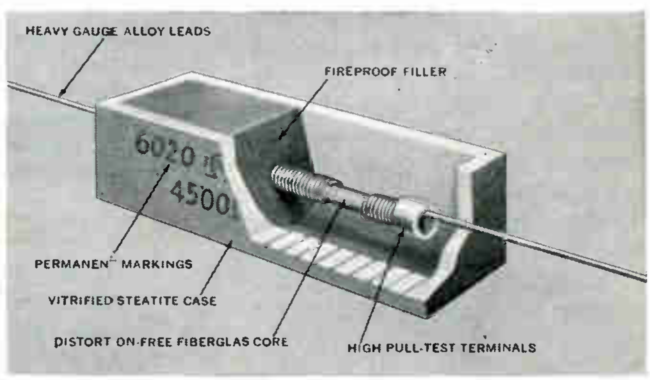
IRC PW Resistors are available with special resistance windings, designed to act as a standard resistor at normal operating wattages and fuse at some specific overload condition. Thus they provide an ideal solution—resistor and fuse in one unit—a great advantage in circuits which tend to short or where overloading of a component creates a fire hazard.

These double-duty resistors come in six sizes—3, 5, 7, 10, 15 and 20 watts. And, no derating is required even at high ranges.

For additional information on IRC Power Wire Wound Resistors, write for Bulletin P-2, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.



IRC

Leading supplier to manufacturers of electronic equipment

No Magnetic Field Around Moon?

Russia's Leonid Sedov, president of the International Astronautical Federation and the man behind the Sputnik, exchanges smiles with Dr. and Mrs. Wernher von Braun in Stockholm

STOCKHOLM—Russian scientists now reveal their Space Probe II, while circling the moon, established there were no radiation belts—which would prove that the moon has no magnetic field.

This disclosure came during the XIth Astronautical Congress held here recently, McGraw-Hill World News reports.

But the Reds said little else.

Only a few summaries of papers presented by the Soviet delegates were available. They mainly concerned probing of meteoric matter, radiation belts and similar investigations.

The United States, meanwhile, walked off with "proof-in-hand" honors by giving more tangible evidence of its space achievements. On display was a full-size replica of the Discoverer XIII capsule, first ever recovered from space.

One highlight of the sessions was Wernher von Braun's lecture on the U. S. space program and particularly the Saturn project. Von Braun said that the possible, future Saturn C2—to follow upon the C1 operational by 1964—would not only be capable of placing small manned space stations, cargo ships and propellant tankers into orbit, but could also place a shorter version of the space station into a circumlunar trajectory.

Such a manned circumlunar spaceship would have the same escape capsule as the space station, he said. Preliminary estimates indicate the manned spaceship would weigh about 15,000 lb (including 6,000 lb for the capsule with its instruments and control systems.)

This capsule may well be fitted with lifting devices for use during the reentry maneuver prior to the time the parachutes are deployed.

In addition to the 6,000-lb reentry capsule, 4,000 lb would be devoted to the "caboose", the section where the scientific payload, cargo, etc., would be carried.

Finally, some 5,000 lb would have to be allotted to a combination abort and midcourse control (and possibly reentry deceleration) propulsion system.

Ernst Stuhlinger, from Redstone Arsenal in Huntsville, another of the invited lecturers at the propulsion session made a comparison between electrical systems and conventional chemical ones, stressing that the former are still in their infancy but will certainly become of special interest.

He distinguished between three electrical systems: electrothermal, electrostatic and electrodynamic and said that the electrical methods of propulsion would be particularly important by transfer between different orbits and trajectories.

On the other hand, he said, chemical propulsion systems were to be preferred when defying gravity and propelling a vehicle from the surface of a planet out into space.

A team from the Lockheed Aircraft Corp. presented a paper on studies into a nuclearthermionic-ionic propulsion system.

A combination of a rather small reactor with a mass of 42 kg, a vacuum-diodes thermionic power generator and an ion motor with germanium power transistors, would result in a total mass of the propulsion system without propellant weighing only 80 kg.

Interplanetary trajectory studies indicate, the authors said, that with 50 kg of propellant the system could transport 50 kg of payload to Jupiter in two years, starting from an orbit in the vicinity of the Earth.

A subject of less dramatic scope was that treated at the Small Sounding Rockets symposium. Six papers were read by Americans, but rocket research from other countries, including Belgium, India, Italy, Japan and the Netherlands, was also presented.

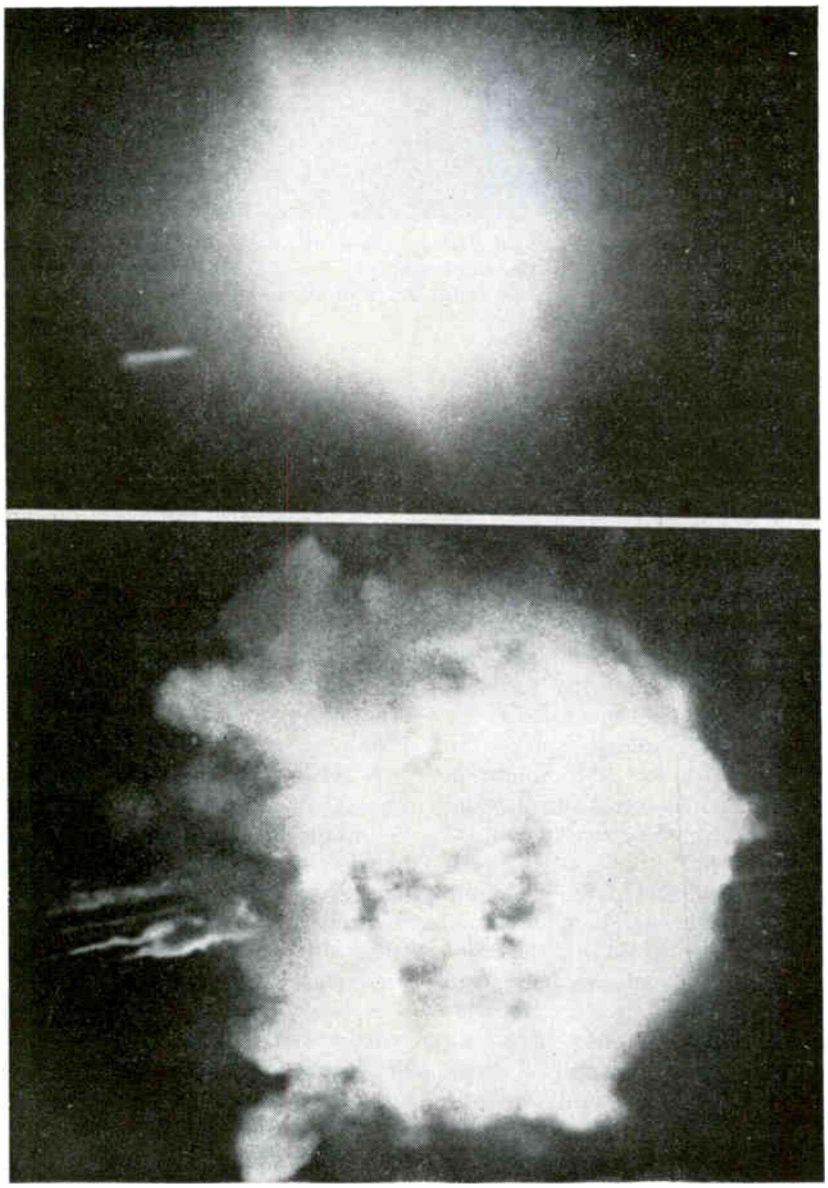
A common trend in most countries was the effort to cut the cost of sounding rockets and make them smaller although more efficient and capable of carrying a fairly large payload. India reported having tabulated comparative studies to show the efficiency of the smaller ones.

Scientist J. Gustavson of the Grand Central Rocket Co., Calif., submitted an analysis of the effects of important propulsion system parameters on performance. The calculations were made on relatively low-cost electronic computers.

Various University of Michigan scientists described experiments with aerodynamically stabilized sounding rockets.

A proposed autopilot system with only one moving part and weighing approximately 5-10 lb was said to be capable of controlling attitude of a 500-1,000-lb rocket during and after powered flight in a vacuum.

New Ground Radar Upgrades Hercules



Nike-Hercules target missile (light streak left of explosion in top photo) moves into detonated attacking missile (another Hercules) and is destroyed

NIKE-HERCULES GAINED a stronger foothold in the nation's weapons arsenal recently when it successfully killed another ground-to-air Nike-Hercules in flight.

The Hercules target missile was fired from the northern end of the 100-mi White Sands Missile Range, New Mex., and the defending missile from the southern. The kill occurred some 32 miles from the southern end, 11 miles high. Rate of closure of the missiles was in excess of Mach 7.

Hercules' performance adds a new dimension to the weapon's capability; defense against air-to-ground missiles like Hound Dog. Earlier this summer, Hercules proved its ability to destroy field artillery ballistic missiles, when it knocked down a Corporal in ballistic flight.

The Hercules missile was originally designed to protect the U. S. against enemy bombers and is now deployed around major cities.

Responsible for reenforcing the Nike-Hercules' position as a continuing weapon system, and thus continuing business for its producers and suppliers, is improved ground equipment for the missile.

Used in the White Sands test was the prototype of a high-power, long-range acquisition radar, called Hipar, that more than triples the defensive capabilities of the present Hercules system. The new radar was developed by the General Electric Heavy Military Electronics Dept. under a subcontract with the Bell Telephone Laboratories. Western Electric is prime contractor for the Hercules system, with Douglas supplying the missiles.

In addition to longer range, the high gain, narrow beam antenna used by Hipar provides high angle coverage. The extremely precise azimuth data obtained by Hipar permits the narrow beam target tracking radars built by Western Electric to lock on to high performance targets. Moving target indicator and receiver circuits are used with Hipar to counter jamming. A new multimegawatt klystron tube is used to produce the high power, pulsed r-f energy transmitted by Hipar.

GE has just received a new $14,455,000 contract for production of Hipar.

Oil Company Brings Stereo to Mid-East

REGULARLY SCHEDULED STEREOCASTS now reach Arab listeners for the first time. Arabian American Oil Co. has started regular programs over the company's a-m and f-m network, as an employee service.

Stereocasts are made on one f-m and three a-m stations. A-M broadcasts are dual-frequency; the f-m uses one r-f channel at 99.7 Mc with the two sound channels multiplexed. Network uses Erco 100-w transmitters for a-m, with special modulation transformer for full a-m; and Gates 200-w for f-m.

Aramco is also planning electronic remote control of unattended gas-oil separator plants in Saudi oil fields. Under study are turbine metering of the pipeline flow with electronic counting and integration, and a process analyzer at the Ras Tanura refinery.

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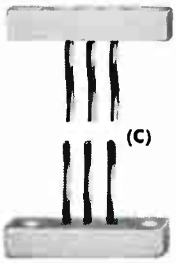

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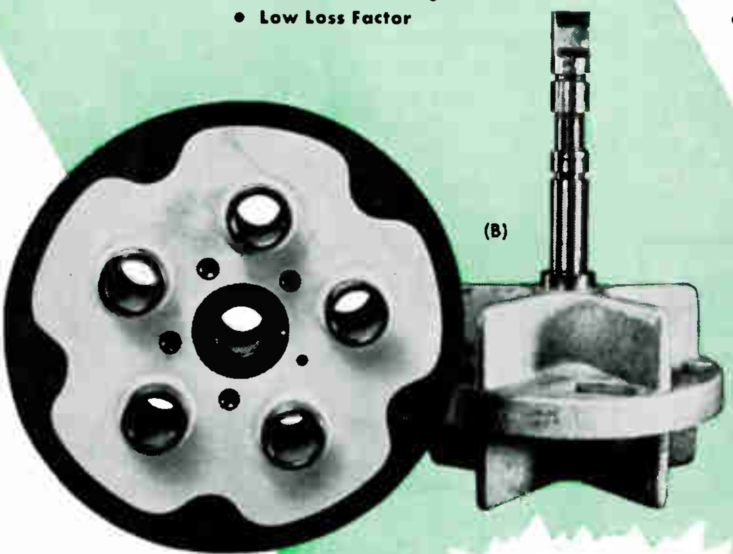

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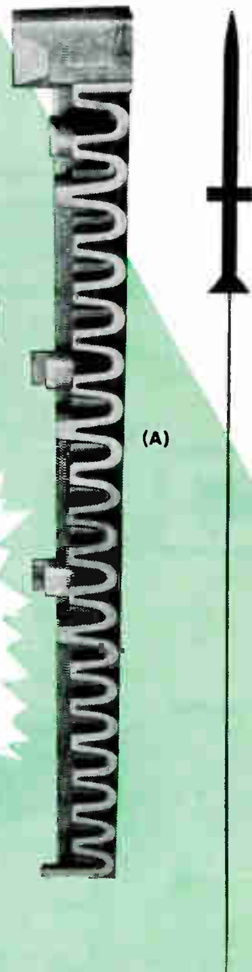

(A)

JUST ANNOUNCED

Haveg Industries has achieved a significant milestone in its Research and Development Laboratory with a new Havelex molding.

Five metal inserts (three terminals, a mounting post, and the outer ring) are hermetically sealed with the Havelex body. Engineers may now consider hitherto unexplored design concepts wherein intricate part designs and close tolerances offered by Havelex are enhanced with hermetically sealed metal inserts.

Recent noteworthy applications of Havelex pictured here are:

(A) Ionizer Components — air filter unit for home heating system.

(B) Disconnect Assembly nearly 5 inches in diameter with massive insets — Havelex provides the electrical insulating "heart" of this disconnect device used in "on the ground" service to military jet aircraft. If for any reason the power disconnection is made while the aircraft is drawing its electrical power from the airport installation, an instantaneous disconnection is insured by this device; hence, protection against personnel injury or equipment damage.

(C) Transistor Test Socket — three stainless steel tubes (.010" wall) integrally molded into Havelex body. A key component in reliability testing of transistors in high ambient temperatures.

Havelex is composed of special glass reinforced with mica. Grey to white in color, this dense stone-like material provides an ideal insulator for wide ranges of ambient operating conditions and electrical stresses. The unusual combination of properties in Havelex plus Haveg's ability to provide precision molded tolerances and intricate shapes permit unlimited design possibilities. Complex metal inserts can be permanently molded in position, facilitating component assembly and assuring end product reliability.

Our forty years experience in custom molding Havelex to stringent specifications, include an extremely wide range of applications . . . such as Lightning Arrestors, Circuit Breakers, Potentiometers, Vacuum Tubes, Switchgear, Terminal Strips, Arc Barriers, Actuators, Armatures, and Transistor Test Sockets.

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CIRCLE 47 ON READER SERVICE CARD

Photo Engineers Demand More Speed

Modern instrumentation requires nanosecond exposure times. Devices at meeting include high speed shutters

HIGHLIGHTING the Society of Photographic Instrumentation Engineers Convention at Los Angeles last month were demands for faster photographic techniques, more sensitive instrumentation, and reliable reconnaissance systems for outer space and underwater.

Mechanical shutters have maximum speed limits imposed by inertia of moving parts and time delays in actuators and linkages. Two electrooptical shutters, of different design, seem to have the best potential for ultrahigh speed operation, extending to nanosecond exposure times.

The Kerr cell is a hermetically sealed glass container filled with high-purity nitrobenzine in which two planar electrodes are immersed. The cell is placed between two polarizers, oriented to stop transmission of light. When about 35 Kv is applied across the cell electrodes, the direction of polarization of light from the first polarizer is changed, permitting it to pass through the second polarizer. The duration of transmission depends on the pulse duration. A Kerr cell developed by Electro-Optical Instruments Inc., Pasadena, Calif., has a 5 nanosec exposure time.

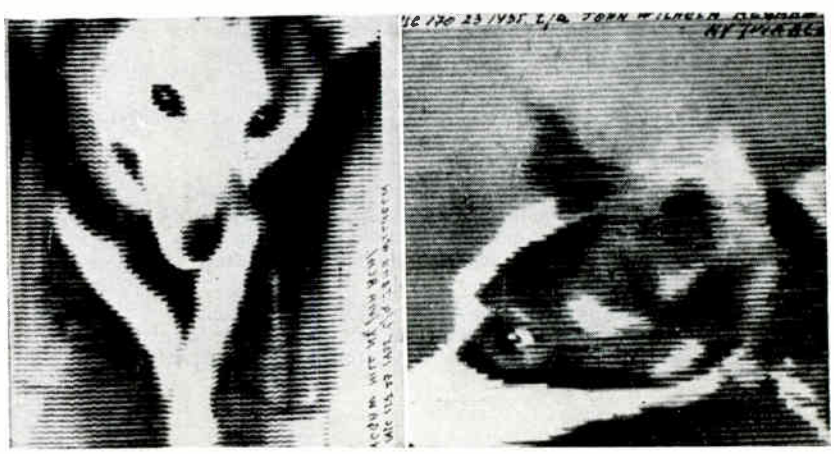
A second device, the stressed plate shutter, is a mechanical analog of the Kerr cell. A glass plate is mounted between stacks of piezoelectric drivers. Voltage applied to the drivers causes them to expand or contract, stressing the glass plate, and altering the direction of polarization of light passing through the plate.

The shutter is mounted between two polarizers oriented to stop transmission. Although the speed of the stressed plate shutter is on the order of 100 microseconds, the voltage requirement is much lower than that of a Kerr cell. A shutter developed by Electro-Optical Systems, Inc., Pasadena, Calif., requires a 3,000 volt signal.

L. Frederick of Lowell Observatory reported that 70 percent of all astronomical investigations depend upon photoinstrumentation. He said the Carnegie Committee recommends that low-cost instrumentation be developed and made available to small astronomical laboratories that do not possess elaborate telescopes.

This recommendation highlights the importance of photo image intensifiers that have quantum efficiencies of 25 percent versus photographic film plate efficiencies of 0.1 percent. An image intensifier

Pair of Pooches are Space Pioneers



Photograph of tv monitor receiving transmission from the recently recovered Soviet orbiting menagerie spaceship could increase the speed of a small research telescope up to 16 fold.

Dr. Frederick and his associates have constructed an inexpensive phosphor-window cathode - type image intensifier using single and multiple electrostatic stages. Resolution of the tube operating at 12 to 25 Kv is 56 lines per mm visually or 36 lines per mm on Kodak Plus-X film.

A new Ansco automatic recording microdensiometer was suggested for astronomical photoinstrumentation. The device can measure the size of a star image to determine the star's brightness. Other applications include determination of the width of cathode-ray tube scan lines as a function of brightness, and measurement of transient phenomena displayed on an oscilliscope.

Future outer space and underwater studies will depend heavily on electronic photoinstrumentation. The cancellation of U-2 reconnaissance flights make the development of sensitive satellite reconnaissance systems a necessity.

Over 1,000 of the 6,000 photographs taken by the twin tv cameras of the Tiros satellite were described as good, and could be used for reconnaissance.

Recent photographs of the ocean bottom taken at 19,000 feet below sea level appeared similar to photographs taken by Tiros. Undersea reconnaissance systems using high intensity light sources and tv cameras have been suggested for use with bathyscaphs for future hydrospace underwater research.

Geomagnetic Log to Provide True Speed

GEOMAGNETIC LOG will be developed by Edo Corp., College Point, L. I., to record the speed of vehicles over the ground or, in the case of ships, over the bottom. Navy is funding the development contract.

Although details are classified, it is known that the log will electronically determine true velocity in relation to the earth's surface and magnetic field. Edo's device will provide the ship or aircraft navigator with instantaneous indication of actual true speed, unaffected by wind or water currents.

More Grants for Universities

FEDERAL GOVERNMENT continues to finance the biggest share of research and development costs carried on by engineering schools as academic year 1960-61 gets under way, according to latest reports on research grants.

The government gave U. S. engineering schools $48.6 million of the total $71 million they spent for sponsored research and development during 1958, says the National Science Foundation.

A comprehensive Foundation survey of 129 schools revealed that industrial sources contributed $10.3 million to the total. Schools spent $10.5 million of their own funds on R&D, plus an additional $3.5 million to cover indirect costs of outside grants and contracts.

UNIVERSITY OF MICHIGAN researchers are measuring the star-like twinkle caused by air turbulence effect on a powerful light beamed across Lake Michigan, to help study evaporation losses from the Great Lakes.

Variations in wind and water temperatures cause variations in intensity of the light as it crosses a mile and a half of lake to reach the lens of telescope located on a point of land below the city. A photocell at the rear of the scope translates these fluctuations into graphic form.

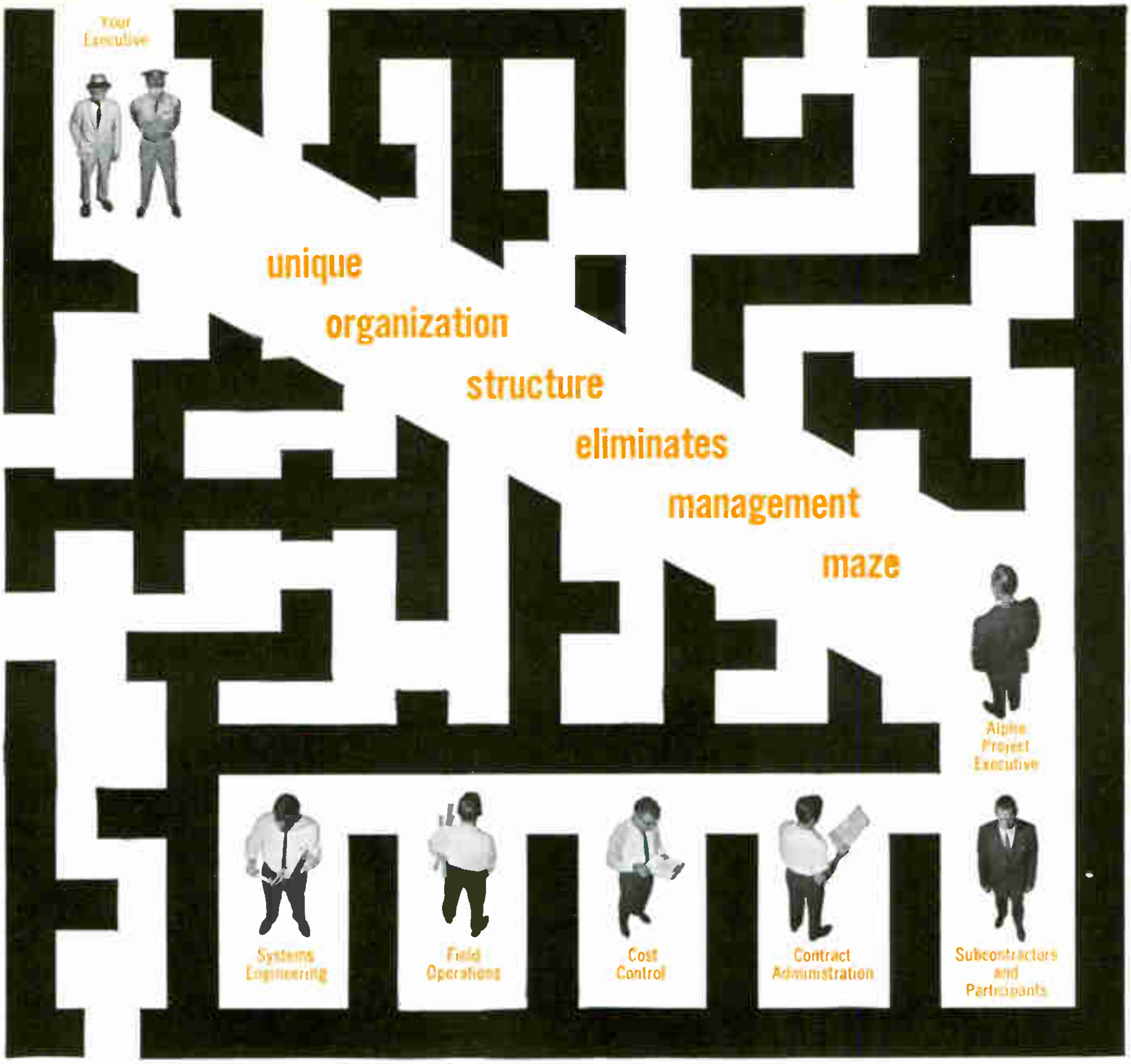
Readings from instruments stationed in the light's path will be correlated with the graphic fluctuations in this new data-gathering technique, usable almost anywhere over water. Mathematical formulas considering molecular transfer between air and water will help evaluate findings.

U. S. AIR FORCE has awarded 39 contracts and 19 grants totaling $3,958,821 since June 1 for basic scientific research to universities, nonprofit institutions and industrial laboratories in the United States and South America, according to Col. A. P. Gagge, commander of Air Force Office of Scientific Research. AFOSR has also negotiated contracts for other defense department agencies—three with **University of California** at Berkeley for a total of $924,113; one with **California Institute of Technology** for $395,193 and one with **University of Michigan** for $200,000.

NATIONAL SCIENCE FOUNDATION has awarded grants totaling $2,153,710 to 54 colleges and universities to help improve their graduate research laboratories, according to Alan T. Waterman, director of NSF. Grants have been made to alleviate obsolescence and inadequacy and to help schools keep pace with rapid growth of graduate science and engineering enrollments and the complexities of modern science, Waterman said. Institutions must provide at least 50 percent of funds needed to construct, convert or modernize laboratory facilities, according to terms of the grants.

POLYTECHNIC INSTITUTE OF BROOKLYN has received a $700,000 grant from the Ford Foundation to establish a new honors program in science and engineering. Exceptional students may receive their doctorates in six years of full time study under the new program, compared to eight to ten or more years it presently takes for science and engineering students to receive doctorates. Approximately six percent of the Institute's September freshman class will be enrolled in the new program, according to Polytechnic president Ernst Weber.

UNIVERSITY OF COLORADO faculty members Frank S. Barnes, Donald G. Burkhard and Masataha Mizushima have received a $40,795 research grant from the U. S. Army Signal Corps to investigate the feasibility of developing a new frequency standard in the regions from 100 to 400 Gc. Using electrical resonance in molecules, the proposed instrument could be as much as ten times more accurate than present atomic frequency standards.



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CIRCLE 51 ON READER SERVICE CARD

MEETINGS AHEAD

Sept. 9-10: Communications: Tomorrow's Techniques—A Survey, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 13-14: Bionics Symposium, Applying Biological Principles to Engr. Design, ARDC, Wright Air Devel. Div., Dayton Biltmore Hotel, Dayton, O.

Sept. 14-15: Industrial Electronic Test Equipment Symposium, Armour Research Foundation, Chicago.

Sept. 15-16: Engineering Management Conf., IRE, Morrison Hotel, Chicago.

Sept. 15-17: Upper Midwest Electronic Conf., Twin Cities Elec. Wholesalers, Civic Auditorium, Minneapolis.

Sept. 19-21: Data Transmission, International Symp., PGCS of IRE and Sectie Voor Tele. of Koninklijk Ins. van Ingonieurs, Delft, Neth. Contact B. B. Barrow, Benelux Section, IRE, Postbus 174, Den Haag, Nederland.

Sept. 19-22: Space Electronics and Telemetry, Nat. Symposium, Shoreham Hotel, Washington, D. C.

Sept. 21-22: Industrial Electronics, Annual, PGIE of IRE, AIEE, Sheraton-Cleveland Hotel, Cleveland.

Sept. 23-24: Broadcasting Symposium, PGB of IRE, Willard Hotel, Washington, D. C.

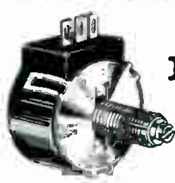
Sept. 23-25: Hi-Fi, Home Entertainment Show, Palmer House, Chicago.

Sept. 26-30: Instrument-Automation Conf. and Exhibit of 1960, ISA Annual Meeting, Coliseum, New York City.

Sept. 27-30: Space Power Systems Conference, ARS, Miramar Hotel, Santa Monica, Calif.

Sept. 27-Oct. 1: Electrostatic Forces and Their Applications, Laboratoire D'Electrostatique et Physique du Metal, Institut Fourier, Place du Doyen-Gosse, Grenoble, France.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

Waters new PT ¾  meets MIL-R-19A and MIL-R-19/1A at half the cost!"

At less than half the cost of the only other comparable unit, Waters introduces a new ¾" plastic case pot completely meeting MIL-R-19A and MIL-R-19/1A specifications! A true military pot at a commercial pot price! "O" ring shaft seal and complete internal sealing virtually eliminate humidity, salt spray and similar environmental problems. Provides the same protection as encapsulation in less space. Resistance range (ohms), ±5%, 1 to 20,000. Electrical and functional rotation, 355° without stops; 300° with stops. Dissipates 1.5W at 40°C. Torque, .3 to 6 oz./in. Weight, .02 lbs. Available with split or plain bushings, ¼" or ⅜" in diameter. Write for Bulletin PT 760.

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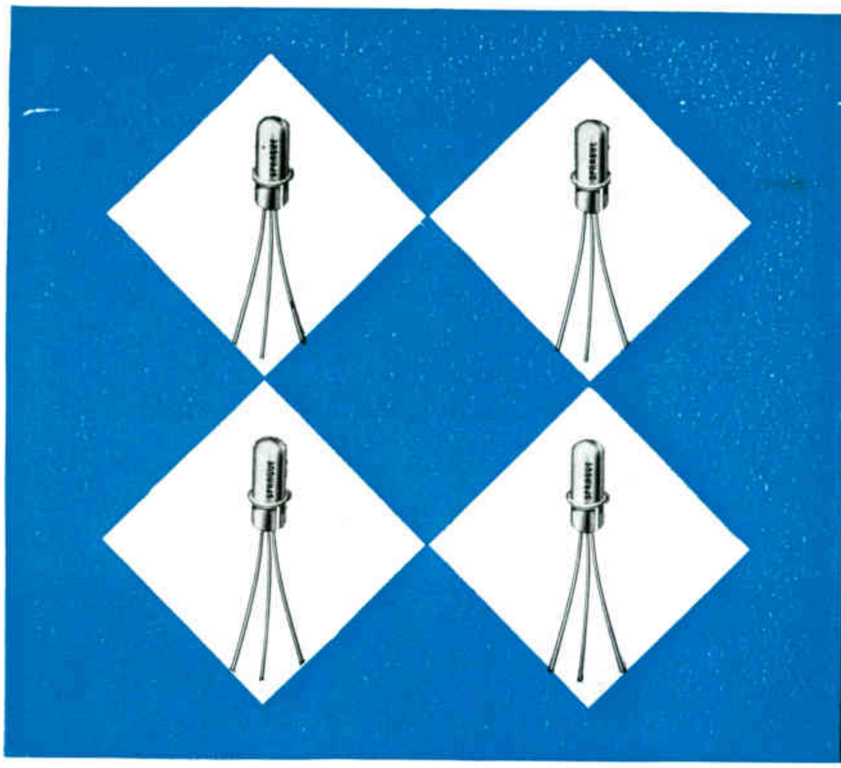

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2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
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**Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.*

For more than a quarter century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Out of this priceless experience are emerging startling new ideas and hard-hitting, fast-moving techniques to keep our country one jump ahead in electronic warfare . . .

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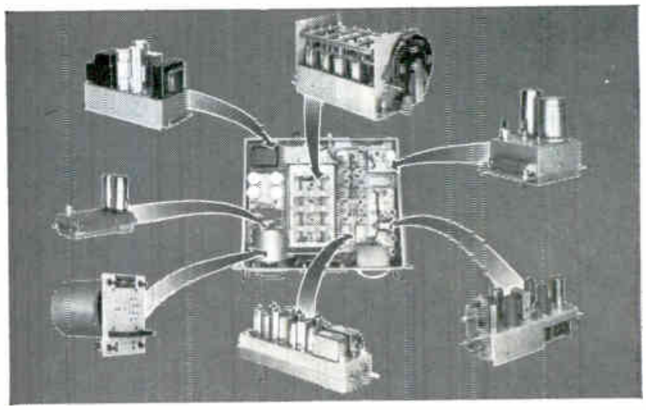
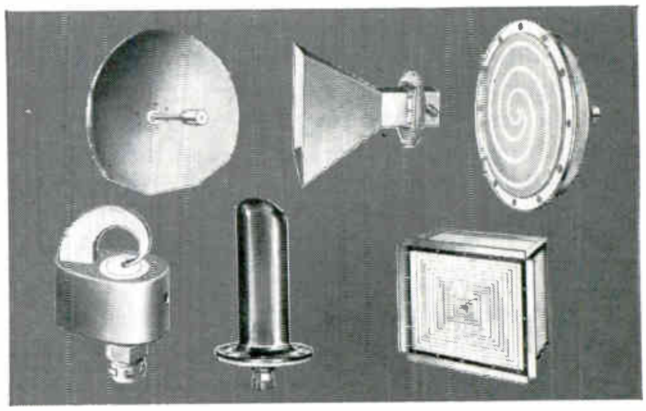


Hallicrafters communications leadership is exemplified by new high frequency Single Sideband receiver, (model no. SX-116). 100% modular design permits simple modification for compatability with existing and future communications systems. Stability, with proper available plug-ins, is better than one part in 10,000,000 per month. Hallicrafters also offers an existing capability in receiving and transmitting techniques up to frequencies of 50,000 megacycles.

Hallicrafters participation in the Atlas missile project helped to develop capability for many areas of the complex missile field, including code translator data systems; ground support equipment; ECM testing and antenna systems. Current explorations involve latest Infra Red techniques.



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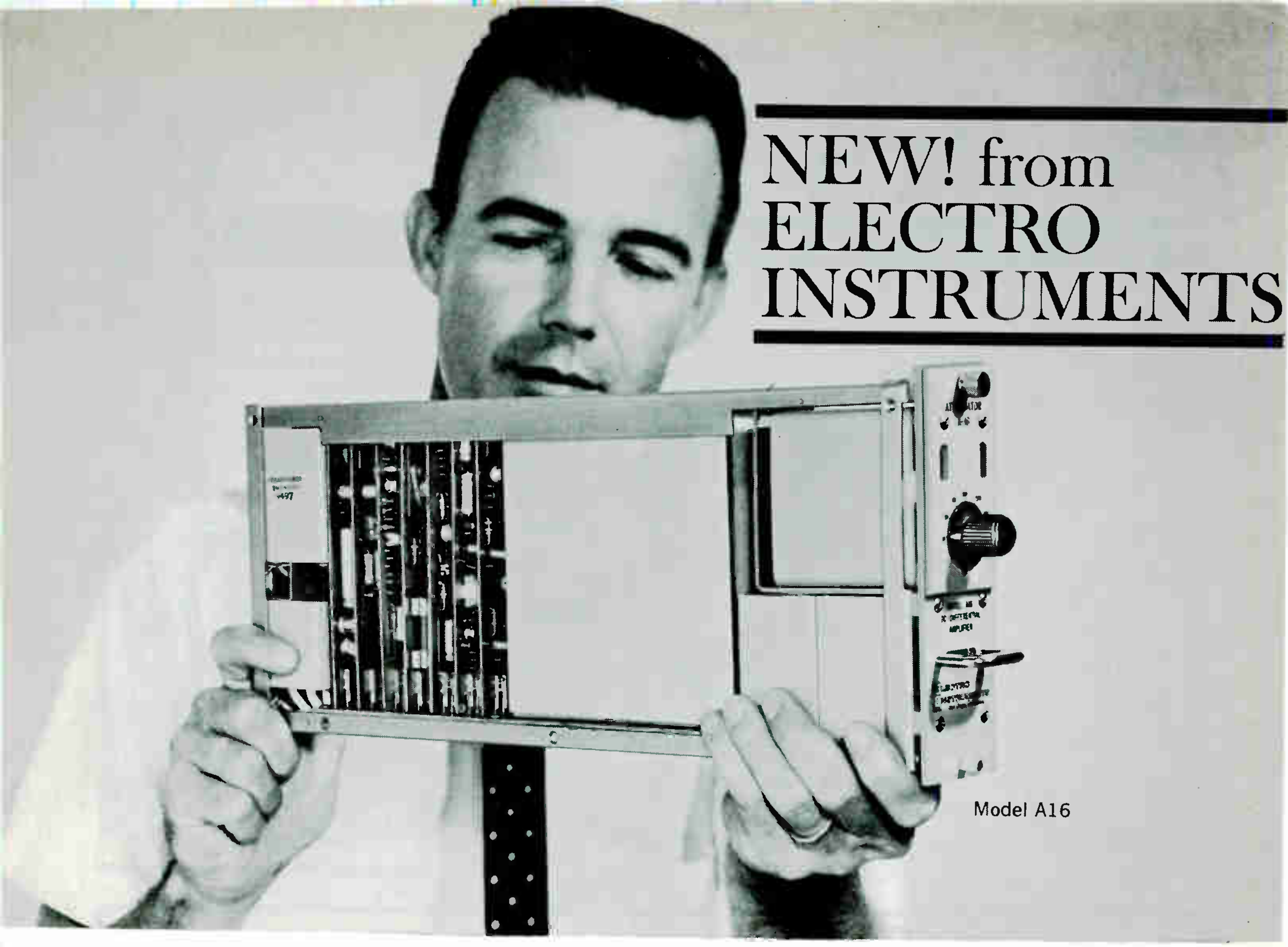

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Model A14—For operational, computer and control system applications. Operates at gains of from 1 to 100 with 0.01% stability.

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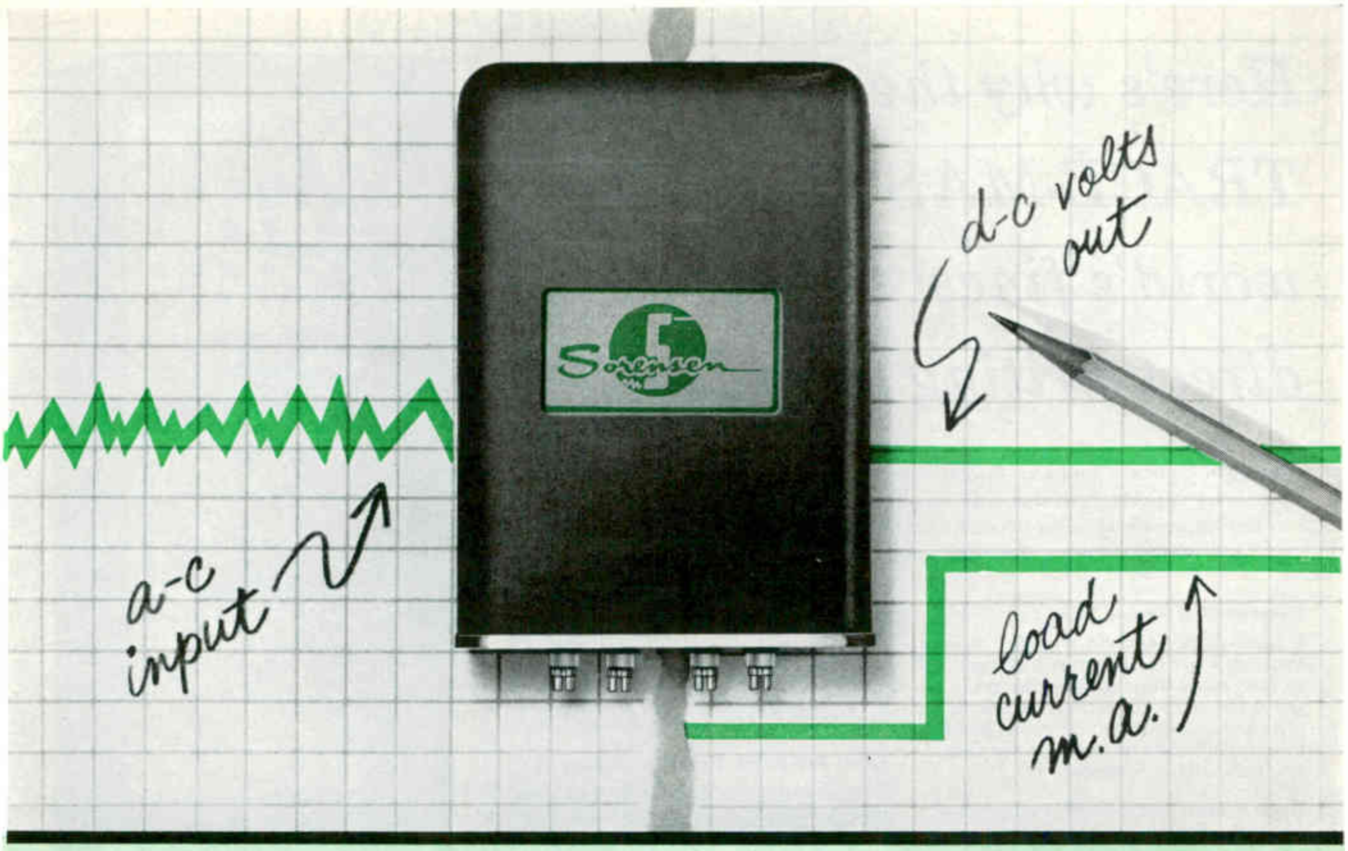

MODELS AND PRICES

(Digits preceding dash in model number indicate output voltage: those following, indicate current.)

2 WATT		4 WATT		8 WATT		15 WATT		30 WATT	
QM 3.0-.66	$115	QM 3.0-1.3	$130	QM 3.0-2.6	$170	QM 3.0-5.0	$210		
QM 4.4-.45	95	QM 4.4- .90	120	QM 4.4-1.8	160	QM 4.4-3.5	195		
QM 6.3-.32	80	QM 6.3- .64	108	QM 6.3-1.28	140	QM 6.3-2.4	176	QM 6.3-4.75	$212
QM 9.0-.22	78	QM 9.0- .44	105	QM 9.0- .88	137	QM 9.0-1.7	172	QM 9.0-3.33	207
QM12 -.16	76	QM12 - .32	102	QM12 - .64	134	QM12 -1.25	168	QM12 -2.56	202
QM16 -.13	74	QM16 - .25	100	QM16 - .50	131	QM16 - .94	164	QM16 -1.87	197
QM21 -.10	72	QM21 - .19	98	QM21 - .38	128	QM21 - .71	160	QM21 -1.43	195
QM28 -.07	70	QM28 - .14	95	QM28 - .28	125	QM28 - .53	160	QM28 -1.07	195
QM36 -.06	70	QM36 - .11	95	QM36 - .22	125	QM36 - .43	160	QM36 - .83	195

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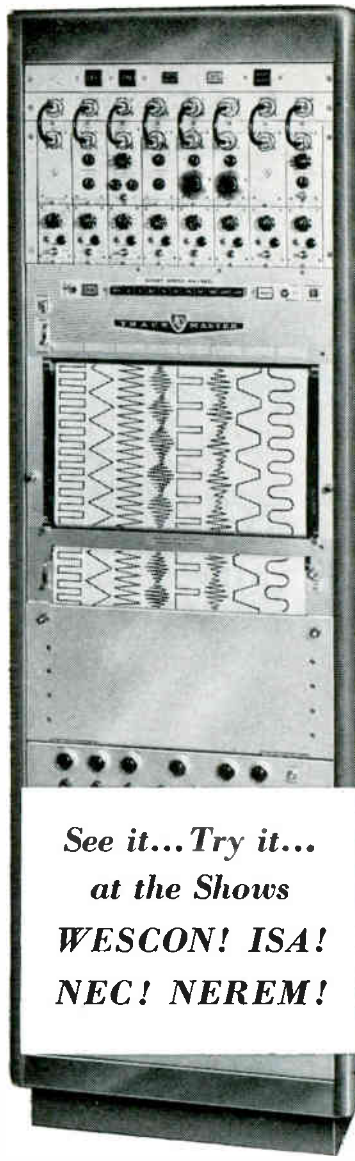
CIRCLE 61 ON READER SERVICE CARD

Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!



American Optical Company, famous for precision instrumentation for 138 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance.*

Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

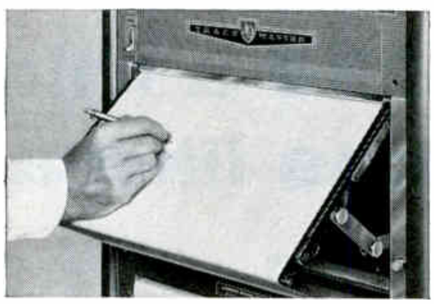
Finest Resolution, Linearity, Stability

Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

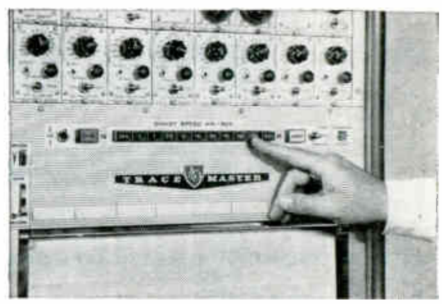
Finest Systems Oriented Compatability

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.

Entire channel easily accessible and completely interchangeable as single unit.



Platen tilts to convenient writing angle.



Widest range chart speed... push-button selection through 0.1 mm/sec to 500 mm/sec.

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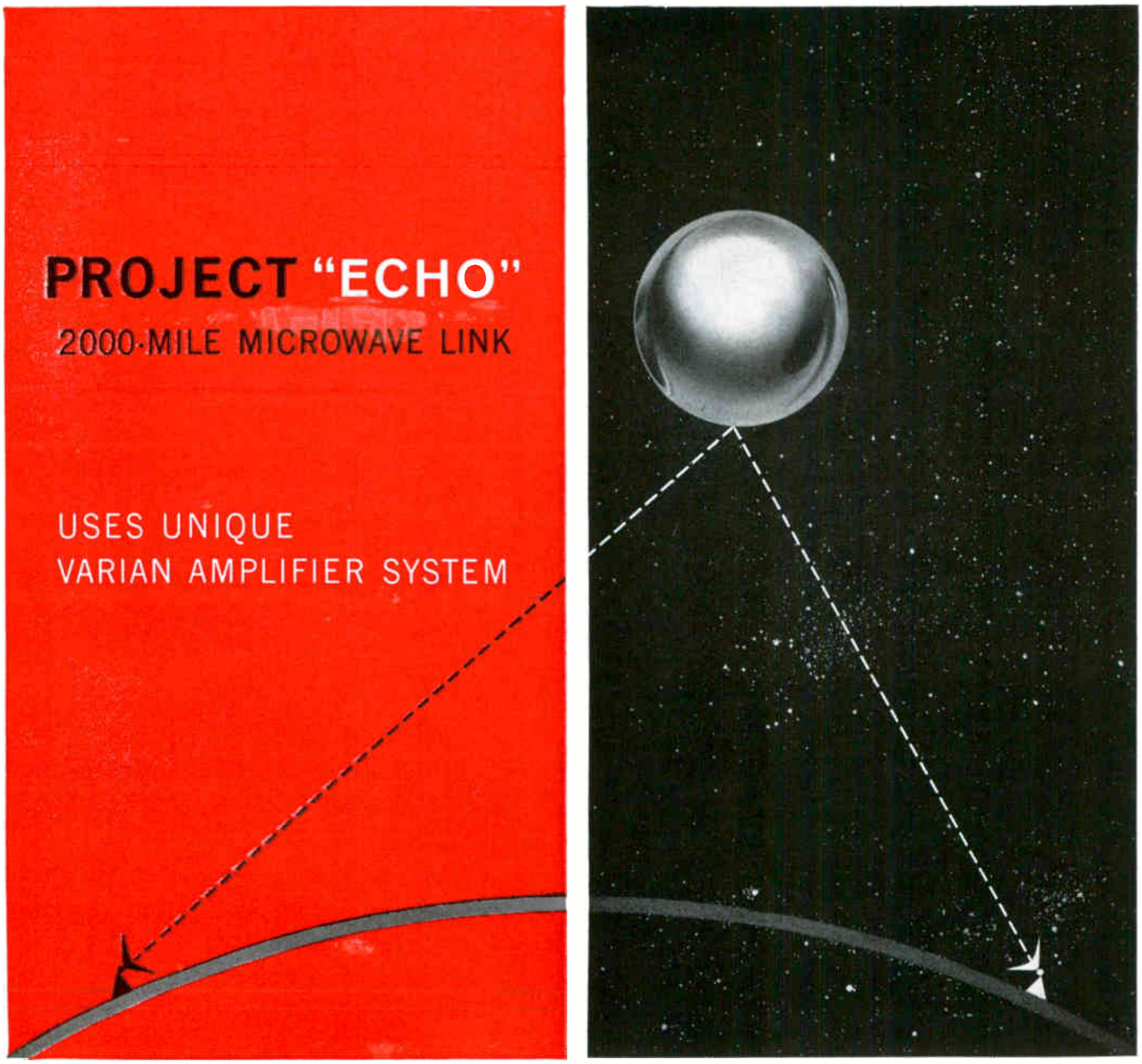

Project "Echo"— using a passive, 100-foot diameter, inflated sphere orbiting the earth to reflect signals—is investigating the feasibility of reliable and efficient long-range microwave communication. Radio and voice signals were bounced off the sphere between California and the East Coast. This followed earlier successful "moon-bounce" signalling between the same locations using the same transmitter.

Varian was contracted by the Jet Propulsion Laboratory (JPL)* to develop the unique klystron amplifier system built right into the 85-foot diameter parabolic transmitter antenna. To assure maximum success in "echo transmission," the system was designed around the proved and reliable Varian VA-800 C Klystron, to provide 10kw output at the desired 2390 megacycle frequency.

*Jet Propulsion Laboratory, a research and development facility of the NASA

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MODEL 212A $129 WITHOUT METERS

0.1% REGULATION MODELS	DC OUTPUT VOLTS	DC OUTPUT MA	0.01% REGULATION MODELS
220A	0-50	0-500	220AK
213A	0-50	0-1000	213AK
215A	0-50	0-3000	215AK
225A	0-75	0-2000	225AK
212A[1]	0-100	0-100	212AK[1]
2-212A[1, 3]	0-100X2	0-100X2	2-212AK[1, 3]
224A[1]	0-100	0-200	224AK[1]
221A	0-100	0-500	221AK
214A	0-100	0-1000	214AK
226A	0-100	0-2000	226AK
218A	0-100	0-3000	218AK
229A	0-150	0-300	229AK
228A	0-150	0-1000	228AK
230A	0-200	0-1000	230AK
231A[2]	0-300	0-100	231AK[2]
232A[2]	0-300	0-200	232AK[2]
233A[2]	0-300	0-300	233AK[2]
234A	0-300	0-500	234AK
237A	0-300	0-1000	237AK
236A[2]	0-600	0-200	236AK[2]
235A	0-600	0-500	235AK

[1] Has modulation input.
[2] Has additional 0-150 V DC output and 6.3 V AC CT output.
[3] Equivalent to two Model 212A's.

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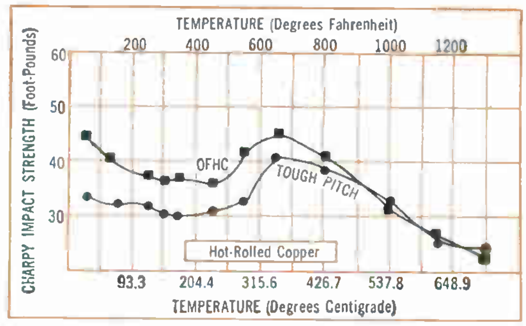

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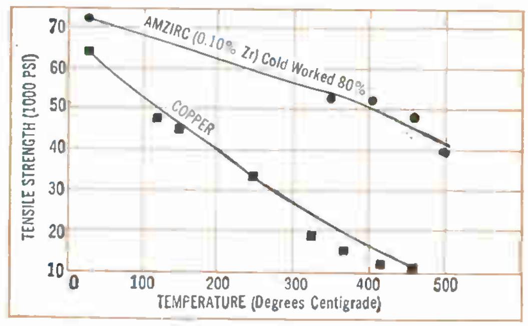

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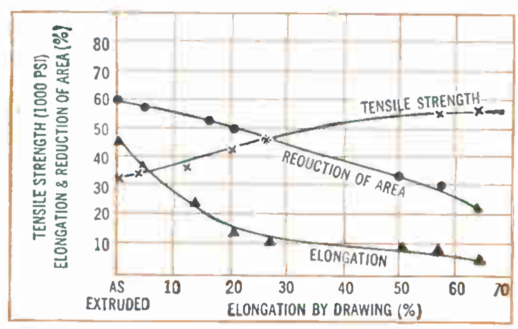

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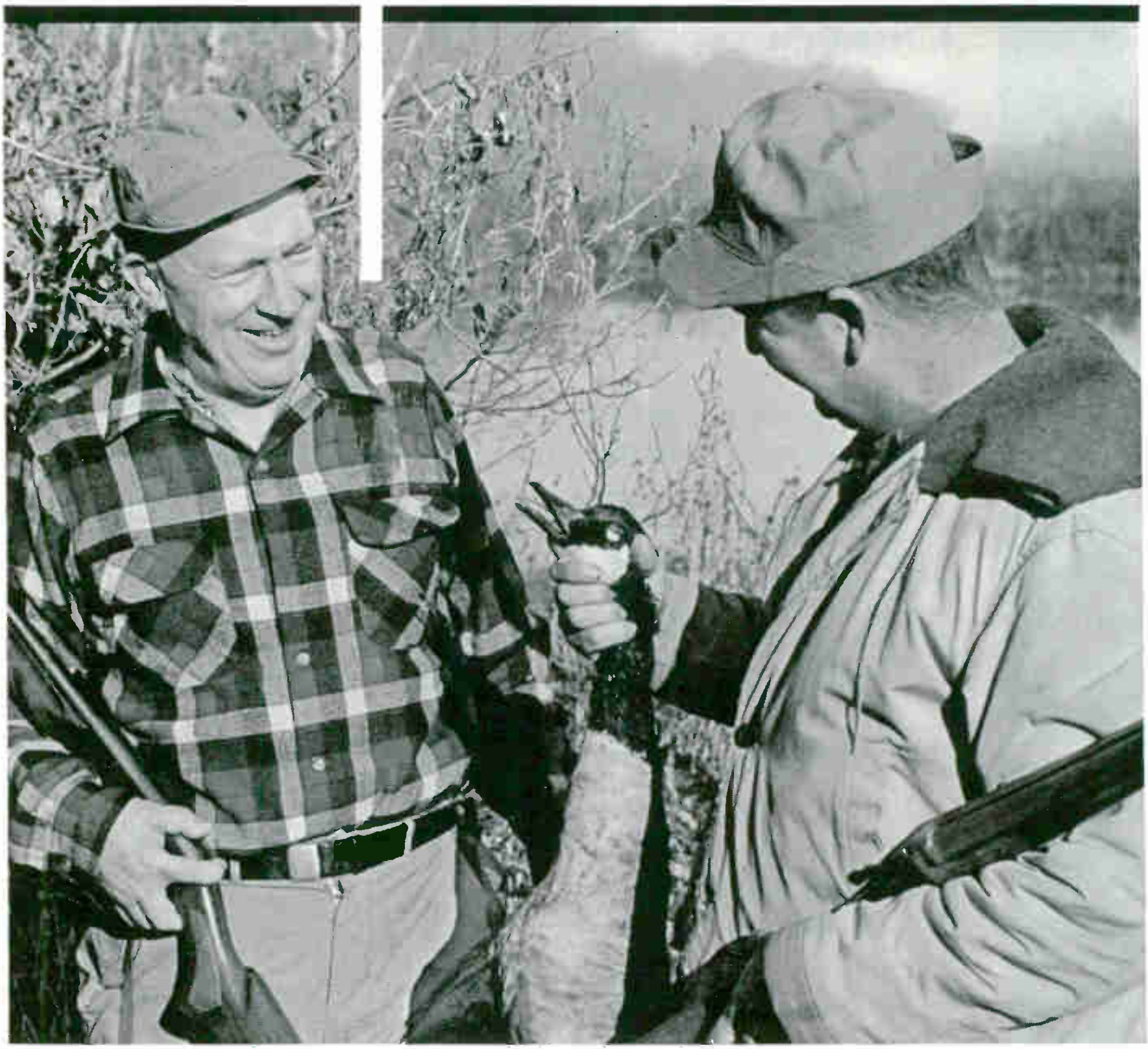

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TYPICAL SPECIFICATIONS

SYNCHRO TRANSMITTER TYPE SP-152

Input Voltage (to Rotor)— 400 cps—volts	26
Input Power—watts	1.0
Input Impedance (stator shorted)	110+j 36
Input Impedance (stator open)	89+j 230
Transformation Ratio	.454
Output Impedance (Rotor open)—ohms	27+j 44
Output Voltage—volts (line to line)	11.8
Voltage Gradient—volt/degree	0.206
Total Null Voltage (mv. max.)	30
Electrical Accuracy (Max. Error from E.Z.)—minutes	±3.0

(Tighter accuracy tolerances available for applications requiring limited ranges of rotation.)

A. C. TORQUER MOTOR TYPE SP-170

	Fixed Phase	Control Phase
Rated Excitation Voltage—volts	26	40
Frequency (cps)	400	400
Current—(mv.)	230	226
Power—watts	3.1	4.6
Power Factor	.517	.505
Resistance—ohms	58.5	89.3
Reactance—ohms	85.5	152.5
Impedance—ohms	113	177
Effective Resistance—ohms	218	348
Capacitor for Unity Power Factor—mfd	1.35	2
Torque at stall (min.)—oz.in.	1.0	

Operating Temperature Range—minus 55°C to plus 125°C

A. C. SPIN MOTOR TYPE SP-167

Input Voltage (line to line)—volts	26
Frequency—(cps)	400
Input Line Current (mv.) at stall condition	350
Total Input Power (watts) at stall condition (max.)	10
Input Line Current (mv.) at 24,000 rpm	300
Total Power (watts) at 24,000 rpm. (nominal)	5.5
Stall Torque—(min.) in.oz.	.34
No-load Speed (rpm.)—(in air)	24,000
Run-up time with rated voltage (in air) to NLS—sec. max.	90
Moment of Inertia Gm.Cm²	190
Angular Momentum Gm.Cm²/Sec. at 24,000 rpm	475,000
Dynamically balanced to within 10x10⁻⁶ oz.in. max. unbalance	
Coasting time (in air) (min.)	2½
Total weight—gms.	151

Ambient Temperature Range—Minus 55°C. to Plus 125°C.

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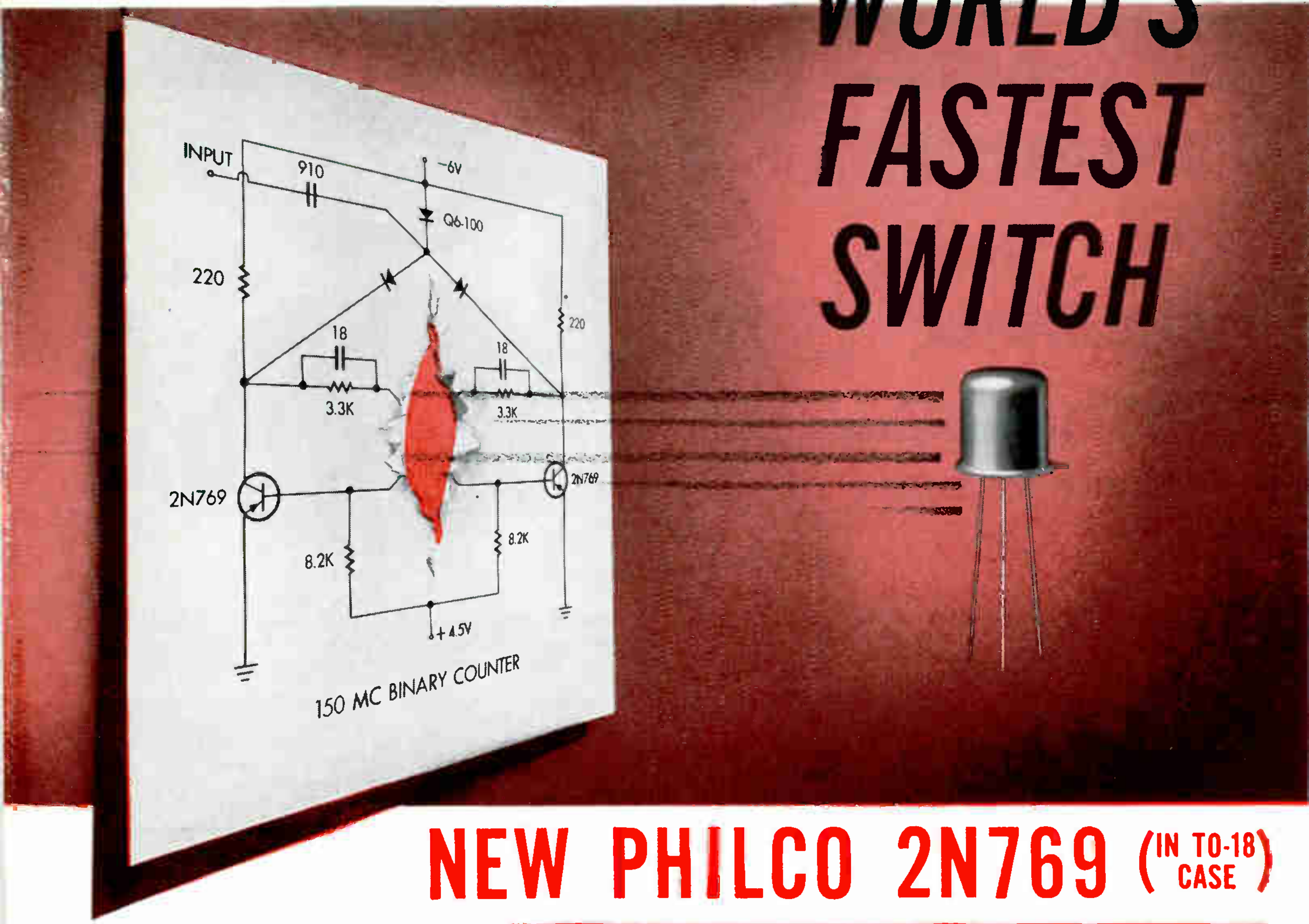

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature	100°C
Collector Voltage, V_{CBO}	−12 volts
Collector Voltage, V_{CES}	−12 volts
Collector Voltage, V_{CEO}	−7 volts
Emitter Voltage, V_{EBO}	−2 volts
Collector Current, I_C	−100 ma
Device Dissipation @ 25°C	35 mw

ELECTRICAL CHARACTERISTICS (T=25°C)

Characteristics	Condition	Min.	Typ.	Max.
Collector Cutoff Current, I_{CBO}	$V_{CB}=-5v$			−3 μa
Current Amplification Factor, h_{fe}	$V_{CE}=-0.5v$, $I_C=-20$ ma	25		
Collector Saturation Voltage, V_{CE} (SAT)	$I_C=-10$ ma, $I_B=-1$ ma			−0.24 volt
Base Input Voltage, V_{BE}	$I_C=-10$ ma, $I_B=-1$ ma	−0.30		−0.45 volt
Output Capacitance, C_{ob}	$V_{CB}=-5v$, $I_E=0$		1.5	3 μμf
Gain Band-Width Product, f_T	$V_{CE}=-5v$, $I_E=7$ ma	600	800	mc
Hole Storage Factor, K'_S	$I_B=-2$ ma		15	30 mμsec
Emitter Transition Capacitance, C_{TE}	$V_{EB}=-1v$, $I_C=0$, f=4 mc		5	8 μμf

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September 9, 1960

Sound Velocity Measurement in Liquids

Pulse and waveforms generated in the velocimeter are observed on an oscilloscope

Instrument for direct measurement of velocity of sound in sea water has many possible industrial applications—it will detect impurities to one part in 100,000 by weight when impurity is in solution

By WAYNE D. WILSON,
DUDLEY D. TAYLOR*,
U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland

TABLES FOR velocity of sound in sea water were developed in 1939 by S. Kuwahara.[1] However, advances in the field of ultrasonics, particularly since World War II, have shown these tables to be inadequate for pressures corresponding to sea level conditions.[2] This discovery prompted the design of an instrument capable of measuring directly the velocity of sound for the conditions of temperature, pressure and salinity found in the ocean. Although the instrument was initially designed for this purpose, it has been found suitable for similar measurements in other liquids. The general principles of this instrument were initially developed by M. Greenspan and C. Tschiegg[3] at the National Bureau of Standards.

The velocity of sound is obtained by measuring the time required for a pulse to traverse twice the length of the velocimeter. The velocimeter test chamber is bounded by a transmitting and a receiving crystal. The transmitting crystal is driven by a series of pulses, each of 0.05 μsec duration. When a pulse is applied to the transmitting crystal, a wave train is transmitted through the liquid and is reflected back and forth between the two crystals. The repetition frequency of the 0.05 μsec pulses is adjusted so that a new pulse is initiated each time the reflected wave returns to the transmitting crystal. In this manner all wave trains move through the liquid in phase. To provide a visual indication that the waves are superimposed, the waves are picked up by the receiving crystal and displayed on an oscilloscope. Thus, the reciprocal of the pulse repetition frequency represents the time required for the sound waves to travel twice the length of the acoustic path. Sound velocity in the liquid is computed from this time and from the known distance between crystals.

The velocimeter, shown in Fig. 1A and 1B, is a stainless steel cylindrical housing 4.997934 inches long with a ½-inch bore. Each end of the cylinder is terminated by a 5-Mc gold-plated quartz crystal attached to Mycalex disks. The Mycalex disks are seated on springs located in cylindrical end blocks which are attached to the cylindrical housing. When the instrument is assembled, the springs force the quartz crystals against the ends of the cylindrical housing. Care must be taken to machine the two ends of the housing plane parallel and perpendicular to the axis of the tube. Otherwise, the crystals may be distorted and the sound paths from different portions of the crystal will not be equal. One end block is used for electrical terminations; the other end block has a bellows attached for the transmission of pressure from the hydrostatic pressure field outside the velocimeter to the liquid inside the housing.

Optimum size of the velocimeter depends on the crystal frequency and the delay time of the sound waves in the test liquid. The diameter of the test chamber should be at least 12 times the wave length of sound in the crystal to prevent

*Also affiliated with High Pressure Engineers, Inc., Beltsville, Md.

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viscous effects of the tube walls from affecting the velocity appreciably. Since a wave train is propagated in the liquid, the length of the chamber must be sufficient to prevent the trailing portions of the wave train from overlapping the leading edge when coincidence is established. If this should occur, the wave velocity would interfere with the group velocity being measured.

Velocity of sound in liquids varies with temperature, pressure and composition. Therefore, it is necessary to control these variables. A schematic of the instrumentation required for monitoring and controlling the environment of the velocimeter is shown in Fig. 1C. The velocimeter is placed in a pressure vessel and submerged in a 110-gallon constant-temperature bath. The temperature of the bath is controlled by a mercury thermoregulator connected to the bath heating elements and an external refrigeration unit for obtaining low temperatures. A thermistor is used to sense temperature gradients in the bath; such gradients were eliminated by installing pumps to circulate the liquid. During operation, the thermistor is used to detect the variations in bath temperature as a function of time. Absolute temperature is measured with the platinum resistance thermometer.

The pressure gage in Fig. 1C is actually a coil of manganin wire wrapped on a core and positioned in a separate pressure vessel. Communication of pressure between the pump, the gage vessel and the vessel containing the velocim-

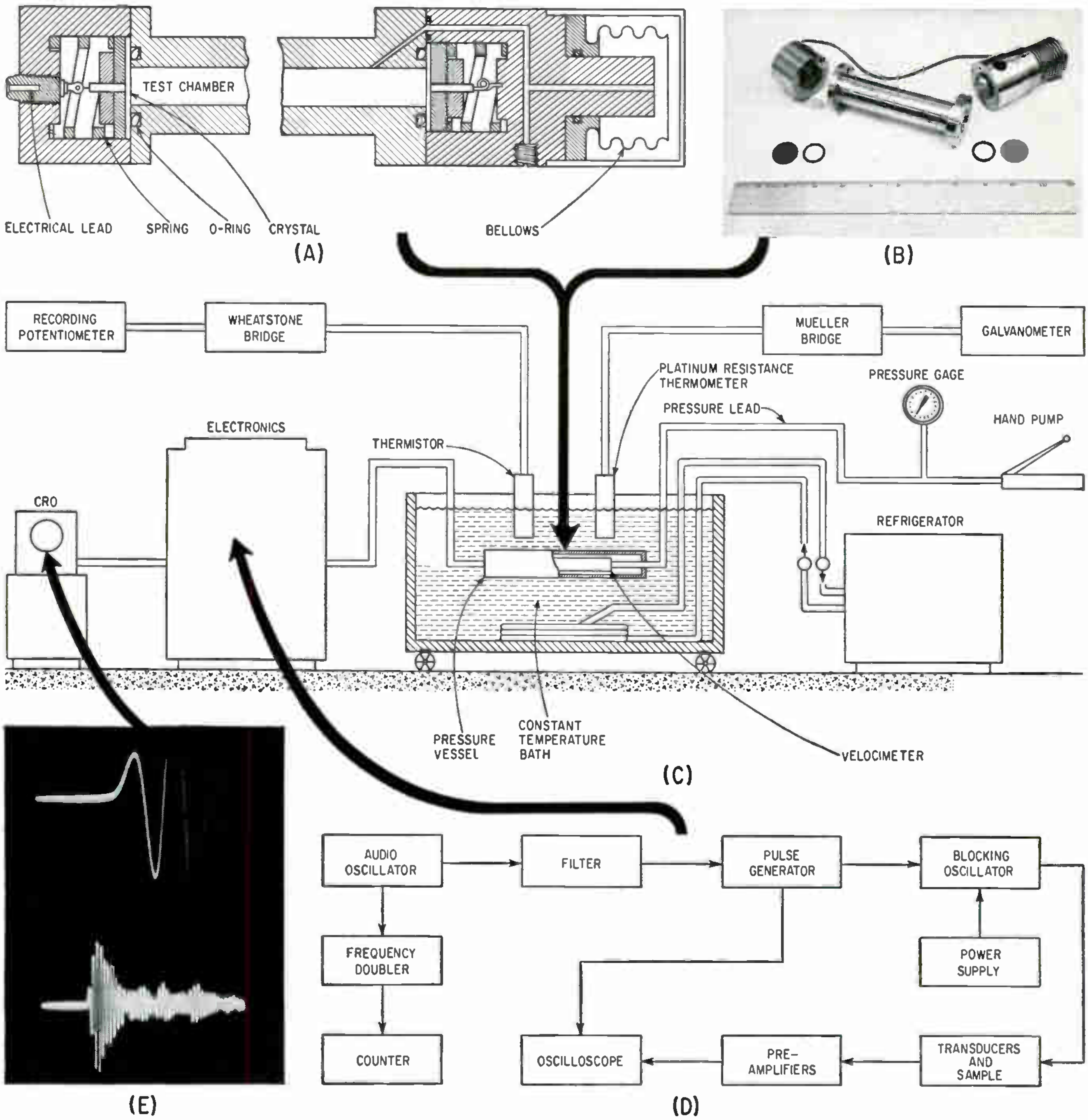

Fig. 1—Velocimeter design (A and B), laboratory setup of instrumentation required for monitoring and controlling the environment of velocimeter (C), the electronics package (D) and oscillograms of wave train (E)

eter is through high-pressure tubing. The resistance of the manganin wire varies with pressure; it is consequently located in one arm of a temperature-regulated Mueller bridge. Bridge output is fed into a photoelectric galvanometer which in turn drives a second galvanometer that indicates bridge balance. The resistance of the coil was initially calibrated as a function of pressure against a free piston gage. In constructing the manganin resistance gage care must be taken to select connecting wires and terminals that will not produce contact voltages at the junctions. In addition, to obtain a coil which is stable and whose resistance depends linearly on pressure, the coil must be thoroughly temperature and pressure seasoned. For work requiring less accuracy than that required for these precision measurements, a sensitive Heise gage is recommended.

The electronics shown in Fig. 1C is expanded in Fig. 1D. The audio oscillator is equipped with a fine frequency control. It is not necessary to filter the oscillator output; however, it may be desirable. A band pass filter is used to reduce harmonic frequencies and line noise. The oscillator signal is fed to a pulse generator and a blocking oscillator before it is applied across the transmitting crystal in the velocimeter. The signal detected by the receiving crystal is amplified before displaying the trace on the oscilloscope. Figure 1E is an oscillogram of the waveform photographed on different time scales to show the detail of the leading edge of the wave train.

The external triggering sweep of the oscilloscope is obtained from the output of the pulse generator. The pulse generator is essentially a multivibrator with the sine wave synchronizing voltage applied to the grid. Output of the multivibrator is rectified by a IN34 diode to give a positive pulse; R-C coupling between the multivibrator and subpositive pulse. The R-C coupling between the multivibrator and subsequent amplifiers differentiates the signal to sharpen the pulse. Since the synchronizing frequency is higher than the natural frequency of the multivibrator, the repetition frequency of the pulses is controlled by the sine wave input. One output of the last amplifier stage is used to drive the external triggering sweep on the oscilloscope and the other output drives the blocking oscillator. The action of the blocking oscillator circuit is standard. Its purpose is to provide a symmetrical pulse of narrow width to drive the transmitting crystal of the velocimeter. When taking measurements with the velocimeter, the first half-cycle of the wave train is normally used to determine when coincidence occurs. If other peaks of the wave train are used, it is necessary to rectify the output of the blocking oscillator to give consistent results between measurements taken at the different peaks. Blocking oscillator output was rectified by a 643 low-capacitance diode.

Velocity data, along with supporting tables for density, can be used to compute all thermodynamic quantities of interest. Once calibrated for a particular liquid, the velocimeter can be used as a sensitive temperature gage or, for a given temperature, as an accurate pressure gage. Also, owing to discontinuities in velocity at phase boundaries, the velocimeter can be used to determine freezing and boiling points of solutions as a function of temperature and pressure.

One interesting industrial application of the velocimeter is in quality control. Where purity of sample is important, the measurement of sound velocity will detect impurities to one part in 100,000 by weight when the impurity is in solution. For bulk production of solutions the velocimeter, with suitable electronic systems, could drive servo mechanisms that control the proportions of the constituents. The petroleum industry, for instance, could use the velocimeter to identify and evaluate for purity the products from distillation and cracking processes. Mixing of anti-knock gasoline blends could be controlled. One application in the food industry is the measurement of sound velocity to determine the carbohydrate and butter fat content in milk.

Instrumentation similar to that described has also been used for the measurement of longitudinal and shear velocities in solids. These measurements are sufficient to determine Young's modulus, Poisson's ratio, and the coefficients of compressure. Because velocity depends on the past history of the solid, the velocity can determine the temperature at which a specimen has been annealed. Very little information is available at the present time on the variation in velocity with composition. It is possible, however, that when such data are available, the velocity in a particular specimen could be used as a method for identifying the specimen.

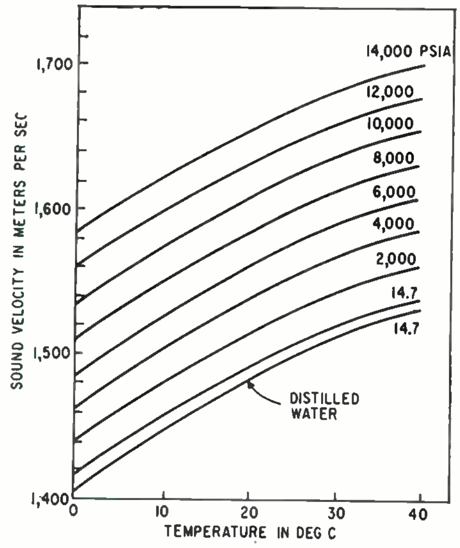

FIG. 2—Typical results obtained with velocimeter in 9 parts per thousand NaCl solution

Typical results obtained from the velocimeter are shown in Fig. 2. The points representing the sound velocity in a sodium chloride solution (9 grams of salt per 1,000 grams of solution) were used to plot curves of sound velocity versus temperature for the different pressures considered (in pounds per square inch absolute). A plot of the velocities at atmospheric pressure for distilled water is shown to demonstrate the effect of salt concentration. From these curves it may be seen that the pressure, temperature, and salt content coefficients of sound velocity are approximately 0.012 m/sec/psi, 4.3 m/sec/deg C, and 1.2 m/sec/parts per thousand, respectively . With respect to other liquids, water and its derivatives are abnormal. In most liquids the sound velocity decreases with increasing temperature.

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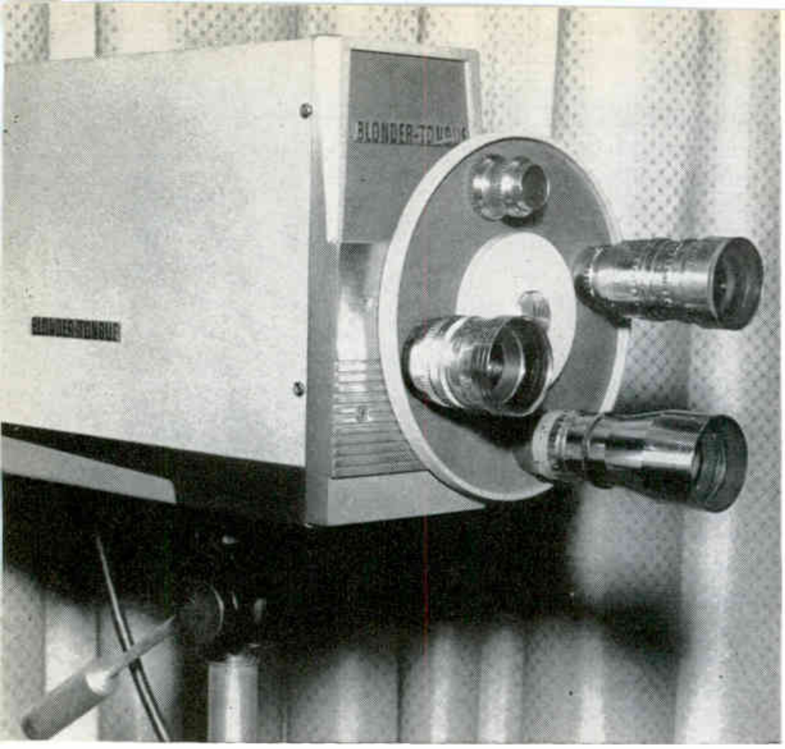

Designing

Special circuits and techniques are needed if at all the advantages of transistorizing a tv camera are to be realized

Portable camera uses vidicon and 28 germanium transistors

HIGH RELIABILITY, long life, mechanical compactness and low power drain have been the strongest factors to give impetus to the transistorization of equipment. There are several interesting problems in transistorizing a tv camera to gain all these advantages.

Low-frequency noise of transistors raises problems in video amplifiers and difficulties presented by the use of transistors in crystal oscillators must be overcome. It is also difficult to achieve blocking oscillator frequency stability. In all cases the design should allow for the wide variation in transistor characteristics.

The block diagram of a transistorized tv camera that overcomes these problems is shown in Fig. 1. The camera is designed to use a tipless, 1-in. vidicon, preferably types 7038, 7038A or 7325. The regulated —20 v supply follows conventional design practice, and will not be discussed here. Attention will be focused only on special circuits and their design.

Transistors exhibit a rising noise figure with decreasing frequency. This has been called 1/f, semiconductor or excess noise in the literature. On a tv picture, this type of noise appears as random horizontal streaks compared to the usual snow from Johnson or thermal noise.

This noise problem is solved by selection of the transistor for the first two stages and adjusting the R-C time constant of the coupling network between stages to cut off low frequencies beyond that required to reproduce the horizontal scanning interval without tilt.

The video amplifier uses nine 2N384 (or 2N1225) drift transistors. A 2N270 provides the video agc voltage. Response is flat from 15 Kc to 8 Mc with a peak at 7.5 Mc.

An input network introduces a peak to the response at 7.5 Mc. This pi network, shown in Fig. 2A, consists of the output capacitance C_o of the vidicon, L_1 shunted by R_1, and the input capacitance C_i of the video amplifier. The network produces partial aperture correction. Peaking at this point produces a minimum of h-f noise.

Input stage of the video amplifier is designed for minimum noise figure partly compromised with temperature stability. Lower quiescent collector current gives less noise, but the stage is more sensitive to I_{co} variation with temperature. The 2N384 transistor for this stage is selected for lowest noise (particularly 1/f noise) and the stage uses emitter peaking.

A 330-pf mica coupling capacitor minimizes leakage from the high impedance target circuit. For a similar reason, metallized paper capacitors couple the video stages.

Figure 2B shows the automatic video gain control circuit. Potentiometer R_1 adjusts the low-frequency gain of the video amplifier. Gain control over the whole video band is achieved by the nonlinear dynamic impedance characteristic of diodes D_1 and D_2. Varying the current through the diodes varies the dynamic impedance and hence, the amount of degeneration in this stage. Since the quiescent current through Q_1 has not changed, output capability and frequency response are independent of video gain. Transistor Q_1 is also selected for low noise, but the noise level may be higher than that of the first stage.

Automatic video gain control is provided for in the following manner. The video signal appearing at the collector of Q_3 is integrated. A d-c voltage proportional to the average video signal appears at the collector of Q_3. This is the biasing voltage for D_1 and D_2. Because of the low currents being drawn by D_1 and D_2, capacitors C_1 to C_4 must be tantalum types. Otherwise, leakage currents would alter the operating point of the diodes.

The third stage (Fig. 1) is the high peaker. A low load resistance in the collector of the third video transistor plus a shunt peaking inductance compensates for h-f rolloff in the input resulting from the high output impedance of the vidicon. Compensation for the vidicon output R-C time constant is possible only if the fourth stage has a high input impedance. Hence, the fourth stage is connected as an emitter follower. The peaking coil of this stage affects the lower midband gain of the video amplifier.

The aperture correcting circuit is

Transistorized Television Cameras

By DANIEL G. CARREON, Project Engineer, Blonder-Tongue Electronics, Newark, N. J.

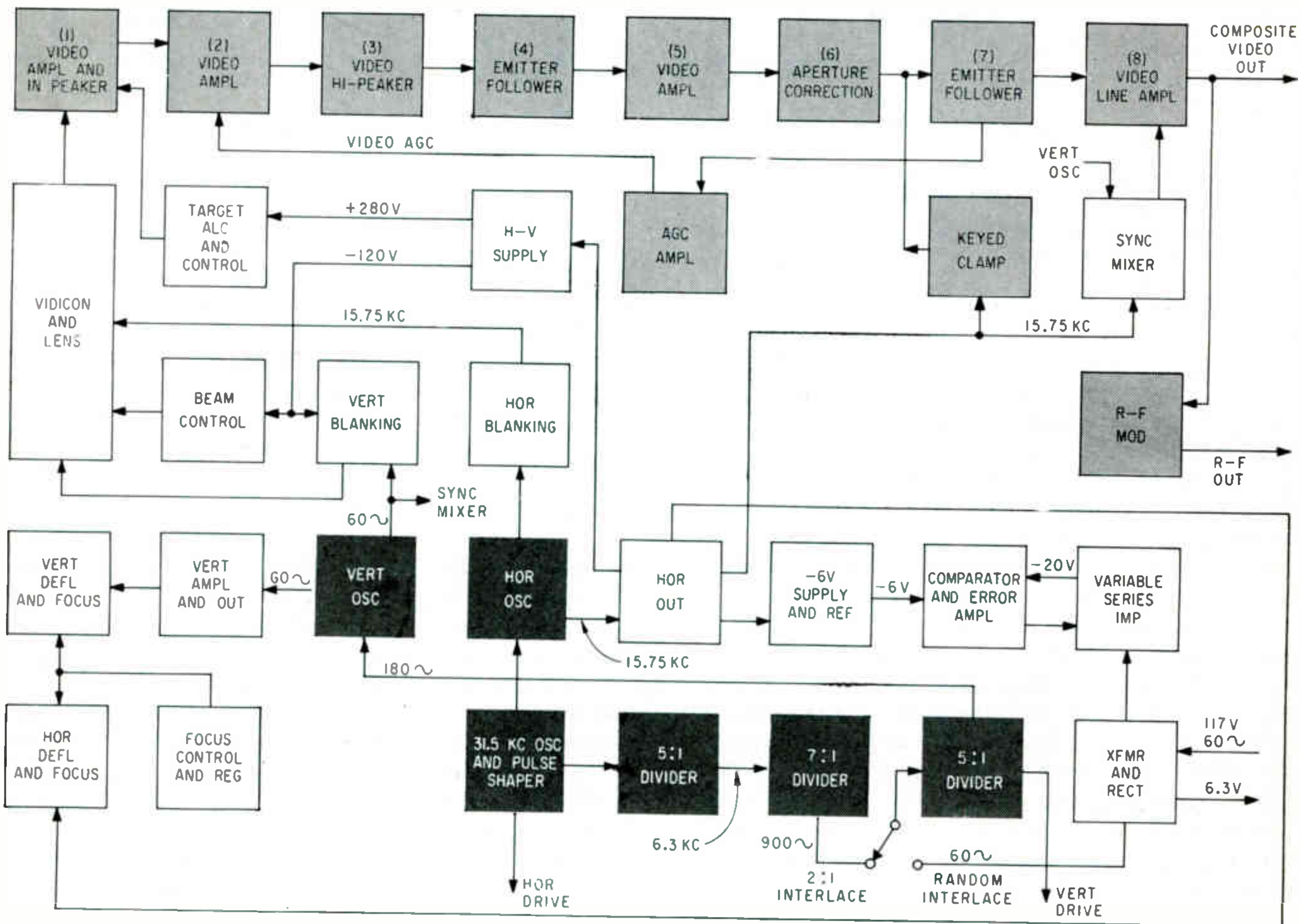

FIG. 1—Shaded blocks include circuits which are discussed in detail

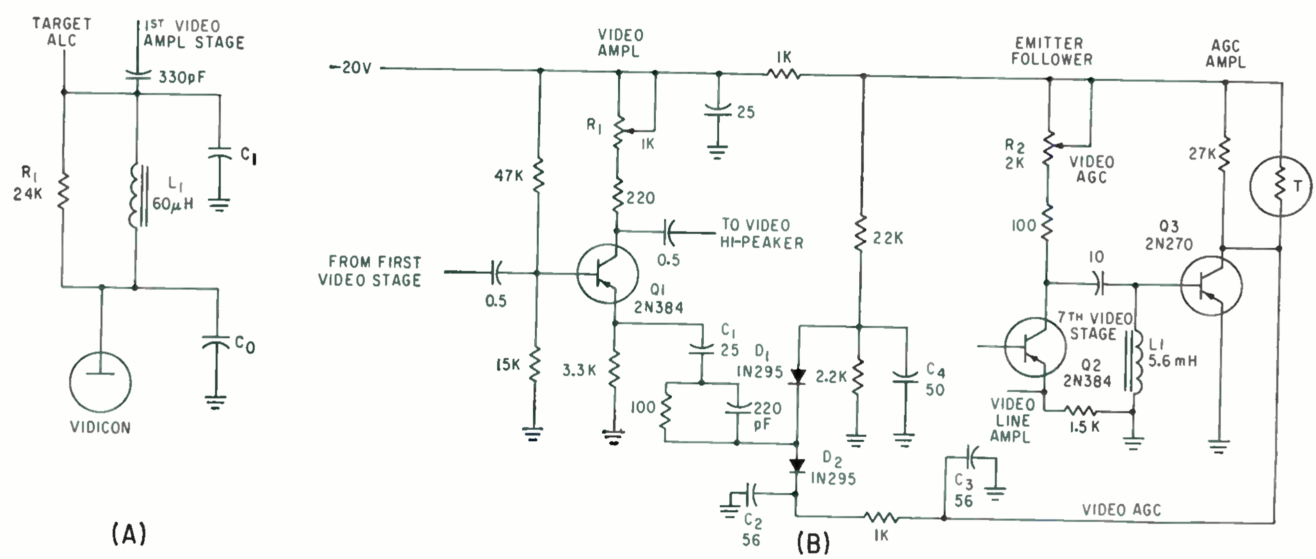

FIG 2.—Input circuit (A) peaks response at 7.5 Mc. Circuit (B) provides automatic video gain control

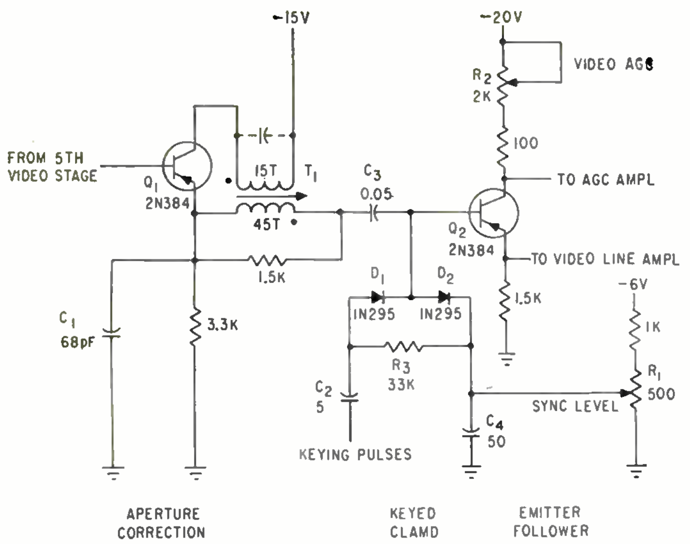

FIG. 3—Diode D_1 of keyed clamp acts as a conventional peak rectifier d-c restorer

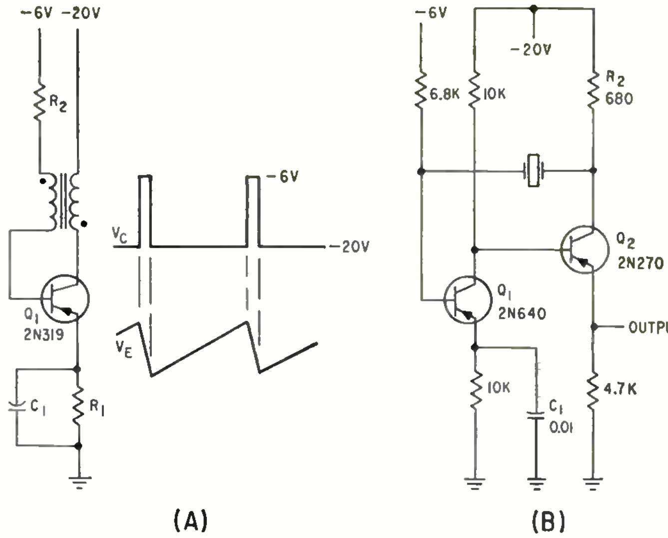

FIG. 4—Blocking oscillator (A). Oscillator in (B) provides sync signals for sweeps.

shown in Fig. 3. Because of the finite spot size and bandwidth limitation of the video amplifier, video response to a square pulse is rounded. The pulse is sharpened by the combined action of T_1 and C_1. Capacitor C_1 increases the initial swing at the collector which is opposite in phase with respect to the input. The collector winding then rings with the stray and/or distributed capactiance across it. The emitter pulse is in phase with the base input but slightly delayed because of C_1. The ringing pulse at the collector is coupled to the transformer secondary and added to the emitter waveform. In the resultant waveform, initial swing at the collector causes an undershoot.

To generate the required frequency, the horizontal and vertical deflection circuits use the blocking oscillator shown in Fig. 4A. The same circuit is used in the frequency dividers for 2:1 interlace. Transistor Q_1 is ON only during the narrow pulse intervals or flyback time. Capacitor C_1 charges during this interval and discharges through R_1 during the sweep periods. The R-C network in the emitter performs both timing and integrating functions.

The oscillator can be synchronized at the base, emitter, or collector. Frequency can be changed by varying either R_1 or C_1. Pulse width is a function of transformer primary inductance, base circuit resistance and capacitor C_1.

Although other blocking oscillator circuits are possible, this circuit has the best frequency stability and the minimum number of parts. Base circuit impedance is low and since the time constant is in the emitter circuit, the frequency is independent of the I_{cbo} component of base cut-off current which is temperature dependent.

For the oscillator frequency to be stable with temperature variation, the net effect of the following factors must be compensated for:

1. The electrical characteristics of the transformer and resistors can be assumed to be temperature invariant. However, the value of emitter capacitor C_1, whether it be an aluminum electrolytic, tantalum or metallized paper, increases with temperature. This tends to decrease the frequency.

2. The Zener diode used to obtain the 6-v bias has a positive temperature coefficient. Increasing the base bias increases the frequency.

3. The collector supply voltage tends to decrease with temperature because of I_{co} variation in the error amplifier of the series regulator (Fig. 1). Decreasing the collector supply increases the frequency.

4. Heating of the transistor increases the frequency due to the change in β and conduction point with temperature.

5. For blocking oscillators used as frequency dividers, input pulse amplitude must be stablized.

In the design of this transistorized camera, three thermistors are used to stabilize the frequency-dividing chain that gives a 2:1 interlaced picture. The blocking oscillator has been found to have only a small drift in its natural frequency of oscillation. This is because the increase in frequency from heating of the transistor is counter-balanced by an increase in capacitance of the metallized paper capacitor used. Three external factors—collector supply voltage, base bias voltage and amplitude of the input pulses—remain to be compensated.

The I_{co} of the error amplifier in the voltage regulating circuit changes the −20v collector supply. A thermistor with −5.4-percent temperature coefficient is shunted across the base-to-ground resistor of this transistor. Another thermistor is used to compensate for the positive temperature coefficient of the Zener diode for base bias. It is interesting to note that since the same Zener diode is used as a reference in the error amplifier of the voltage regulator, the increase in Zener voltage tends to increase the collector supply voltage and partially cancel the I_{co} effect. A third thermistor keeps the amplitude of the input pulses to the first counter constant. These pulses increase in amplitude with temperature because of the increase in β of the transistors in the crystal oscillator and pulse shaper.

The clamp circuit (Fig. 3) allows a-c coupling into the video amplifier. Low-frequency response of the video amplifier is adjusted to reproduce adequately a square wave at half the horizontal frequency. The low input impedance

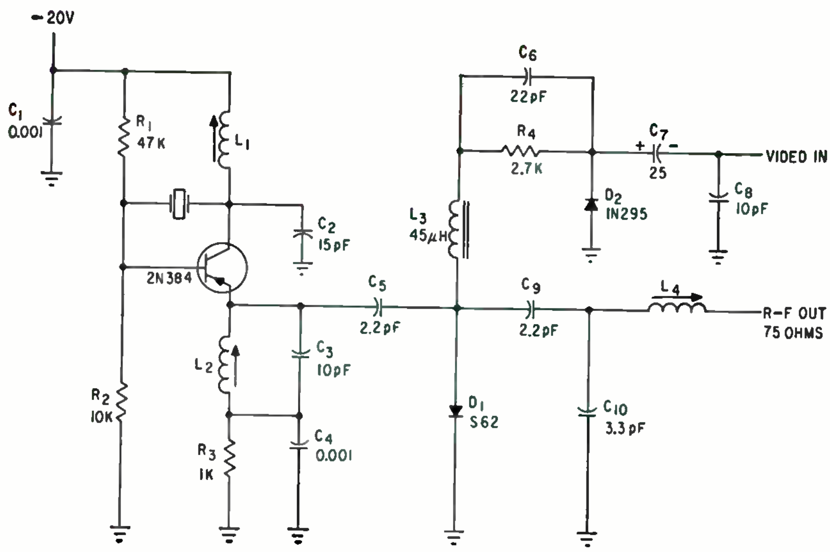

FIG. 5—R-f output is 50 mv into 75-ohm load. Resistors R_1 and R_2 form bleeder network for base bias

of common-emitter transistor amplifiers make it necessary to use coupling capacitors much larger than those used with vacuum tubes to give a long enough time constant.

The driven clamp works in the following manner: the output of Q_1 is video negative. A positive keying pulse makes diodes D_1 and D_2 conduct, fixing the potential of the base of Q_2 at the start of each horizontal line. This potential is set by R_1 and controls the height of the sync pulses in the video output. At the end of the pulse the diodes stop conducting. Resistor R_3 discharges C_2 slightly during the sweep period, making D_1 and D_2 conduct more heavily when the clamping pulse is applied.

The clamping pulse is about 4.5 v positive and is narrower than the retrace period (width is about 5 μsec). This amplitude is large enough to charge C_2 to a voltage that keeps the diodes cut-off during the horizontal sweep period. Capacitor C_2 is large enough to have a long discharge time, yet small enough relative to C_4 to absorb most of the pulse voltage.

The crystal used in the 31.5 kc oscillator vibrates in the flexural mode, the lowest frequency natural mode of vibration of long thin bars. This cut resonates at one of the lowest frequencies attainable from a homogeneous piece of quartz. At low frequencies like 31.5 kc, the flexural mode is most suitable to use. This design, however, results in a high impedance, leading to design problems.

A high impedance makes it difficult to excite the crystal. It could also lead to oscillation at unwanted harmonics of the crystal frequency. Series resonant operation is much easier to use than parallel resonant operation, even with vacuum tubes. For such a crystal, it is difficult to build an oscillator using one transistor or a single vacuum triode, tetrode or pentode. The camera uses the symmetrical, collector-coupled multivibrator type of oscillator shown in Fig. 4B.

Transistors Q_1 and Q_2 are connected in a positive feedback loop with the base of Q_2 direct coupled to the collector of Q_1 and the crystal forming the feedback from the collector of Q_2 to the base of Q_1. Assume Q_1 conducts when the equipment is turned on. Its collector voltage drops, cutting off Q_2 and bringing the collector voltage of Q_2 to −20 v. The crystal is excited, the voltage across it decreases, the collector voltage of Q_2 moves in the positive direction. This is coupled to the base of Q_1 making it draw less current. The negative swing at the collector of Q_1 and the base of Q_2 drives Q_2 out of cut-off.

With Q_2 drawing current, its collector moves in the positive direction. The 31.5 Kc component of this positive going pulse is coupled to the base of Q_1 by the crystal to complete the positive feedback loop at this frequency. Transistor Q_1 cannot be driven to cut-off because of direct-coupling to the base of Q_2 which cannot go more negative than its collector. During this interval Q_2 is in saturation. When the crystal voltage decreases, the base of Q_1 is driven more negative and Q_1 starts drawing more current. The collector of Q_1 goes less negative making Q_2 draw less current. Positive feedback around the loop results in Q_1 being driven to saturation and Q_2 being cut off, completing the cycle of oscillation.

To keep the dissipation in the crystal below the 0.1 mw maximum rating, the voltage excursion at the collector of Q_2 is not allowed to exceed about 5 v. This is achieved by keeping the value of R_2 low. Furthermore, the input impedance at the base of Q_1 is made high to reduce the crystal power required to drive it.

The r-f modulator is shown in Fig. 5. Crystal frequency is half the desired r-f. The parallel combination of L_2 and C_3 is tuned to the second harmonic of the crystal frequency to give the desired r-f channel. Inductor L_2 provides the tuning adjustment.

In the r-f oscillator the crystal operates between the series resonant point and the parallel resonant point. In this narrow region, the crystal is inductive. The circuit of the r-f oscillator can be simplified since L_2 and C_3 present a low impedance at a frequency half its resonant point. For the circuit to oscillate, the L_1 and C_2 combination should be tuned below the crystal frequency presenting a capacitance matching impedance from collector to ground at crystal frequency. With this condition the voltage at the base is 180 degrees out of phase from the voltage at the collector. Since there is a 180-degree phase shift between transistor base and collector the total phase shift around the loop is 360 degrees, and oscillation is sustained.

Power consumption, size, and weight are factors in which the transistorized camera may be favorably compared to an equivalent vacuum tube version. Power consumption is about 90 percent less and almost one third of the power consumed by this transistorized camera is in the vidicon heater. Size and weight is reduced about two-thirds.

This camera was designed under the direction of I. Horowitz with valuable assistance from B. Tongue. W. Sampson was responsible for the mechanical engineering.

Relay contacts are brought out to plug on front panel

Variable-Program

Automatic variable-program triggering source was designed to vary camera exposure rates and durations. The triggering rate can be constant and adjustable, or variable for a selected period between predetermined initial and final rates

THIS TRANSISTORIZED instrument was designed to provide a predetermined variable-rate triggering source for instrumentation cameras. Its heart is a unijunction transistor and time-constant circuits.

A bank of charged capacitors is the source of potential for a unijunction transistor acting as a relaxation oscillator. Each capacitor, with its discharge resistance, is diode coupled to the emitter of the unijunction. The capacitor-resistor networks determine, sequentially, the potential applied to the unijunction emitter. By selecting capacitors and resistors, a wide range of triggering-rate decay characteristics can be had.

To provide alternate pulse spacing, a bistable multivibrator circuit, which adds and subtracts capacitance, is coupled to the unijunction emitter.

In the circuit diagram Q_1 is a unijunction transistor. Type 2N489 was used, although any of the types from 2N489 to 2N494 are suitable. Switch S_4 in the FIXED position connects the emitter of the unijunction to the arm of S_3, and through resistances to the 20-v supply. If S_5 is in the EQUAL position as shown, C_1, C_2, C_3, and C_4 will be connected from the emitter to ground. As the capacitor bank charges, the voltage on the emitter rises. When it has reached about 10 v the resistance between emitter and base B_1 decreases, a small current flows and the cumulative action results in a low resistanc between E and B_1. This does not discharge the capacitors completely, but to a value determined by R_1. Here it is 4 v, at which the unijunction ceases to conduct. The voltage on the emitter will slowly rise again to 10, when the action will be repeated. The voltage to which the emitter will rise before it breaks down is determined by R_2 and R_3, and the supply voltage. The triggering rate is variable from two a second to one a minute. The variable resistance R_2 is for recalibrating the device, so that intervals will correspond with the dial settings if the unijunction is replaced or if the components change value. The control is inside the chassis to prevent inadvertent adjustment.

The signal fed into B_2 of the unijunction has an interesting function. As the emitter voltage increases slowly because of the charging of the capacitors, the emitter draws negligible current until it reaches the firing voltage. At this point it requires about 2 μa to trigger the unijunction. If the value of the charging resistor in the emitter circuit is too high, this current is not available and the emitter will remain at about 10 v without firing. To overcome this difficulty, a square wave of 60 cps and 1 v peak-to-peak is applied to B_2 through capacitor C_5. This square wave is available from the 12-v winding of the power transformer through R_4 where it is maintained at constant amplitude by diodes D_1 and D_2. This jiggle voltage is sufficient to trigger the unijunction when the emitter reaches the threshold voltage. The circuit continued to operate with 52 megohms as the value of the charging resistor, and with 64 μf capacitance. The recurrence rate with this time constant was once every 22 minutes. The accuracy of repetition was about 0.3 percent. However, a repetition rate of once a minute fills the requirement for which this instrument was built.

When the unijunction fires, it produces a positive pulse at B_1 of less than 10 v. This has two uses. First, it triggers the monostable multivibrator Q_2-Q_3, lengthening the pulse to Q_4 that operates relay K_1. The duration of operating time will vary from 0.1 to 0.5 second, depending on the setting of R_5. One set of contacts on the relay operates a glow lamp. Two sets are for external use.

The second use of the pulse from B_1 of the unijunction is to trigger bistable multivibrator Q_5-Q_6. This action indirectly alters the time constant of the unijunction, which produces alternate long and short intervals between pulses. To obtain this effect, switch S_5 is set in the L & S position, while S_4 remains in the FIXED position. This connects capacitors C_6, C_7, C_1, C_3, and C_4 in parallel from the emitter through diode D_3 to the collector of Q_7. Capacitor C_2 is connected directly from the emitter to ground. Consider a pulse from B_1 of the unijunction. It triggers bistable multivibrator Q_5-Q_6 and leaves it with Q_5 conducting and Q_6 cut off. The collector of Q_6 will go to ground potential, which is the negative side of the supply. This provides a negative voltage at the base of Q_7 through R_6 and R_7. Transistor Q_7 will conduct, which will make the collector about 20 v positive. Diode D_3 will be back-biased and the bank of capacitors C_6, C_7, C_1, C_3, C_4 will be disconnected. The only charging capacitor for the emitter of Q_1 will be C_2. This will charge more rapidly than before and will trigger the unijunction sooner. When Q_1 fires, the positive

Triggering Source

By B. E. BOURNE,
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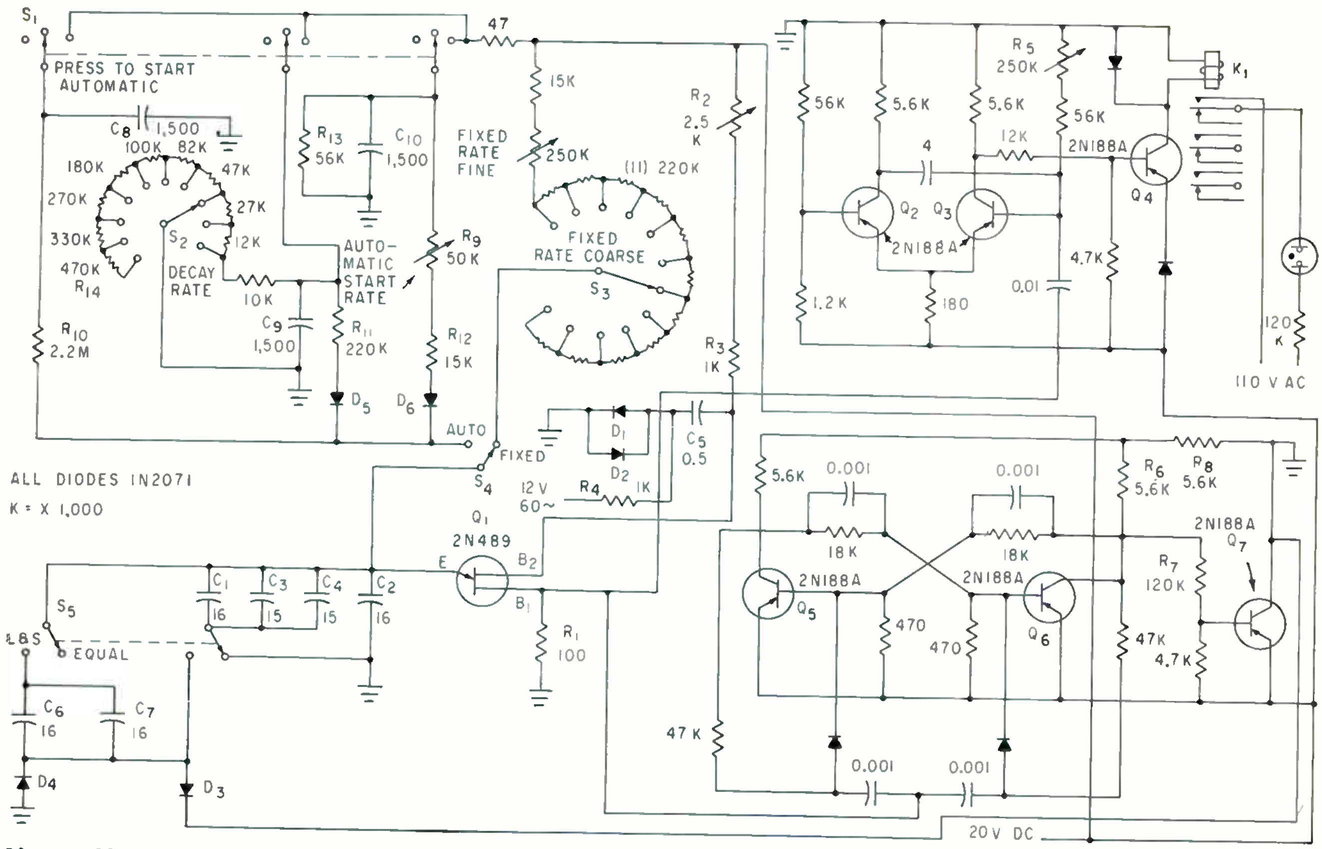


Monostable multivibrator Q_2-Q_3 determines length of triggering pulse that operates relay K_1. Bistable multivibrator Q_5-Q_6 produces alternate long and short intervals between pulses when switch S_5 is in L & S position

pulse from B_1 will trigger Q_5 and Q_6 again, which will leave Q_5 biased to cutoff and Q_6 conducting. Transistor Q_7 will be nonconducting with the collector at ground potential. The common point of the charging capacitors will now be grounded through R_8 and D_3. When the emitter of Q_1 rises in potential the entire bank of capacitors must be charged. When Q_1 fires, the bank of five capacitors is discharged through diode D_4. The pulse from Q_1 again flips Q_5 and Q_6, and the bank of charging capacitors will be out of the circuit for the next interval. The space between alternate pulses will be in the ratio of about 5 to 1, as determined by the ratio of C_2 to the bank of five capacitors. To go back to equal pulse intervals, switch S_5 is moved to EQUAL.

To obtain an automatic decrease in the triggering rate of Q_1, switch S_4 is moved to AUTO. This disconnects S_3 and connects into the circuit a new source of voltage obtained from C_8, C_9, and C_{10}. Switch S_1 is a spring-return, lever-action switch that normally remains in an open position. To start the action the switch is pressed down and held for a few seconds. This charges the three storage capacitors C_8, C_9 and C_{10} to 20 v. While holding the key down R_9 is adjusted until the desired starting rate is obtained. This is variable from 2 a second to 0.5 a second. When S_1 is released, the triggering rate decreases automatically. The storage capacitors C_8, C_9 and C_{10}, are connected to the emitter of Q_1 through R_{10}; R_{11}, D_5; and R_9, R_{12}, D_6, respectively. The resistor-capacitor network that has the greatest effect in determining the starting recurrence frequency of Q_1 is C_{10}, R_9, and R_{12}, because R_9 and R_{12} are much smaller in value than R_{10} and R_{11}. However, C_{10} will be discharged by the load and R_{13} in about 1 minute to a value where it will no longer contribute anything. Diode D_6 will also prevent C_{10} from presenting a load to the remainder of the circuit.

Capacitor C_8 remains charged to approximately 20 v, while the potential of C_9 will be reduced depending on the setting of S_2. At this point the recurrence frequency will be reduced by a factor of 10 in the circuit illustrated. In the next few minutes C_9 will also be discharged, leaving C_8 in the circuit. The recurrence rate by this time will be about once a minute. Resistor R_{10} is of high value, and C_8 will supply voltage to the emitter of Q_1 for more than one hour. By this time the recurrence frequency will be reduced to about once in five minutes. The interval in which the rate will decrease from twice a second to once a minute can be varied from three minutes to fifteen minutes by DECAY RATE switch S_2. The decreasing recurrence rate is not linear but approaches linearity when S_2 is near center position. It is possible to alter the linearity of the discharge curves by combinations of load resistors across capacitors C_8, C_9, and C_{10}.

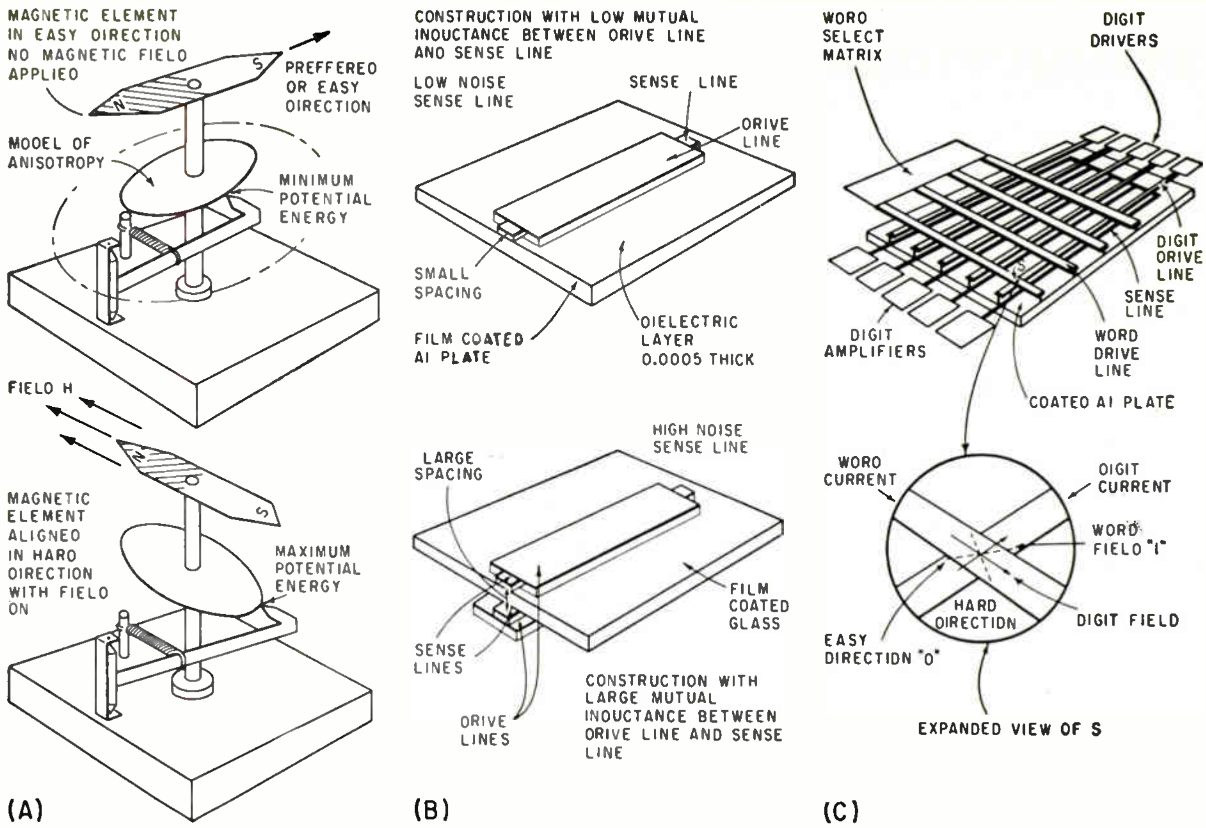


FIG. 1—Model of switching mechanism showing EASY *and* HARD *directions of magnetic polarization (A); aluminum substrate in upper diagram of (B) has much lower noise value than lower glass substrate; expanded view (C) of memory system shows orientation of the various magnetic axes*

Making Reproducible Magnetic-Film

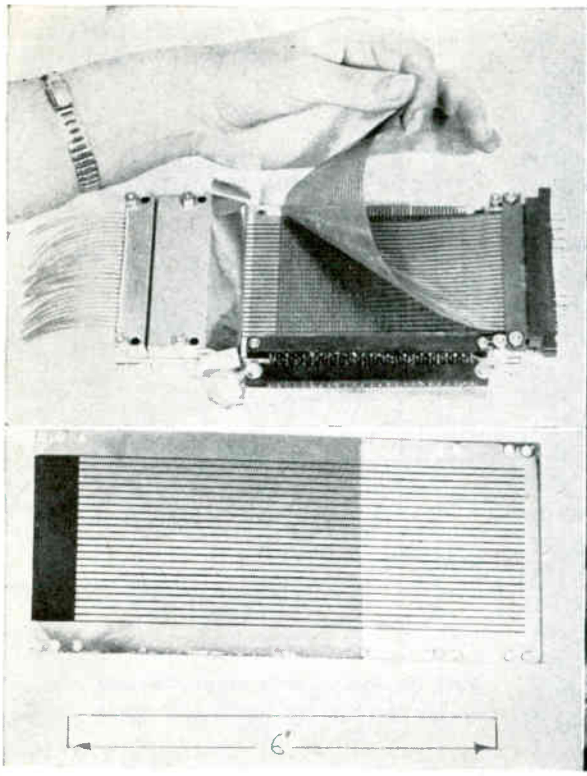
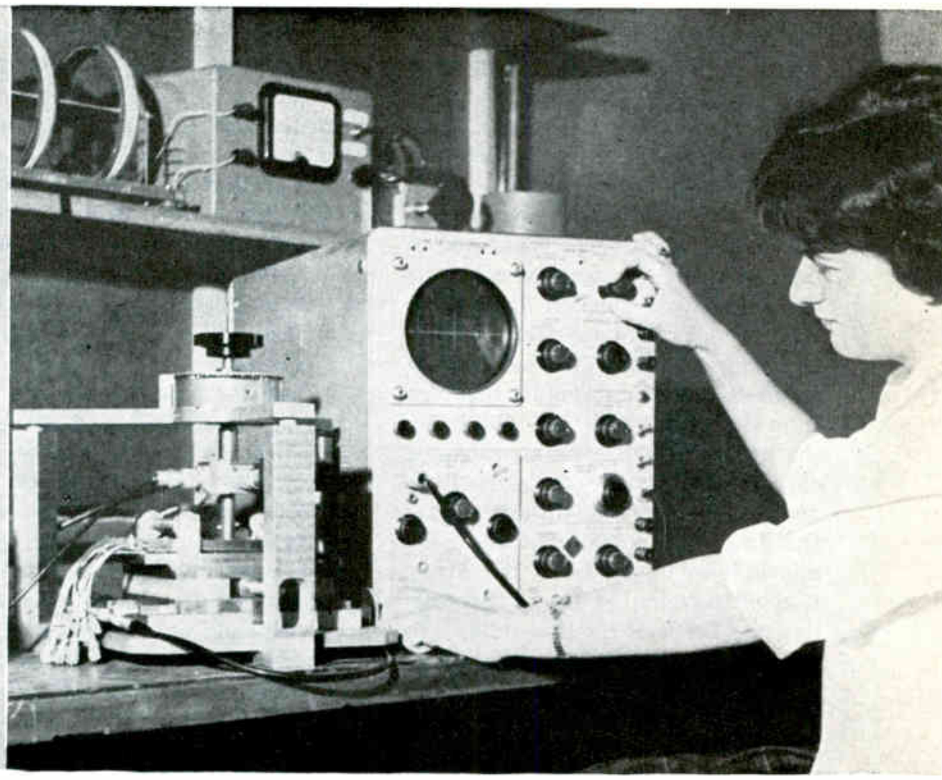
Aluminum substrate permits low-noise readout and good reproductibility of memory units. Single memory stores 1,250 bits, while continuous film, not dot pattern, provides rotation switching process

DEVELOPMENT of high-speed computer logical circuits using transistors has to date outstripped the development of storage devices to go with these circuits. Magnetic films, layers of Permalloy less than 20 micro-inches thick, have been shown to be a promising storage medium with nanosecond access times[1, 2]. However, large scale use of magnetic film storage elements, exploiting the potential low cost and high speed of this medium, has not previously been attempted because of associated practical difficulties.

The major difficulty in constructing magnetic film stores has been the problem of reproducibility of the magnetic properties of the film[3]. It has been known for some time that the rectangular hysteresis loop, obtained when the drive magnetic fields are applied in the preferred direction, cannot be controlled with respect to coercive force at the accuracy required by the coincident current storage system. Furthermore, switching time can be long because the mechanism of switching is prediminantly magnetic domain-wall movement, in which the individual magnetic dipoles caused by the spinning electrons rotate into the opposite direction consecutively[4].

Magnetic films can be prepared which behave differently from other soft magnetic materials[5, 6]. In these films, the magnetization reversal occurs mainly as a coherent rotation process in which magnetic dipoles rotate together. The process is therefore extremely fast. This only occurs in thin films if the magnetic field is applied at a large angle to the preferred direction, that is, the direction where the rectangular loop is found.

The rotational operation can best be illustrated by the drawing in Fig. 1A, which shows that the magnet in this model has two stable positions at minimum potential energy. The magnet, if in either of these positions, is pointing in the preferred direction. These two positions represent the ZERO and ONE stored information states. The magnet has a potential energy maximum if it points at right

Near-complete 2,500 bit magnetic memory unit (top left), coated aluminum memory plate with electro-deposited sense lines in place (bottom left). Photograph on right shows the equipment specially developed to measure the spread of the EASY *magnetic axis*

Memories

By E. M. BRADLEY, International Computers and Tabulators Ltd., Stevenage, Herts, England

angles to the preferred direction, so that if magnetic fields are applied in suitable directions, the magnet rotates over the hump and clicks into the preferred direction of the opposite sense.

This model has been used to conceive new storage devices, but films made from Permalloy have not followed the model accurately enough for it to be of use in the design of a large scale memory. It has been found that films made from an alloy called Gyralloy follow the model more accurately and large sheets of film can be made sufficiently uniform in size 4 by 3 inches permitting 1,250 bits to be stored in a single sheet. It is important to use a complete sheet, to obtain the rotational property, and not a film etched or masked into a dot pattern.

A further difficulty in the design of film memories has been the poor signal to noise ratio. The increased noise is due to induction of a voltage into the sense circuit by the drive currents. The scale of difficulty can be seen if it is realized that a magnetic film storage element contains about one thousandth of the flux produced in a ferrite memory core, but requires about the same current to drive it. The stray mutual inductance between the sense and drive lines must therefore be reduced by 1,000 times of that obtained in ferrite core memories. Such reduction has been achieved in this film memory by depositing the magnetic film by vacuum evaporation onto an aluminum plate and separating the sense line from the plate with an insulator less than 0.0005-in. thick (Fig. 1B). Thus the sense line and the plate behave like a transmission line of very low impedance because of their close spacing. The mutual inductance between the sense circuit and the drive circuit is sufficiently low.

The memory described in this paper is made from two coated aluminum plates, and stores 2,500 bits organized into 50 words.

Use of an aluminum plate as substrate for the film allows many plates to be connected together to form large stores with capacities up to tens of thousands of words. The read-write cycle time can be a fraction of a microsecond and is not so much limited by the reversal time of the film element as by the driving circuits. Contrary to early suspicions, rotation of the magnetic dipole moment of the element is not damped by eddy currents induced in the aluminum plate or the drive strips.

The elements of the memory are organized as shown in Fig. 1C. In this device, the rows of the matrix are arranged to intersect each bit of a word, and the columns a particular digit position in every word. In the write process it is necessary to select the word row into which it is desired to write, and to pass a suitable current pulse along it through the word drive line. The chosen word is then primed and a small current pulse is passed down each column or digit drive line into which it is desired to write ONE. This current is sufficient to place the primed elements into the ONE state but not those which have not been primed.

The read process is similar except that a read amplifier is connected to lines running in parallel with the digit drive line and no digit drive lines are activated. The desired word line is again activated and the magnetic elements are all reversed into the ZERO state. In doing so, the magnetization rotates, causes a change in flux cut by the sense lines and thus induces a voltage across the line. The polarity of the voltage induced depends on the direction of rotation of the magnetization and hence of the magnetic state prior to the word select pulse.

Magnetic film memory operation (using the coherent rotational mode of switching) has been proposed before on a small experimental scale but in the matrix to be described here the operation is somewhat different. The inset in Fig. 1C shows how the magnetic fields are applied to an individual memory element and Fig. 2 shows the behavior of the magnetization vector at various stages in the write ONE cycle.

The field caused by a current pulse along the word line is arranged to be at righ angles to the field caused by the digit line, which in turn is arranged to at a small angle, about 5 degrees to the preferred magnetization direction. If the element is storing a ONE the magnetization vector points downwards in Fig. 2; if ZERO, it points upwards.

In the write ONE process, the digit field is switched ON first but is of insufficient amplitude to switch the element to the ONE state by itself (Fig. 2b). With the digit field still ON, the word field is turned ON causing the magnetization to rotate nearly into line with the word field against the torque acting in the opposite direction (which is a result of the magnetic anisotropy of the material). The word field is then switched OFF and the digit field by itself is able to exert sufficient torque on the magnetization to rotate it past the direction where the sign of the anisotropy torque changes. The magnetization then rotates very nearly into the ONE state easy direction under the action of the anisotropy torque and the digit field torque. When the digit field is turned OFF the magnetization rotates into line with the easy axis.

The write ZERO process is similar except that no digit field is applied, and thus at the end of the word pulse the magnetization rotates back to the ZERO state easy direction under the action of the anisotropy torque alone.

During the read process only the word field is applied, and since the magnetization can be in either the ONE or ZERO state, it rotates into line with the word field and then back again into the ZERO state ready for the next write process. The direction of rotation of the magnetization depends on the state of the film before the word pulse. Therefore if a loop is arranged to cut flux in the same direction as the digit field (Fig. 3) then the polarity of the voltage pulse generated in the loop at the leading edge of the word pulse depends on the previous state of the film element. At the end of the pulse the magnetization rotates into the ZERO state in both cases, resulting in the same output polarity.

It has been shown that a small angle must be maintained between the EASY axis and the word drive line (referred to as tilt angle) and it has been found that the widest tolerances in this angle can be allowed if the nominal value is 5 degrees. Actually, satisfactory operation can be achieved if the tilt angle is 5 ± 3 degrees.

One of the difficulties in designing thin film memories is that the changing field generated by the selection pulses induced a large voltage in the sense loop. This is due to the large area of the sense loop which encloses the glass substrate as well as the film (Fig. 1B lower). It is not practicable to reduce the thickness of glass to smaller than 0.1 mm and it has been found difficult to make magnetic film of the desired properties on thin mica or on plastic. Evaporated sense lines are also unsuccessful because they have too large a resistance and form a poor substrate for the magnetic film.

In this present film memory, aluminum sheet is used as the sub-

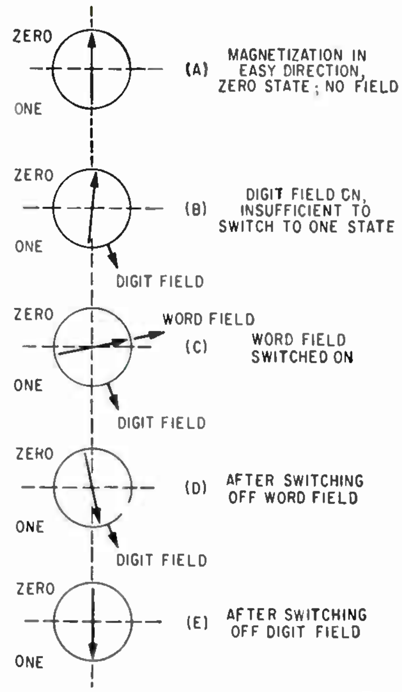


FIG. 2—Behavior of magnetization vector during the write ONE *cycle*

strate for the magnetic film, and forms an earth return for the sense line, which can then be close to the film. This results in a sense loop of small effective area as shown in the upper diagram of Fig. 1B. The sense line itself can be a thick electroplated layer, eliminating attenuation difficulties.

There are two further advantages in using an earthed plate. First, the magnetic field due to a current passing through a strip line near to the film is doubled because of eddy current image effects. Second, the inductance of the driveline is reduced so that back voltage generated during current change is reduced thus limiting the drive power required.

It has been suggested[7] that if metal conductors are placed near to the magnetic film, rotation of the magnetic dipole will be damped by eddy currents induced by this rotation. However, magnetic elements deposited on aluminum have been switched successfully in a time as short as 10 nanosec with no evidence of eddy current damping.

Specifications for the magnetic film are as follows: (1) each storage element must perform closely to the simple coherent rotational model; (2) each film element must have its easy axis placed within ±3 degrees of the design angle; (3)

the anisotropy energy should be of such a value that the drive currents can be generated conveniently.

A test apparatus was built to test the properties of small film areas, using current pulses of rise time and duration similar to that to be used in a storage system. This apparatus determines the angle between the easy axis and the edge of the plate. In the test shown in the photo two drive conductors placed at right angles to each other are turned together to any angle with respect to the edge of the plate. Any point of the plate can be placed under the drive head, so that variations over the area of the plate may easily be studied.

During the measurement, the drive head is rotated while a current pulse train generates magnetic field pulses near the hard direction of the film element. The head is moved so that the field is swept past the hard direction. When this occurs, the voltage response observed in the sense line, which cuts flux at nearly right angles to the hard direction, is observed to change polarity, as expected from the simple model. It is possible to identify the easy axis by this test, for those films which are a good approximation to the simple model. Most thin magnetic films, however, unless specially prepared, do not behave according to the model. Instead of magnetization reversal occurring mainly by rotation, it occurs mainly by wall motion, with the consequence that very little change of flux is cut by the sense line, thus yielding small output.

It has been shown in an earlier paper that low frequency hysteresis loops of a specimen of a film 2 *cm* square prepared from 81:19 nickel-iron alloy approximated the characteristics expected from the simple rotation model[5]. It has been found that large sheets of film prepared from 81:19 alloy are not sufficiently consistent in their rotational behaviour and in the position of the easy axis to be of use in a large computer memory.

However, films of an alloy called Gyralloy 1, can be made to fulfill the memory requirements, even over areas of 4 by 3 inches for a film thickness of about 1,000 A.

These properties are only found in a complete film sheet where individual storage elements are defined by the magnetic field pattern generated by the drive line.

The field in the plane of the film falls off rapidly beyond the strip if the film is spaced close to the strip. The field normal to the film has no effect because it is four orders of magnitude smaller than the demagnetizing field in this direction.

Previously proposed storage devices have used masked or etched dot patterns. Storage plates have been tested before and after etching into a dot pattern of 2.5-mm diameter dots. It was found that the flux rotating due to a field applied near the hard direction was very much reduced and the tolerances available in the drive currents in the memory are also reduced using the etched dot pattern.

After it had been shown that films of the necessary properties could be made, the next step was to find out the packing density that could be achieved. This was done by using an etched copper circuit pattern on which there were 16 conductors each 0.020 inch wide spaced 0.005 inch apart. Activation of suitable conductors could then simulate various strip widths and spacings. This experiment showed that it was possible to use drive strips of 1 mm width and the word drive strips should be spaced by 0.5 mm and the digit drive strips by 1.5 mm. The currents required were 1.2 amp-turns word current, 0.5 amp-turns digit current. The output voltage was about 3 mv for word pulses having a rise time of 40 nanosec.

The prototype store, having 50 words each of 50 bits, was built in the following way. A magnetic film of Gyralloy 1 of about 1,000 Angstrom thickness was deposited onto a plate of aluminum 7 inch × 3 inch with the film coating confined to one end of size about 4 inch × 3 inch. The plates were tested for

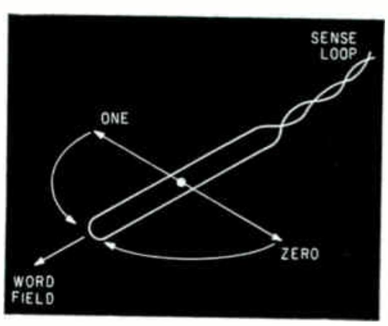


FIG. 3 Orientation of sensing conductors for information readout

rotational switching properties and for angle of tilt of the film at many spots over the total area.

Satisfactory plates were then coated with a thin layer of cellulose lacquer and a layer of copper was evaporated onto the lacquer. The copper was built up to a thickness of 0.001 inch by electro-plating and the required sense strip pattern was etched out using conventional printed circuit techniques. This process results in a sense line pattern in which each line is spaced about 0.0005 inch from the coated aluminum, as shown by the photograph of the plate at this stage. Two plates were then mounted back to back and the word drive strips were wound over the plates. Each word drive strip consisted of 4 turns of enamelled copper strip 0.010 inch wide, 0.002 inch thick and the spacing between the strips was equivalent to 2 turns of this wire.

The next stage of the process was to connect each sense line to a miniature coaxial cable and then to place a screening box over these joints. The final stage was to fix the digit drive line pattern over the assembly. This pattern was made by the usual printed circuit technique from a thin 0.005 inch plastic copper clad. Figure 4 shows a photograph of the store before the digit line pattern was fixed to the plate.

The performance of the store can best be summarized by the following measured characteristics: word drive 0.3 amp $< I_w <$ 3 amp (not tested above this value), digit drive current 0.6 amp $< I_d <$ 0.8 amp. word drive inductance 0.6 μH at 0.5 amp (0.2 μH contributed by the film).

This means that, for a pulse of rise time 100 nsec, back voltage generated is 6 volts at I_w = 0.5 amp.

Acknowledgment is given to Journal of British Institution of Radio Engineers for permission to use some of the data contained in a paper to be published.

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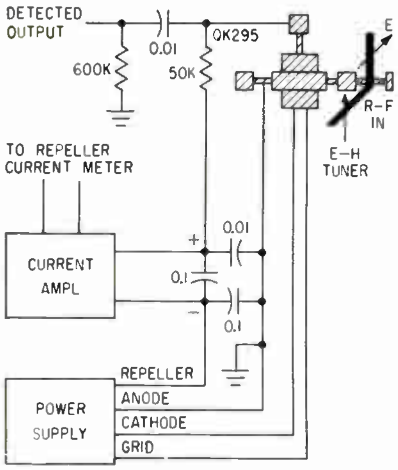

FIG. 1—Reflex klystron regenerative detector uses QK-295 klystron

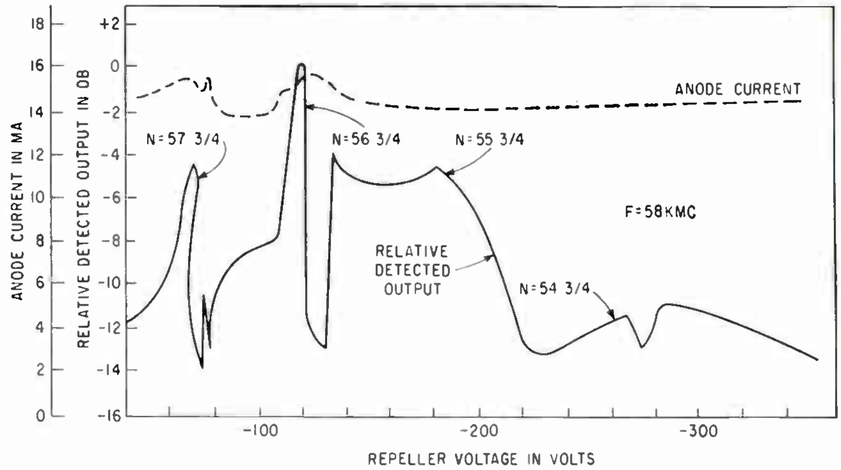

FIG. 2—Repeller characteristics of QK-295 reflex klystron detector having an anode voltage of 3,000 v and a grid voltage of —131 v

Use of Reflex Klystrons

By feeding 58,000 Mc signals to the cavity resonator of this reflex klystron regenerative detector, output signals at repeller are 12 db greater than those of conventional crystal detector. Study of repeller current suggests detection is caused by electrons striking repeller

By KORYU ISHII, Dept. of Electrical Engineering, Marquette University, Milwaukee, Wis.

SUPERHETERODYNES have the highest sensitivity in receiving systems. However, this type of receiver has two problems—circuit complexity and image response. To solve these problems, a backward-wave amplifier and a reflex klystron were proposed for microwave autodyne reception[1,2]. Both these tube types showed successful results in X-band.

The reflex klystron approach is simple and economical. In this article, the behavior of the QK-295 reflex klystron as a millimeter-wave regenerative detector is analyzed.

A schematic diagram of a QK-295 regenerative detector is shown in Fig. 1. The repeller voltage is adjusted so that the electrons can reach the repeller.

The input signal, which is a 58,000-Mc wave modulated by a 1-Kc square wave, is fed into the reflex klystron through an E-H tuner. The detected output is taken from the repeller circuit, measured with a vacuum-tube voltmeter and observed on a cathode-ray oscilloscope. Repeller current is measured by a microammeter with a transistorized current amplifier.

When the 1-Kc square-wave modulated 58,000-Mc signals are fed to the reflex klystron detector, the detected output varies as a function of the repeller voltage as shown in Fig. 2. The anode current increases when the detected output peaks.

This characteristic is similar to oscillation or amplification[3]. This suggests that when the detected output is optimized by electronic tuning with the repeller voltage, the electron behavior is similar to regenerative amplification.

Electronic tuning for detection can be achieved by adjusting the anode voltage. Only one mode—$N = 56\frac{3}{4}$—was clearly observed. When the anode voltage decreased, the beam current decreased. The $N = 57\frac{3}{4}$ mode will occur theoretically at $V_a = 2{,}925$ v if the beam current is sufficient. At this voltage, the current was so low that this mode had degenerated. The anode

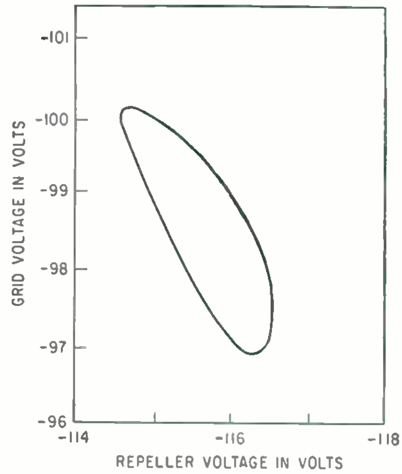

FIG. 3—Combination of repeller and grid voltages to produce same detected output in $N=56\frac{3}{4}$ mode

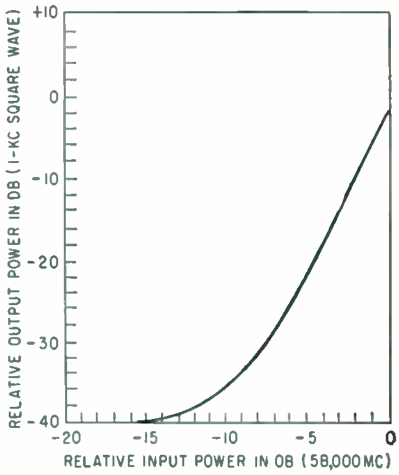

FIG. 4—Input versus output power level characteristics of QK-295 reflex klystron detector

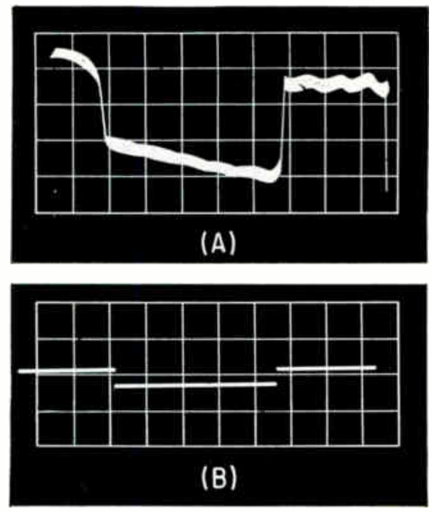

FIG. 5—Klystron detector output (A) is 12 db greater than conventional crystal detector output (B)

As Millimeter-Wave Detectors

voltage could not be raised much above the specified voltage, so the experiment involving mode $N = 55\frac{3}{4}$ was not carried out. For similar reasons, only one mode was observed when the electronic tuning was done by grid-voltage variations.

Optimum output can be obtained within a range of grid voltage in the $N = 56\frac{3}{4}$ mode if the repeller voltage is adjusted as shown in Fig. 3. Repeller and grid voltages were adjusted to give 0.7 mv detected output.

The linearity of the detector is good within the range of operating power levels as shown in Fig. 4. The relative detected output level is plotted against the relative input power level and zero db of input power does not correspond to the zero db level of the output power. The scales of input and output are independent and both represent relative values.

Investigation of the standing-wave ratio suggested how the mechanism of electron motion of the reflex klystron detector might be described.

The vswr on the input waveguide line was adjusted to 1.2 with the detector tube inoperative. The vswr increased to 2.7 with the detector operating. When detection started, strong reflected waves were observed in the input waveguide. One interpretation of this phenomena is that these waves are amplified waves resulting from regenerative amplification by the reflex klystron tube[3].

When the QK-295 is used as a regenerative detector, d-c repeller current flows in a direction opposite to that of the 2K25 reflex klystron detector. With the 2K25, d-c repeller current flowed toward the repeller[2]; with the QK-295 repeller current flowed toward the power supply as if the repeller were emitting electrons.

Repeller current increased when the input r-f intensity increased indicating that the speed of the electrons contributing to the repeller output signal increases when the r-f intensity increases.

When the anode voltage decreased, the repeller current decreased. Again, the repeller current depends on the speed of the electrons. The repeller current is controlled by the grid voltage, which controls total emission as well as the repeller current.

Details of the 58,000-Mc, 1-Kc square-wave modulated waveforms are shown in Fig. 5. The reflex klystron output (5A) is 12 db greater than that of the matched DBB-319 crystal detector (5B). Although the klystron has much greater output, its pulse response is not as good as that of the crystal detector.

The author thanks the Raytheon Co. for contribution of the klystron tubes. Acknowledgments are made to J. Tsui, J. A. Stefancin, J. E. Billo, A. Treder, S. Krupnik and J. D. Horgan of Marquette University, and to the University Committee on Research.

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Practical Approach To Interference

Information is provided on circuit interference problems and on

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MUCH TIME AND MONEY can be saved by carefully planning the means of reducing interference in the initial phases of system design. This article presents methods of estimating interference and preventing it. The problem is examined by first considering circuit cards, then sub-assemblies, then the combining of sub-assemblies into a system package.

Figure 1 shows circuit cards containing circuits chosen only to illustrate interference problems. They show incorrect (A) and correct (B) layout methods. The positions of components in the schematics approximate their actual physical layout. The circuits have high gain and contain many of the circuit elements which are sources of electromagnetic radiation.

Inspection indicates the following possible sources of radiation: delay line DL_1, which could be located in any portion of an actual circuit; stage-input coils L_1 and L_2; the tuned circuit at the collector of Q_1; peaking coils L_4 and L_5; Zener diodes D_1 and D_2, and relay K_1. The obvious sources of radiation having been determined, the problem becomes one of determining how much attenuation and shielding is necessary. Since the characteristics of shielding and filtering are such that the shields and filters are least effective at the lowest frequency encountered, the first design criteria involves this frequency.

Assume the frequency interval of interest to be between 0.15 and 1,000 Mc. In considering the energy radiated by the tuned circuit for Q_1 (the same procedure would be followed for the other circuits), a knowledge of the characteristics of the incoming signal is necessary. The incoming signal is a pulse type which can be represented to a first approximation by a square wave having an amplitude of 5 volts, a width of 1 μsec, and a repetition rate of 5 Kc. Since various amplitudes will be encountered throughout the circuitry, assuming pulse-width preservation, a family of radiated-interference curves can be drawn for various amplitudes (A_ω) based on a plot of the solution to $A_\omega = 2\,Et\Delta f \int_{0.15\text{ MC}}^{1{,}000\text{ MC}} (\sin \pi tf/\pi tf)$ Such a plot is shown in Fig. 2 where E is the amplitude of the pulse in volts, t is pulse width in μsec, Δf is the prf of the pulse train, and f is the frequency at which the amplitude A_ω occurs. It can be seen that at 150 Kc and for the assumed input conditions (using curve D), approximately 48 mv of radiation will exist at the tuned circuit. When using this data, space attenuation and component configuration must be taken into account. The radiated level to which it is desired to reduce this signal is 5 μv; this reduction represents approximately 80-db attenuation.

Given a requirement of 80-db attenuation of the radiated energy, we now proceed to determine what material shall be used to enclose the tuned circuit of Q_1 and how thick this material shall be. Since weight is a factor, aluminum, magnesium or some other lightweight metal must be used. From the theory and design data given by C. S. Vasaka[1], we determine the minimum thickness necessary to achieve 80-db attenuation. Using a conservative value of 2.5-db-per-mil thickness for aluminum, it is seen that an aluminum box constructed from 0.030-in. aluminum and having an 0.002-in. cadmium plating, or other similar type of plating to permit soldering of grounds, provides the necessary attenuation at 150 Kc.

Having now chosen the shielding material, we next determine the filter that will produce the desired attenuation. The filter-attenuation requirement is that the signal level at the line side of the filter shall be less than 1.5 mv at 150 Kc, thus giving an attenuation requirement of approximately 30 db at 150 Kc. Figure 1B shows the modification of Fig. 1A for interference suppression. Since effective decoupling must be achieved within the circuit configuration, the d-c voltage lines have rather large capacitors; therefore L-type filter networks are adequate. To achieve the highest amount of attenuation at the upper frequencies, (above 20 Mc), a feed-through type of capacitor having three terminals is best; this type has a terminal external to the package which permits the soldering of lead wires from the cable harness and provides maximum available attenuation as a filter. To complete this filter, we now must connect a choke (L_6) between the feed-through capacitor (C_{17}) and the decoupling capacitor (C_{10}).

Design of L_6 is governed by the amount of attenuation that is required between the points in the frequency spectrum where the decoupling attenuation drops and the feed-through capacitor attenuation begins. (Fig. 3)[2]. The resultant attenuation curve, which is found by drawing a line joining all three curves, becomes the effective attenu-

Prediction And Suppression

proper grounding techniques to aid in system design

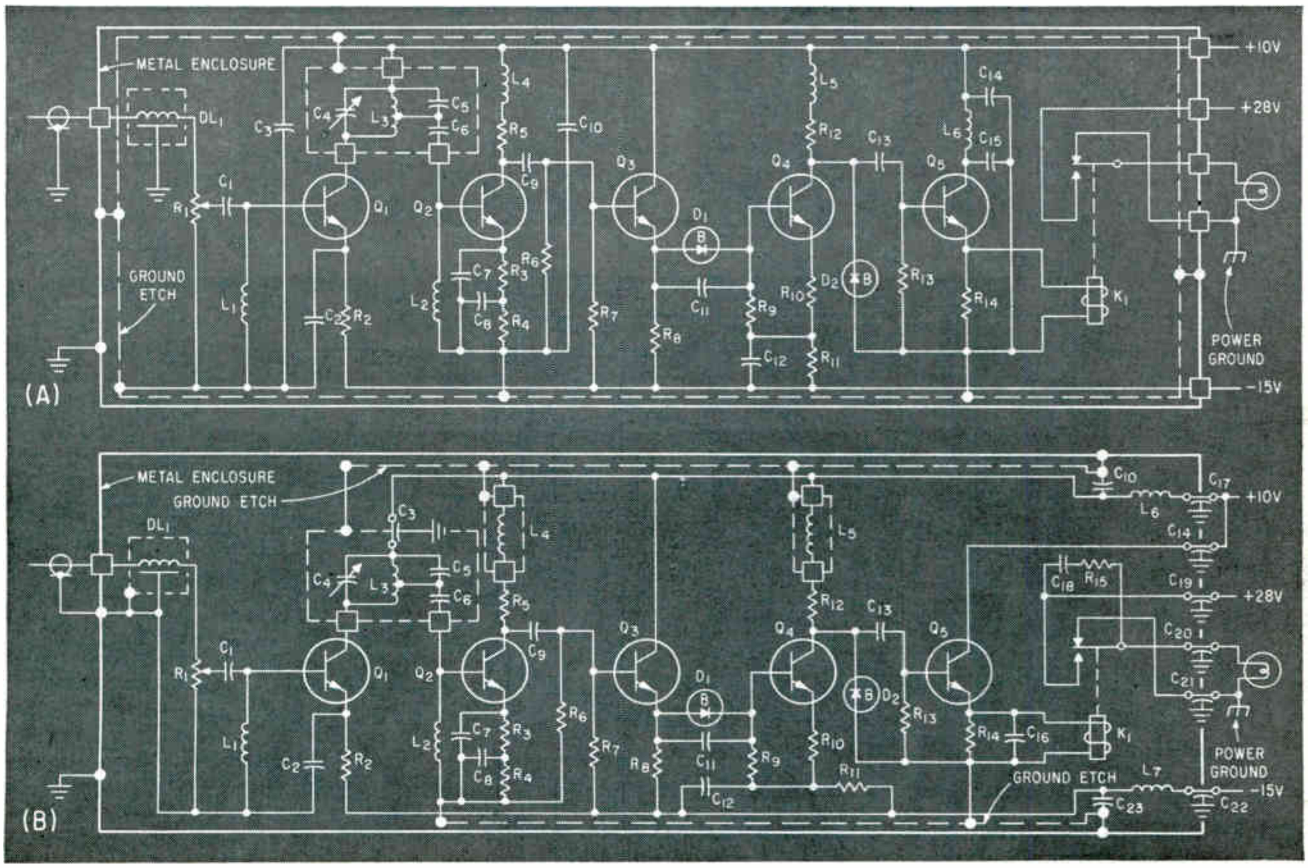

FIG. 1—These circuit cards show examples of incorrect (A) and correct (B) layout methods

ation of the filter. Similar calculations for other circuits will determine the shields and filter sizes that are necessary to confine interference within the enclosure.

When discussing ground-voltage gradients (commonly known as ground currents), it is necessary to define a ground reference point from which all voltage gradients are measured. Here is a definition for the ground reference point: given an infinite conductive plane, the ground reference point is the point at which the difference of potential between it and any other electrical point within the plane is zero, regardless of how far apart they may be. Zero volts cannot be attained in most practical cases, where 10 μv is probably a typical value; the requirement set for Fig. 1B was 5 μv. When specifying how much voltage above this theoretical zero the system can tolerate, bear in mind that the amplitude of any detectible voltage gradient becomes, to a first approximation, the amplitude of the radiated energy detected at very short distances from the ground plane. This, of course, points up the present need for measurement equipment capable of being calibrated to a standard based on this definition, and usable up to and including, the Gc region at sensitivities of a μv or less.

In reducing these ground-voltage gradients, let us consider the physical layout of the circuit. Our first thought is to the placement of decoupling capacitors C_{10} and C_{23} in Fig. 1B. These capacitors should be placed in the circuit where the heaviest r-f current is drawn and their ground leads should be as short as possible. The input circuit should have all grounded compo-

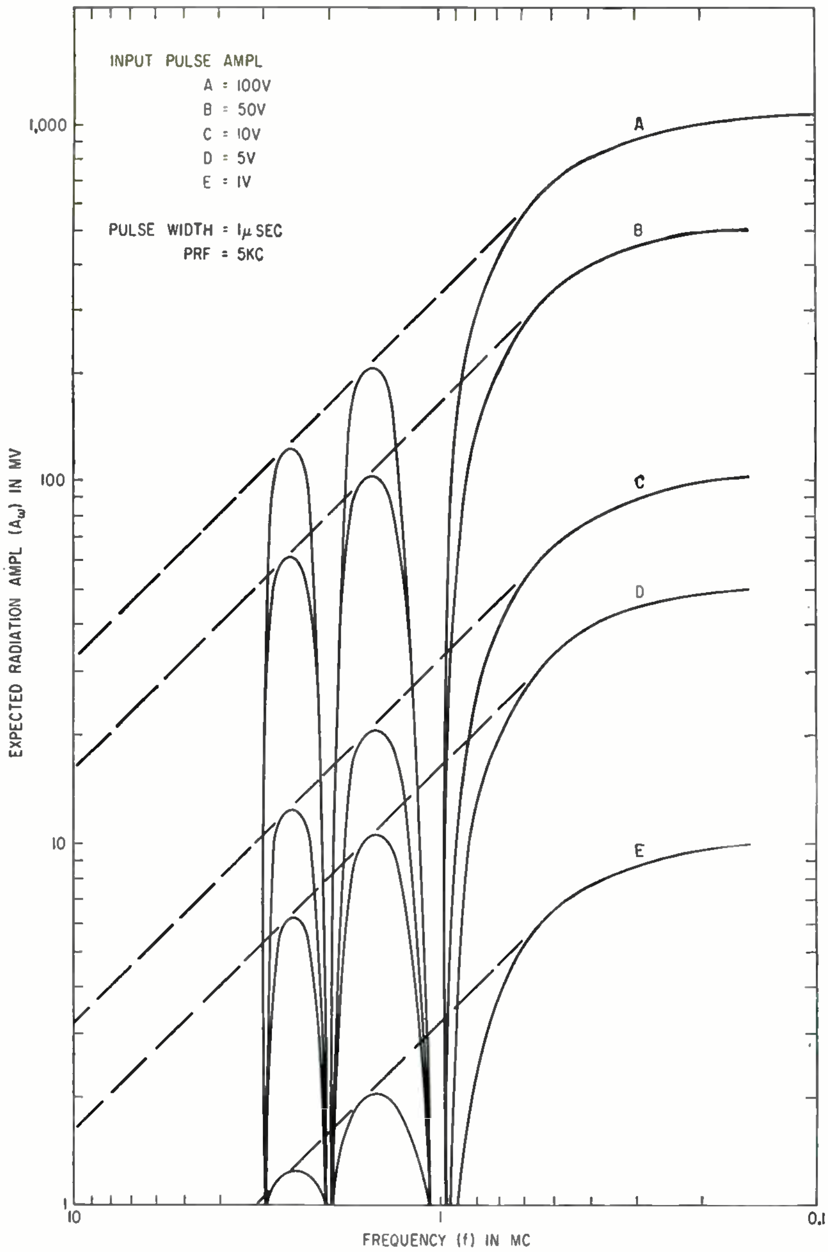

FIG. 2—Expected radiated-interference levels for various input voltages

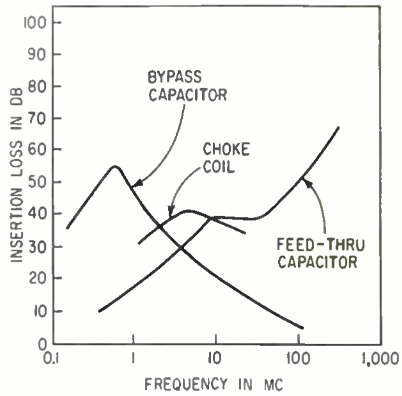

FIG. 3—Attenuation curves of individual filter components

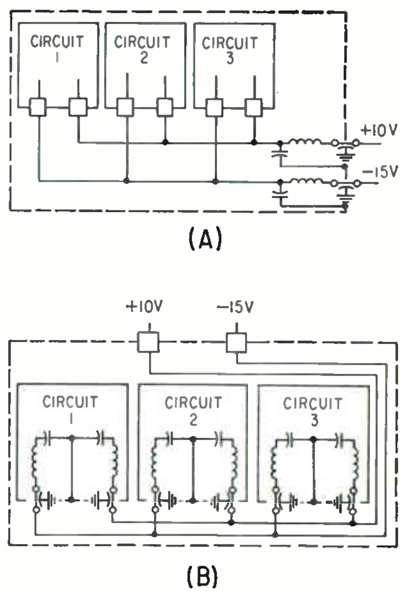

FIG. 4—Incorrect (A) and correct (B) methods of filtering for subassemblies powered by a common supply

nents brought to the physical input ground. This prevents the circulation of ground-voltage gradients. All tuned circuits and peaking coils should be completely enclosed and the shield made a part of the ground etch. The ground etch should be made at least three times the width of the other interconnecting etches. The ground etch should not pass near the high-level signal-carrying etches, nor should the ground etch make a complete loop around the periphery of the circuit board. If it becomes necessary to carry the ground etch around the outside of most of the board, there should be a considerable break between the start of the etch and the end of the etch. This ground etch should be fastened to the shield which comprises the outside cover of the box housing the printed circuit card at the points where the maximum r-f current flows. In the example, these points are near C_{10} and C_{23}; generally, they are determined empirically. This prevents heavy r-f currents from passing through the lower-level signal paths, thus minimizing the circulation of ground current. Note that when ground-voltage gradients exist, the entire enclosure of the circuit may radiate energy and contaminate other packages within the system.

The dynamic impedance of the system's power supply should be kept as low as possible, preferably in the order of less than 100 milliohms; this further prevents circulation of ground currents within the supply, and materially aids the amount of suppression achieved at lower frequencies.

Figure 1A illustrates the type of layout often encountered when circuit designers do not take into consideration the factors outlined above. It shows a composite of many of the mistakes encountered in practice. Any of these can cause trouble, not only from the point of view of interference, but also from that of circuit operation. Often, circuits which fail to operate as the designer intends, can be made to perform properly when laid out with correct interference principles in mind.

In Fig. 1A, for instance, the input signals can pass through the output ground. This creates a feedback situation which may cause unintended oscillations. Note that since the ground etch is located at a point other than where the heaviest r-f signal currents flow, a potential difference is set up which may improperly bias one or more of the transistor bases. Another possible cause of trouble is the positioning of filter choke L_6. The choke's leads must be short to prevent radiation of the signal before filtering. This effect is especially pronounced at higher frequencies.

Input circuits should be located at the opposite end of the card from the output circuit.

Another example is shown in Fig. 4, where several amplifiers are fed from the same power source. In Fig. 4A, which shows the incorrect method, there is only one filter between the three cards and the power supply. The three cards interact and thus create a high noise level. In Fig. 4B, each card correctly has its own filter to prevent interaction between amplifiers.

Up to this point, the problems incident to the design and construction of a single sub-assembly have been discussed. Consider now the combining of a group of sub-assemblies into an operating system. Assume that each system sub-assembly is interference-free within the specification limits.

In laying out the wiring harness, unshielded signal-carrying wires must not run in close proximity to any unfiltered power lines.

Electrical ground (known as power ground) continuity and massive (that is, more than point-contact) ground continuity for signal grounding must be maintained. In most aircraft installations, the system is contained in a box which slides into a rack, like a drawer, and grounds must be set up to provide continuity between the box and air frame (Fig. 5). For this reason, there are usually two grounds, one for power and one for signal circuits. The power ground usually passes through a filter located in the back of the rack, as in Fig. 5, and continues on as a wire to the aircraft power generator where it is grounded to the air frame. The signal ground is usually maintained by finger stock or r-f gasket material which provides an intimate bond between the system box and the rack. If the rack frame contains more than one box, it is grounded to the air frame at a single point, the nearest point possible, to prevent the circulation of ground currents within the rack frame.

In determining the amount of shielding required for the signal-carrying leads within the system box, remember that at the lower frequencies, that is, 150 Kc to 10 Mc, the attenuation afforded by a single-shield 90-percent braid is approximately 40 db—this level being equivalent to a 100 μv/meter attenuation with a 50-ohm load. Consequently, it may be necessary to go to a double braid or a solid shield. Thus, attenuation limits the type of connectors which may be used. If current levels are extremely high, causing the filters to be large, it may be necessary to use shielded leads from the sub-assembly to the power supply or other termination. In this case, use a double-shielded wire.

The mechanical construction or layout of the system box (Fig. 5) should locate the power supply at one end, preferably near the output end, so that there is a shield between the power supply and the output, with the power supply sufficiently far away from the input circuit so that any radiation due to the power supply is not picked up by the lower-level signal circuits.

The metal finish should provide good conductivity when the sub-assemblies are bonded to the box frame. For this purpose, finishes such as metal plating or iridite, which give a relatively high conductive surface, should be used. A grounding pressure of about 40 lb/in^2 should be achieved by the mating surface. This pressure usually ensures intimate ground contact. If an irregular shape is necessary and good metal-to-metal contact is difficult to achieve, use r-f gasket material to take up the differences between the two metal surfaces.

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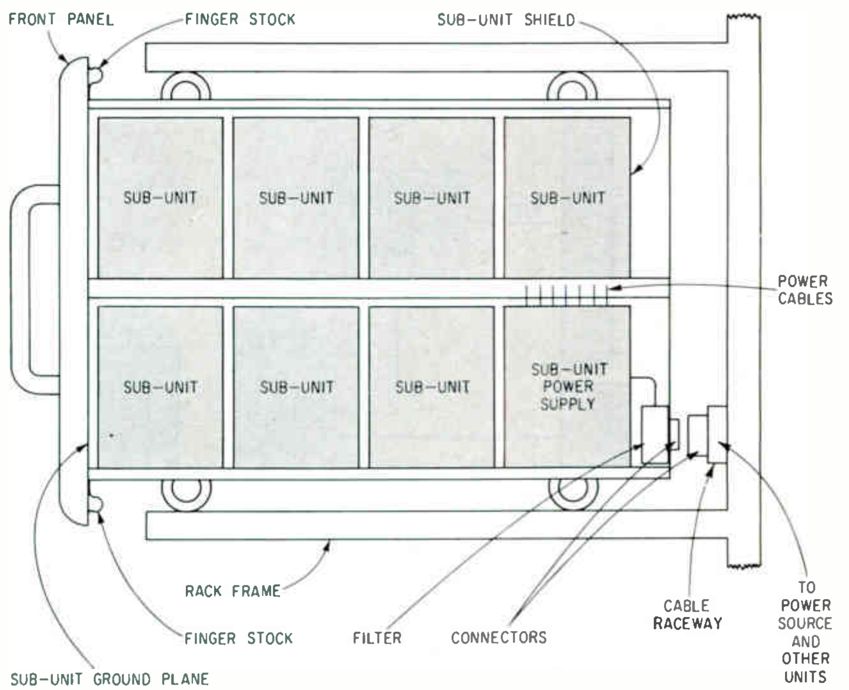

FIG. 5—Grounding scheme for subassemblies

Staircase voltage generator provides a five-digit time code for unique identification and correlation of data on magnetic tape loops as short as 30 inches

Display equipment of B-66 radar development instrumentation system shows at left the remote repeater for the cockpit

Digital Time Code Identifies Recordings

By VERNON B. MORRIS, JR.,
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A RECORDED TIME CODE is often needed in instrumentation magnetic tape and oscillographic recording. Whenever it is desired to determine accurately the time between recorded events, or when two or more recorders must be correlated, a recorded time code becomes essential. In many applications a cyclic timing signal is recorded on one track of each recorder in the instrumentation system. Typical timing signals are one-second pulses on a 100-cycle note. However, the recorded time signal does not identify uniquely any portion of the record. To determine times between events or to correlate two recorders requires counting. Where lengthy recording periods occur or accurate time resolution is required, simple time-pulse recording is not satisfactory. The difficulties may be accentuated by inability to determine exact beginning and end of record and by pulses missed while the recorders are coming up to speed. When portions of the records must be removed for data analysis or editing, the portions removed cannot be identified in time, and corrections to the record must be noted.

The shortcomings of periodic time and correlation pulse recording are overcome by a time-code and data-correlation system that generates a unique output for each time period. Digital timing units that produce unique outputs for each time period are commercially available. These equipments fill the timing and correlation requirements but due to cost and complexity they are not found in many installations. The commercially available units usually require an entire track of magnetic tape, and the output may not be suitable for recording on oscillographs. The recovery on play-

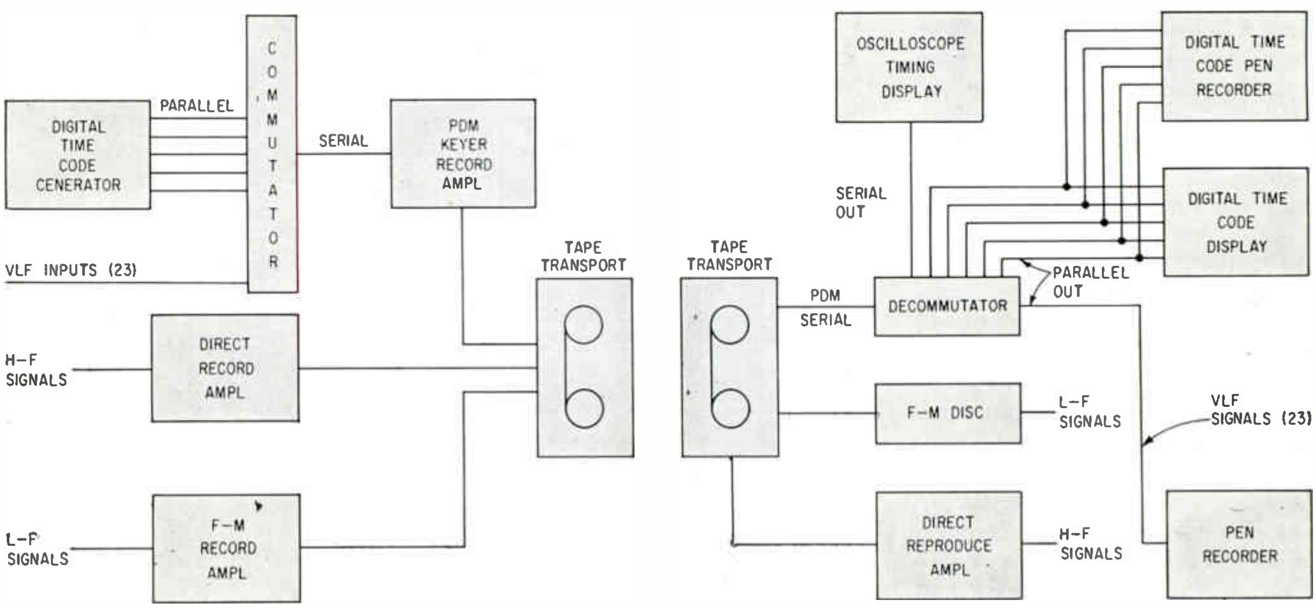

FIG. 1—Block diagrams of record portion (left) and reproduce portion (right) show digital time code equipment added to magnetic tape system

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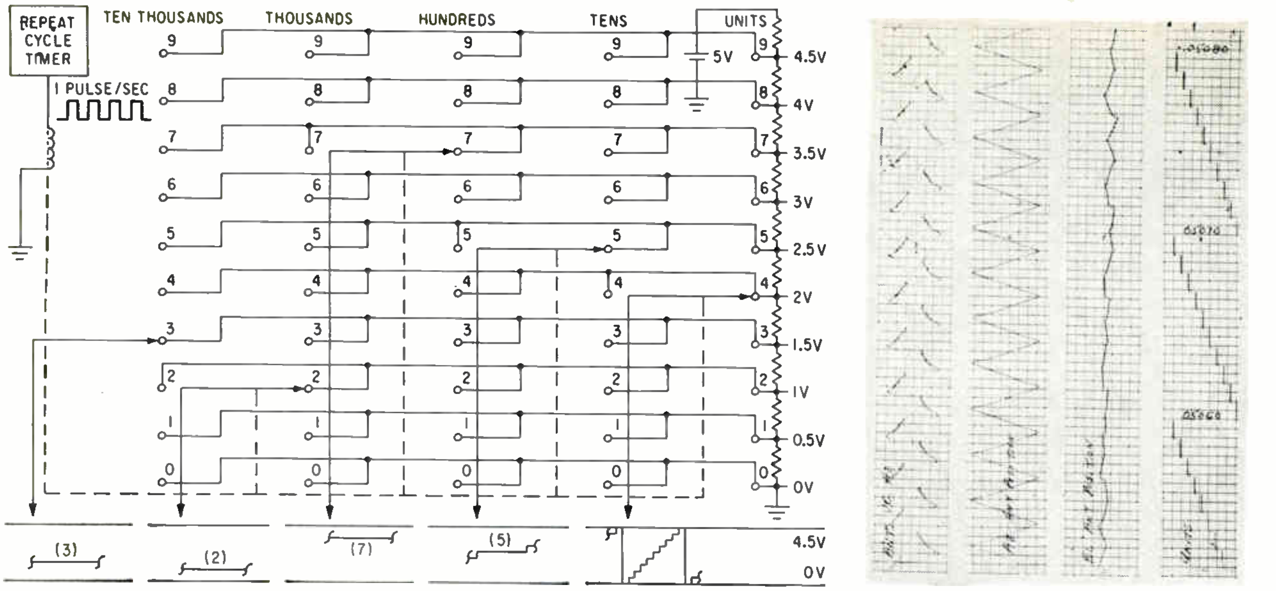

FIG. 2—Repeat cycle timer in digital code generator (left) advances the units wiper of the counter, which advances mechanically the higher order wipers at one-tenth the frequency of the next lower order. Strip chart recording (right) displays only unit seconds

back of the digital timing code generated by these systems also requires costly, complex equipment.

A simple, relatively inexpensive digital timing code and data correlation system (Fig. 1) has been devised that does not require an entire track of the magnetic tape and may be played back on equipment available in many magnetic tape facilities. Several channels of a pulse-duration modulation (pdm) magnetic-tape track are used. Pulse-duration modulation designates the time multiplex system used in magnetic-tape recording. This time multiplex system is also known as pulse-width modulation (pwm). A number of low-frequency signals are time-shared using either electronic or electromechanical commutators. The output of the commutator is fed into a pdm keyer that converts the amplitude pulse train to pulse-width information. Keyer output is recorded on magnetic tape.

The time-code system consists of a repeat-cycle timer, the output of which is used to advance periodically a switch-readout electromechanical counter. The output of the counter is a decimal time code. A diagram of the system is shown in Fig. 2 (left). A one-second unit time has been shown. Also the staircase voltage output of each wiper of the counter is shown as zero to +4.5 volts to match the pdm system input of 0 to +5 volts. The voltage on each wiper of the counter is recorded on a separate channel of the pdm system. The wiper output voltages may also be recorded on separate channels of a multichannel oscillograph. Unit time used and the number of decades recorded will depend upon the application. The electromechanical counter also has a visual display which provides a continuous indication of the time code.

When the magnetic tape is played back and the pdm information decommutated, the decimal time code is reconstituted. The played-back time code may be recorded on a strip chart or displayed on a meter panel. A neon lamp array may also be used to display the digital time code. In short records, difficulties may arise with the neon lamp display due to transients on the pdm playback when starting or stopping the playback tape transport. These transients cause flashing of the neon lamps. The pdm decommutator monitor oscilloscope is usually provided with a pdm playback system to give a readily interpreted visual display of the digital time code. The complete digital time code may be recorded on a strip chart at playback. To conserve stripchart capacity, it may be desirable to record directly only seconds on the chart and note the complete time code from the playback visual display as shown in Fig. 2 (right).

Each second of the entire record is uniquely identified. By interpolating it is possible to determine the times of events more accurately than to one second. For a 30 × 30 commutator (30 channels each sampled 30 times a second) the resolution is one-thirtieth second. Better resolution may be obtained by recording the units output of the counter on more than one channel of the pdm commutator. For example, resolution of one-ninetieth second is achieved by recording units on three equally-spaced channels of the commutator.

An advantage of the pdm recorded digital time code over commercially available serial time code systems is that short lengths of magnetic tape may be uniquely identified. Where spectrum analyses are made of signals recorded either directly or by f-m, it is possible to identify the time of recording of tape loops cut from the continuous recording. Loops as short as 30 inches may be uniquely identified. With a serial time-code recording at one pulse a second and a tape speed of 60 ips, the length of tape required for unambiguous identification is at least 900 inches.

The playback of the pdm recorded digital time code requires expensive and complex decommutating equipment but in a great many magnetic-tape installations decommutating equipment is already available. The repeat-cycle timer and the switch readout counter are the only new equipment required.

High-Accuracy Pulse-Measuring Technique

By L. M. TIBBETTS, Jr.,
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EVALUATING special pulse-type tubes requires accurate, repeatable measurements of tube performance. Because of the rapidly increasing use of pulse circuits, such measurements are also needed for proper selection of tubes.

A method has been developed that can measure tube input and output pulse voltages from zero to 500 volts to four significant figures. Cummulative errors are less than 0.5 percent, a ten-fold increase over some conventional methods. Key to the high accuracy is use of choppers for oscilloscope comparison of pulse amplitudes with d-c references, which eliminates reading absolute values from the display.

Limitations of past methods have often led to reliance on a calibrated oscilloscope to set input and measure output voltages. Accuracy is usually assumed to be only 5 percent because of zero drift, calibration shift, vertical nonlinearity and parallax. Using the same oscilloscope for both voltage measurements can compound the error. Bias must be subtracted from a display of total input to determine pulse voltage, which can also lead to error. To measure both grid-to-cathode voltage and cathode current pulse across a current-viewing resistor would require two oscilloscopes.

A simplified version of the new method displays output across a one-ohm cathode resistor as shown in Fig. 1. Internal triggering of the oscilloscope alternately displays the pulse and the leading edge of the d-c reference as shown at the left of Fig. 3 by synchronizing it with the chopper. Need for oscilloscope calibration and maintaining the zero level are eliminated. Since both pulse and reference are amplified similarly during the first few microseconds, errors from incorrect adjustment of bandpass trimmers are eliminated.

A decade divider is used for low-level outputs. A standard 10,000-ohm decade divider shunting the one-megohm oscilloscope input resistance results in a 0.1 percent error when set at 1 volt. This error can be reduced by a lower resistance decade.

The oscilloscope in the complete system in Fig. 2 must be d-c coupled and have flat frequency response because it is triggered by the driving pulse. With adequate bandpass, the leading edge of the d-c pulse from the chopper can be used to check and adjust input trimmers for flat frequency response. The oscilloscope must also have sufficient gain and it must incorporate a dual-channel, alternate-sweep preamplifier.

Choppers are connected in phase so that input and output pulses are measured at the same time. Since the oscilloscope is grounded to measure output, input must be measured from grid to ground. However, grid-to-cathode voltage can be determined by returning the negative lead of the input reference supply to the positive end of the cathode resistor.

Voltage drop across the cathode resistor is superimposed on the d-c reference line. By making input pulse voltage from grid to ground coincide with the d-c reference line plus the pulse on the oscilloscope, grid-to-cathode pulse voltage will equal the d-c value only. External triggering permits positioning the cathode pulse on the input reference line and also brightens the trace.

The negative lead of the floating input reference can be returned to the cathode end of the one-ohm resistor without adversely affecting cathode wave shape. If applied voltage is specified from grid to ground, this lead can also be returned to ground. Since pulse voltage above zero bias is usually specified, bias level is not critical. However, if total input pulse voltage must be measured, the input d-c reference lead must be returned to the negative lead of the bias supply.

Stability of d-c reference supplies is 0.1 percent with 5 mv maximum ripple. Proper shielding, grounding and lead dress avoid pickup and distortion. A reversing switch in the input to the decade divider permits measurement of plate and grid current pulses across one-ohm resistors in the negative supply returns. Incorporating a reversing switch on the input of the oscilloscope permits inverting grid

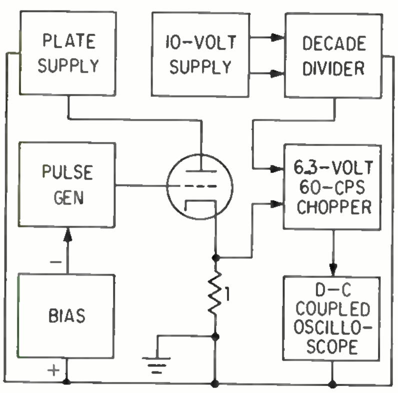

FIG. 1—Output pulse voltage is compared with stable reference on internally triggered oscilloscope

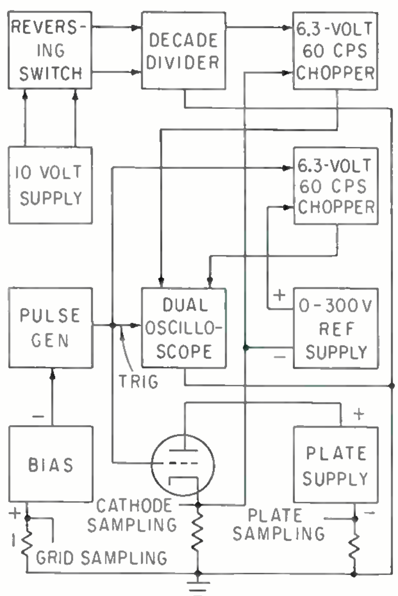

FIG. 2—Both input and output pulses are compared with reference lines using externally triggered, dual-channel oscilloscope

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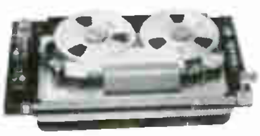
Radar, for instance, can now be tape recorded off receiver and played back repeatedly to scopes, analytical devices or radar guided equipment. Radar testing, reconnaissance and tracking are enormously aided by tape's live-playback capabilities. And for simulation and training, elusive transient phenomena now become repeatable at will.

For predetection recording and communications monitoring
The recorder's bandwidth catches everything at once – any 4-megacycle band of radio frequencies or the IF stage off a telemetering receiver. This simplifies on-site equipment. One kind of recording serves for all usual types of communications and telemetered data. Later you can play back through detector, discriminator and other equipment as many times as necessary to separate and process the desired channels of information.

For 5,000,000 binary bits per second
Super-efficient acquisition and reduction systems can be developed around serial pulse-coded data put directly on tape. One reel lasts 60 minutes – holds over seven billion binary bits. Compare this with previous PCM techniques on tape limited to less than 1,000,000 bits per second even at much higher tape speeds and proportionately shorter recording time.

The essential data
The Models: AR-300 Mobile or airborne record only; FR-700 single-rack laboratory record/playback. Response: 10 cps to 4 mc (±3 db). Tape speeds: 12½ and 25 ips. Playing time: 60 minutes. Tape: 1.0-mil Mylar, 2-inch width, 10½-inch reels. Data tracks: two wideband plus two auxiliary. Electronics: all solid state. Environmental (AR-300): 10g vibration; 50,000 ft. alt.; −54°C to +55°C. Tape interchangeability: yes, among all AR-300/FR-700 recorders.

Write for full information
AMPEX DATA PRODUCTS COMPANY
Box 5000 • Redwood City, California • EMerson 9-7111



AMPEX

and plate waveshapes.

At the center of Fig. 3, waveshapes are shown below their d-c reference lines for clarity. Only the top of the input waveshape at the bottom of the display is shown. Gain of both channels can be increased to show only the tops of the waveshapes for better resolution.

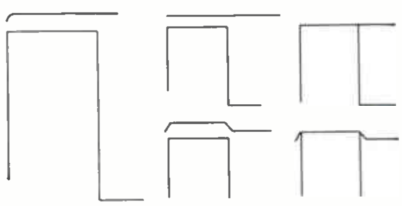


FIG. 3—Cathode pulse at left is compared with reference line using setup in Fig. 1. Grid pulse is also displayed at bottom of center display for comparison with reference plus pulse developed across cathode resistor. Display at right shows correct coincidence with references

Correct coincidence is shown in the display at the right. For go-no go production testing, the output d-c reference may be set to the specified minimum.

This technique permits simultaneous measurement of input and output voltages with different ground potentials on the same oscilloscope and prevents the bias supply from being a source of error. Parallax is avoided because the oscilloscope graticule is not used with this method and waveshapes and d-c reference lines are displayed on the same plane.

Although a flat-topped driving pulse is assumed, voltage at the leading edge or other desired parts of other waveshapes can be measured. The setup is not limited to pulse measurements.

Fission Heat Produces Electricity Directly

THERMIONOC converter using a cesium cell produced 90 watts of electrical power directly from the heat of nuclear fission. Conversion efficiencies as high as 10 percent were achieved at an operating temperature of about 3,500 F.

This performance was achieved in a series of tests at General Atomic Div. of General Dynamics Corp. The cesium cell converter contained a nuclear fuel element of uranium carbide and zirconium carbide. Power density of 21 watts per square centimeter was delivered into an external load. Over-all efficiency of the experimental system of converting fission heat to electrical energy was measured outside the reactor.

The reactor tests are the first step in a series of experiments to determine the feasibility of a nuclear thermionic reactor system as a space and land-based power source. The tests demonstrated that the cesium cell converter can produce electrical energy at high power levels and at adequate voltages in an actual reactor environment. It also has the capability for high temperature operation. Optimizing dimensions and temperatures of the cesium cell could apparently permit further increases in efficiency.

More than 12 cycles totaling several hours of operation at temperatures between ambient and incandescent were conducted during the test series. No attempt was made to use waste heat rejected by the converter, which could increase electrical output and over-all efficiency.

The thermionic-emitter element of the cesium cell used fully enriched U-235. It was made using the carbide fabrication technique developed by General Atomic. In the cesium cell, electrons are released from the emitter because of the heat from the fissioning of the uranium. An electric current collector, which surrounds the emitter element, receives the electrons. Cesium vapor present in the gap between emitter and collector of the converter cell enhances power production.

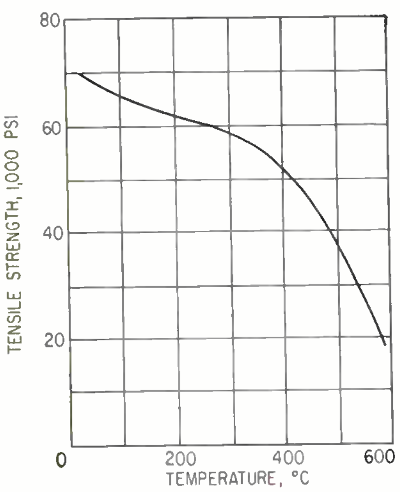
The entire assembly was housed in an aluminum cladding tube. Two heavy electrical conductors deliver power from the cesium cell to an instrumented load.

The tests were part of General Atomic's program of research and development in direct conversion. This program is being carried out with support from the Rocky Mountain-Pacific Nuclear Research Group, composed of eight western utility companies and the San Diego Gas & Electric Co.

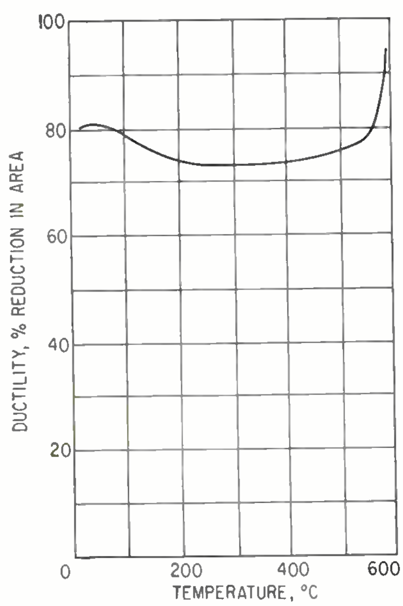
Cu-Zr Alloy for High Temperature Devices

ALLOY HAS HIGH CONDUCTIVITY AND STRENGTH AT ELEVATED OPERATING TEMPERATURES

A new copper-zirconium alloy that retains low temperature hardness and strength at extended operating temperatures, and during manufacturing processes, may soon replace pure copper as the conventional material for power rectifier and power diode stud bases.



(A)



(B)

Graphs show tensile strength (A) and ductility (B) for Cu-Zr alloy at 375 C

Called Amzirc, the alloy, containing 0.15 percent Zr, is produced by American Metal Climax, Inc. It combines high strength, at prolonged temperatures up to 750 F, with electrical conductivity of 90-96 percent on the International Annealed Copper Standard scale.

Efficient heat transfer from power rectifiers and diodes requires the stud base to have a flat bottom and accurate threads of uniform size. Base material must be hard enough to withstand a tightening torque sufficient to insure good seating, without deformation and breaking of the base, or stripping of the stud threads.

Manufacturers report that oxygen free high conductivity copper, although hard at the beginning of base processing, becomes heat treated during the manufacturing steps, and is softened. In particular, the copper bases become annealed when a welding ring, used to fasten the case cap to the base, is brazed to the base.

After exposure to manufacturing temperatures of 750 F, the strength of Amzirc is 2 to 3 times greater than pure copper.

One large electrical equipment manufacturer is about to release for production 1-1/16 in. bases with ½ in. threaded studs. Laboratory tests on 1-1/16 in. bases with ⅜ in. studs are almost completed.

Initial test data and manufacturing experience have been sufficiently encouraging so that the manufacturer plans to use the new alloy across the board in six different stud sizes.

The company estimates that once production is rolling, 1 million copper-zirconium rectifier bases will be produced annually.

Other potential applications of the alloy include resistance welding wheels and tips, fine wire, high temperature magnet wire, commutators, collector rings, canned motor windings, rotor wedges, soldering tips, studs for x-ray tubes, and electron tube side rods.

For many years, a copper-0.7 percent chromium alloy was used in applications of this nature. High temperature performance was satisfactory, but the alloy is notch sensitive, and its properties are poor in the transverse direction compared to the longitudinal direction.

The introduction of oxygen free high conductivity copper, with negligible hydrogen penetration, eliminated embrittlement typical of ordinary copper.

The Battelle Memorial Institute was asked to develop an alloy which would have equal or better conductivity than OFHC copper. and would possess greater strength at high temperatures.

Battelle suggested the use of zirconium as an alloying element, but recommended a Zr concentration of 0.23-0.25 percent. Although this alloy possessed the desired properties, considerable difficulty was encountered in melting and in component fabrication.

Through the development of a series of phase diagrams, American Metal Climax found that 0.15 percent max Zr provided optimum properties for fabrication, and possessed the required characteristics.

An outstanding property of the new alloy is the high strength level it develops through cold working and aging, and the extent to which it retains this strength at elevated temperatures.

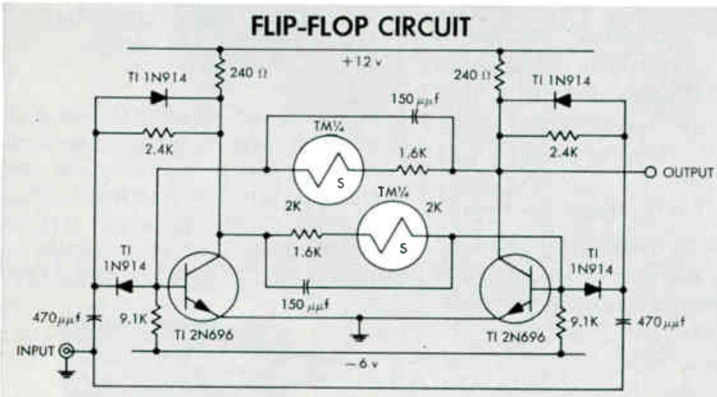
A typical bar of the alloy, cold worked 85 percent, and aged for one hour at 375 C, has the following mechanical properties at room temperature:

Ultimate tensile strength: 65-70,-000 PSI

Yield strength: 57-62,000 PSI

Elongation: 10-12 percent

How to compensate for temperature variation in a transistorized flip-flop



sensistor® SILICON RESISTORS

Positive TC of +0.7%/°C for temperature compensation and sensing.

Standard available resistances ±10% @ 25°C:
68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820, 1000, 1200, 1500, and 1800 ohms.

Additional resistance values and tolerances available on special order.

Type No.	Wattage Rating	Body Dimensions	
	W	Length	Diameter
TM ¼	¼	0.585"	0.200"
TM ⅛	⅛	0.406"	0.140"
TC ⅛	⅛	TO—5 Transistor Package	
P-100†	—	0.500"	0.078"

† Hermetically sealed glass package for instrumentation and temperature control available in resistances of 100 ohms, 500 ohms and 1000 ohms ±10% measured at 25°C

This flip-flop circuit, designed by Texas Instruments, uses *sensistor*® silicon resistors in the cross-coupling network to compensate for increases in h_{FE} with temperature. At 125°C, it resolves 100 mμsec input pulses arriving at a 5 mc rate whereas a fixed resistor version was limited to 3.6 mc. In addition, at +125°C the circuit will operate at a resolution rate greater than 5 mc if the input pulse can be greater than 10 volts when the pulse width is decreased from 100 mμsec.

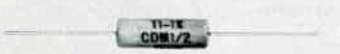
Another advantage of *sensistor* silicon resistors in a flip-flop using high h_{FE} transistors is the reduction in input voltage required to trigger at high temperatures. For instance, the *sensistor* silicon resistor circuit requires only 10 volts to trigger whereas the fixed resistor circuit required 14 volts.

Sensistor silicon resistors are temperature-sensitive devices that feature a positive temperature coefficient of +0.7% per °C. This predictable rate of resistance change makes *sensistor* resistors ideal for temperature compensation from —50°C to +200°C at frequencies up to 250 mc.

The *sensistor* silicon resistor, developed by TI, provides circuit design engineers with a lightweight temperature compensating and sensing device. Commercially available for over two years, the devices have been used successfully for bias stabilization in a-c coupled stages and in the first stages of d-c amplifiers; and have found wide application in amplifiers, power supplies, servos, telemetry, magnetic amplifiers, computer switching, and thermometry.

In addition, specify from this complete line of TI precision film resistors.

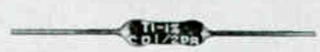
MOLDED



±1% tol

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CDM⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDM¼	¼	RN65B	10 Ohm-1 Meg	500
CDM½	½	RN70B	10 Ohm-5 Meg	750
CDM 1	1	RN75B	10 Ohm-10 Meg	1000
CDM 2	2	RN80B	50 Ohm-50 Meg	2000

MIL-LINE



±1% tol

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CD⅛R	⅛	—	10 Ohm-1 Meg	350
CD¼R	¼	RN10X	10 Ohm-1 Meg	500
CD½PR	½	RN15X	10 Ohm-3 Meg	650
CD½MR	½	RN20X	10 Ohm-5 Meg	750
CD½SR	½	—	50 Ohm-10 Meg	850
CD1R	1	RN25X	10 Ohm-10 Meg	1000
CD2R	2	RN30X	50 Ohm-50 Meg	2000

HERMETICALLY SEALED LINE

±1% tol

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CDH⅛M	⅛	—	10 Ohm-500K	250
CDH⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDH¼	¼	RN65B	10 Ohm-1 Meg	500
CDH½P	½	—	10 Ohm-3 Meg	650
CDH½A	½	RN65B	10 Ohm-3 Meg	650
CDH½M	½	RN70B	10 Ohm-5 Meg	750
CDH½S	½	—	50 Ohm-10 Meg	850
CDH 1	1	RN75B	10 Ohm-10 Meg	1000
CDH 2	2	RN80B	50 Ohm-50 Meg	2000

Write on company letterhead for your copy of "Transistor Bias Compensation with *sensistor*® Silicon Resistors."

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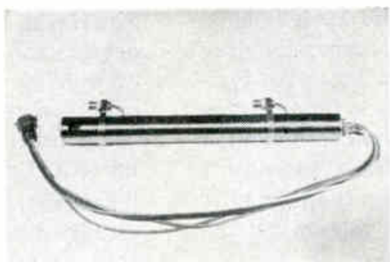
Electrical Conductivity: 90-96 percent ICAS

High temperature properties of the alloy are shown in the graphs.

Temperature Compensated Traveling Wave Tubes

Two temperature compensated, magnetically shielded traveling wave tubes have been announced by Sylvania Electric Products Inc. The tubes are designed for close quarter applications in missiles and aircraft.

Designated TW-4002F and TW-956H the new components employ periodic permanent focusing eliminating the need for solenoids. Both tubes are designed for pulse or CW operation.



Magnetic shields on new tw tubes permit close quarter applications

The tubes are reported to operate without heater blankets from −65 C to 72 C with minimum performance degradation. Frequency response is relatively flat over an octave, from 2.0 to 4.0 KMc. Each tube weighs approximately 3 lbs., is 15 in. long, and has a 1.4 in. capsule diameter.

Specifications at room temperature are:

Type TW-4002F: 37db minimum small signal gain; 10 mw minimum rf power output at saturation.

Type TW-956H: 37db minimum gain with 0.1 mw input; 2-5 watts CW rf power output at saturation.

Ammonia Batteries for Standby-By Power Supply

Ammonia electrochemical systems have been suggested as stand-by power supplies for outer space vehicles and satellites. The auto-

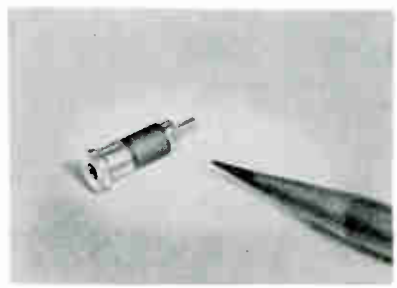
matically activated batteries have a long storage life, and operate over a temperature range from well below −65 F to 160 F. The cells demonstrate short time, high rate discharges with good recovery from large transient currents.

Long unactivated storage periods are practical because of hermetically sealed cases and a reserve system of electrolyte distribution. The ammonia filling system is contained within the battery case, and requires only an electrical pulse, or mechanical motion transmitted through a diaphragm or bellows, to activate.

Cell construction is rugged, and the units can survive any stresses or shocks experienced during launch or later impacts. The hermetically sealed cases are capable of withstanding space conditions.

Prototype units are under development at Eastman Kodak Co., and G. & W. H. Corson, Inc.

Precision Resistors In Crystal Cases



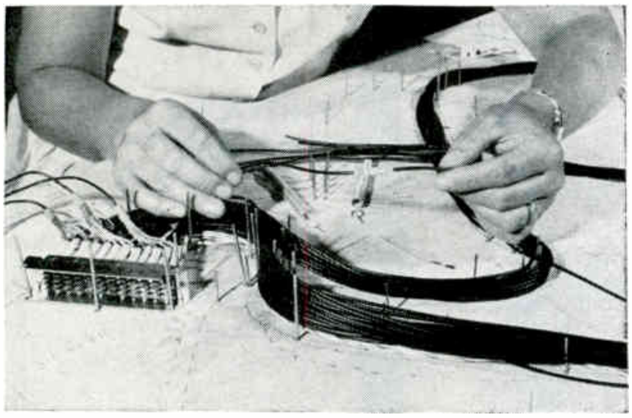
Deposited metal film is coated with impervious material for protection

Crystal type resistors designed to replace crystals during equipment checks with an equivalent impedance are being manufactured by Filmohm Corp., New York.

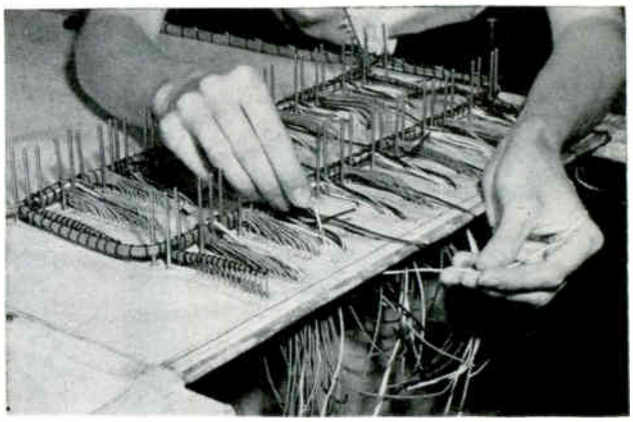
The devices are made by vacuum depositing a thin metal resistance film on a conventional 1N21 or 1N23 crystal body. The film is immediately sealed with an impervious protective coating.

Available values range between 25 and 400 ohms with stadard 2 or 5 percent tolerance. Closer tolerances are available on special order.

Rated power, based on 100 C ambient temperature, is 1 watt average.



With connector in position, wires are routed. Code marker, seen directly above spring in center, is slid along wire as it is put in place



Putting wire ends through holes in harness board allows them to be laced in position for fastening to printed circuit type connectors

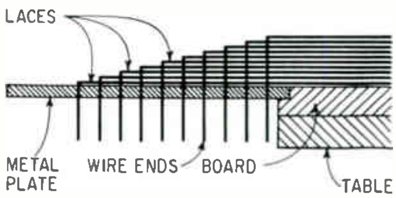
Making Connections First Speeds Harnessing

LARGE WIRING HARNESSES often have several hundred wire ends attached to multipin connectors. As the harness is built, color-coding, tagging, fastening ends in coil springs and similar methods are generally used to segregate wire ends for later attachment to connectors.

Electronic Associates Inc., Long Branch, N. J., has found that in many cases, up to half the time and materials costs of identifying wire ends can be saved by assembling wires to connectors before harnessing. The method also reduces harnessing lead time.

First, all wires are soldered into connectors at a bench, using fixtures. Half the ends, therefore, do not require identification. If the wires are the same color, the free end is identified with E-Z Code tags on Teflon rings. The rings are run down the wire when it is put in place. Wires and terminating plugs also can be prepared in advance.

The harness assembler places the connector in position on a harness board and routes the wires. Harness diagrams include identification and outlines of connectors to avoid confusion. Additional connector-wire assemblies and loose wires are placed as required and the harness laced. One analog computer harness made by this method has 200 wires soldered in advance to four 50-pin connectors, plus 150 wires routed individually.



Sketch of in-line lacing method

Another technique to avoid tagging or special color-coding is used when a large number of ends are to be fastened to printed circuit board edge connectors or similar in-line connectors.

The harness board is provided with metal plates in the areas where the wires terminate (see sketch). After the diagram is pasted over the board, holes are drilled in the metal at wire end positions. The metal plates extend over the edge of the worktable.

Working with a spool of wire, the harnesser pushes a few inches of wire through a hole, which is drilled small enough to hold the wire loosely. The wire is routed. If the other end also goes to an in-line connector, the wire is cut long enough to be pushed through a hole at the second end.

After all wires are positioned, the ends are laced as shown to give each wire a 90-degree breakout bend. When the harness is pulled from the board, the ends are ready for hand-cutting and stripping, and soldering to connectors at a bench.

If precut and stripped wires are to be used, the harness board is mounted above the table on legs so the wire can be pushed through the holes only the distance desired after the 90-degree bend. This method is particularly useful when the wires have been assembled to a connector in advance.

Combinations of these and conventional procedures are used, depending on the judgment of the lead harnesser. By dividing harness preparation into several stages, assemblers can be assigned work at which they are most adept: preassembling wires and connectors, routing and lacing, or assembling connectors to laced harness. The latter is frequently done while the harness is still on the board.

EIA's harnessers have found it easier to work on flat harnessing tables rather than tilted easels. Each table is placed in a clear floor space so harnessers can walk around while routing long wires and lace without stretching.

Wire end identification can also be reduced on small harnesses. If a pair of wires of the same color end at the same point, the harnesser hand strips one end and not the other. Harnesses for small panel assemblies are prepared after the wires have been soldered to panel component terminals. The panel is

4 reasons why you should buy Hughes high voltage silicon cartridge rectifiers

To meet your requirements for IN1730-34, IN2382-85, IN596-98 and IN1406-13 rectifiers . . . Hughes offers you a universal series with the following advantages over competitive devices:

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3 Savings In Space. The case material is a plastic of high dielectric strength, making it possible to mount units in close proximity to each other.

4 Greater Dependability—These assemblies utilize series strings of Hughes hermetically sealed glass diodes...packaged in a non-combustible cartridge. All internal connections are welded together to insure shock and vibration resistance.

These standard Hughes units are available in voltage ratings from 600 to 10,000 volts. In addition, Hughes offers you many custom assemblies designed to meet your special requirements.

ORDER TODAY! To obtain delivery of Hughes Cartridge Rectifiers just call or write the Hughes Semiconductor Sales Office or Distributor nearest you. Or, for a complete Cartridge Rectifier data sheet (Number: D.S. 82) please write Hughes, Semiconductor Division, Marketing Department, Newport Beach, California.

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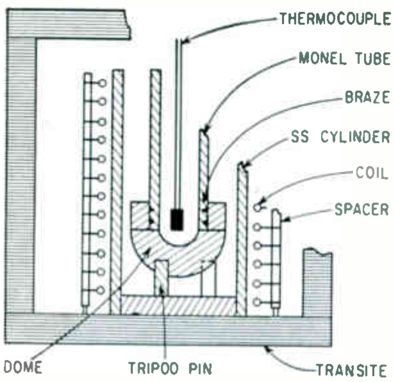
placed on a harness board and the harness prepared by methods similar to that first described.

Cased Coil Brazes Alumina to Monel

WHEN UNIFORM heating and controlled temperature rise are required for brazing, they can be obtained by placing an induction heating coil in an oven. The setup illustrated is employed at John Gombos Co., Inc., Clifton, N. J., to braze a Monel tube to an alumina dome for a missile application. The dome can be fractured by conventional metal brazing methods.



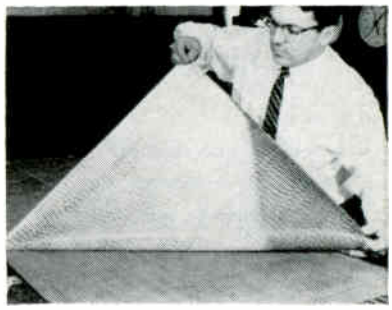
Insulated case and steel heating cylinder raise temperature uniformly

The mating surface of the dome is metallized with 42 percent nickel-iron alloy to match the Monel's coefficient of expansion. The tube is grooved at the joint area to accept silver alloy brazing rings and to allow the brazing material to expand. The dome is pushed over the tube and the assembly placed, dome down, on a tripod of stainless steel rod. Since the assembly is balanced, no other holding fixture is required.

A stainless steel cylinder is placed between the assembly and the surrounding coil. The cylinder, 3.5 inches in diameter, heats the assembly evenly and keeps the tube uniform. The coil has an outside diameter of 4$\frac{3}{8}$ inches, is 7 inches high and is made of 12 turns of $\frac{1}{4}$-inch copper tubing. Each turn is soldered to a washer. The washers are positioned on a tie rod and insulated by asbestos composition spacers. The coil is also coated with an insulating compound. The entire setup is contained in an asbestos composition case with a removable cover.

The coil is designed to heat slowly during the initial, critical warmup. After 8 minutes, the assembly is at 300 F. Temperature is then increased to 1,300 F, the brazing temperature, after 32 minutes. A thermocouple is inserted in the tube and positioned at the braze point for monitoring and control. After the braze is made, the case cover is opened and the assembly allowed to cool down.

Flaws in Welded Metal Show in Plastic Film



Spotwelding pattern is captured in strippable film

MAGNETIC PARTICLE inspection system that provides a reproducible pattern of welds and flaws in metals is being offered by the Instruments Division, The Budd Co., Phoenixville, Pa. Budd has been using the system, called Recordaflux, for nondestructive testing of spotwelds as well. It shows the diameter of spot welds, which can be used to interpret weld strength. Magnetic particles in a solution are sprayed or poured on the surface of a part. The particles are free to migrate in the solution until it sets up, after 8 or 20 minutes depending on the solution, into a plastic film. The films can be washed from the part, or stripped off for reference and reproduction. In addition to the solutions, magnetizers provide a relatively uniform magnetic field over an area, allowing sensitive detection of faint local differences in magnetic properties over the working area of the field. The system can also be applied, the company reports, to magnetic field studies and determination of grain direction in sheet metal and sectional forgings.

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NEW INDICATING 3AG FUSE POSTS

EXAMINE THESE FEATURES

1. New patented knob design to assure high degree of illumination for instant blown fuse indication.
2. Positive finger grip for knob extraction.
3. Quick service bayonet lock.
4. Constant tension beryllium copper coil & leaf spring for positive contact & lower millivolt drop.
5. Optional—at extra cost—neoprene "O" ring to assure splash-proof feature.
6. New high degree vacuum neon lamp for greater brilliance & visibility.
7. Impact black phenolic material in accordance with MIL-M-14E type CFG.
8. One piece brass hot tin dipped non-turning bottom terminal.
9. Double flats on body to permit mounting versatility.

SPECIFICATIONS:

PART #	VOLTAGE RANGE
344006	2½- 7 volts
344012	7 - 16 volts
344024	16 - 32 volts
344125	90 -125 volts
344250	200 -250 volts

Maximum current rating 20 amps.

PHYSICAL CHARACTERISTICS—Overall length 2⅜" with fuse inserted • Front of panel length 13/16" • Back of panel length 1 9/16" • Panel area front 15/16" dia. • Panel area back 15/16" dia. • Mounting hole size (D hole) ⅝" dia. flat at one side.

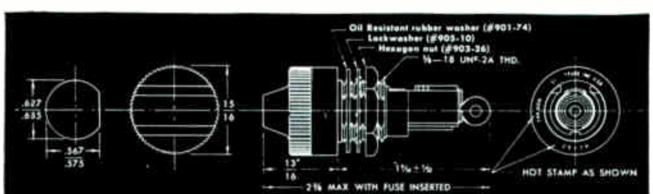
TERMINAL—Side—one piece, .025 brass—electro-tin plated • Bottom—one piece, lead free brass, hot tin dipped.

KNOB—High temperature styrene (amber with incandescent bulbs—2½ thru 32 volts—and clear with high degree vacuum neon bulbs—90 thru 250 volts) • Extractor Method—Bayonet, spring grip in cap.

HARDWARE—Hexagon nut—steel, zinc cronak or zinc iridite finish • Interlock lock washer—steel, cadmium plated • Oil resistant rubber washer.

MILITARY SPECIFICATIONS—MIL-M-14E type CFG. Fungus treatment available upon request per Jan-T-152 & Jan-C-173.

TORQUE—Unit will withstand 15 inch lbs. mounting torque.



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For electronic, instrument, and communication equipment production lines, and for maintenance—where hard-to-reach joints must be soldered in a hurry—General Electric's Lightweight Soldering Iron offers the ideal solution.

It weighs only 8½ ounces, and handles like a pencil. A thin shank and small tip sizes let you solder in tight places where regular-size irons won't go. Rated 120 volts, 60 watts, the iron features extremely fast heat recovery to provide reliable, uniform solderjoints in seconds.

Want more information? Contact your General Electric distributor or nearby G-E Apparatus Sales Office, or write Section 758-02, General Electric Co., Schenectady 5, N. Y.

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Solid-State Transducer

OBVIATES AMPLIFIER

A NEW KIND of solid-state strain gage pressure transducer that obviates the need for an amplifier and that has only two mechanically-functioning parts and that is claimed to combine the best overall characteristics of both strain gage and potentiometer-type transducers without the inadequacies of either has been developed by Fairchild Controls Corp., 225 Park Ave., Hicksville, N. Y., a subsidiary of Fairchild Camera and Instrument Corp. The transducer, designated 3S-G uses a semiconductor strain gage sensor, has unusual accuracy and environmental capabilities, and produces a high-level d-c output signal that eliminates the need for impedance-matching or signal amplification. Responsive to both static and high-frequency dynamic pressures, the device is compatible with existing military ground, telemetry and industrial systems, and is interchangeable with devices now in use.

The transducer incorporates a resistive calibration device that produces an output signal equivalent to half-scale pressure input, enabling the user to determine at will the integrity and scale factor of associated equipment.

The 3S-G transducer consists of three modules, all contained in a rugged anodized aluminum case 1⅛ inches in diameter and 3 inches long, weighing 5 ounces. These modules perform the functions of energy conversion, signal conditioning and calibration.

Energy conversion is accomplished by several microminiature piezoresistive semiconductor elements coupled to a resilient high-alloy steel, low mass diaphragm. These elements form the conducting paths of a four-arm Wheatstone Bridge.

Applied pressures deflect the diaphragm, creating an unbalance in the bridge and producing a d-c signal proportional to the deflection. The diaphragm will fit the selected pressure range—from 0-100 psig to 0-10,000 psig full scale. Pressure ranges below 100 psig will be available shortly.

Input excitation to the transducer is from 10-25 volts d-c nominal, and it can take up to 30 volts d-c without damage. Input impedance is approximately 700 ohms. Output impedance is less than 4,500 ohms. Input pressures up to 150 percent of rated have a negligible effect on instrument calibration. Pressures in excess of 200 percent of rated cause no damage.

Signal conditioning: A transistorized amplifier receives the differential signal generated in the sensing element and produces the output signal. The transducer transfer function is 25 percent. Thus, a full-range change in pressure at 20 volts d-c (rated excitation) results in a 5-volt d-c output signal.

The calibrator is an internally-contained shunt resistor. When it is keyed across one leg of the Wheatstone Bridge (by shorting two connector pins) the transducer produces an output signal equivalent to one-half full scale rating.

Frequency response is limited by the design of plumbing that conducts the measured pressure media to the 3S-G pressure port, and by the nature of the media itself.

Accuracy: better than plus or minus 0.1 percent linearity and 0.1 percent hysterisis over a temperature range of minus 65 F to plus 250 F; it has infinite resolution. Both zero and full range sensitivity change less than plus or minus 0.5 percent over any 100 F temperature excursion within the rated temperature range. It can withstand 50 G's vibration to 2,000 cps without damage and can measure all gaseous and liquid media, including liquid oxygen, strong alkalies, corrosive acids such as red fuming acids, and nitrozene.

CIRCLE 301 ON READER SERVICE CARD

Gaussmeter Features

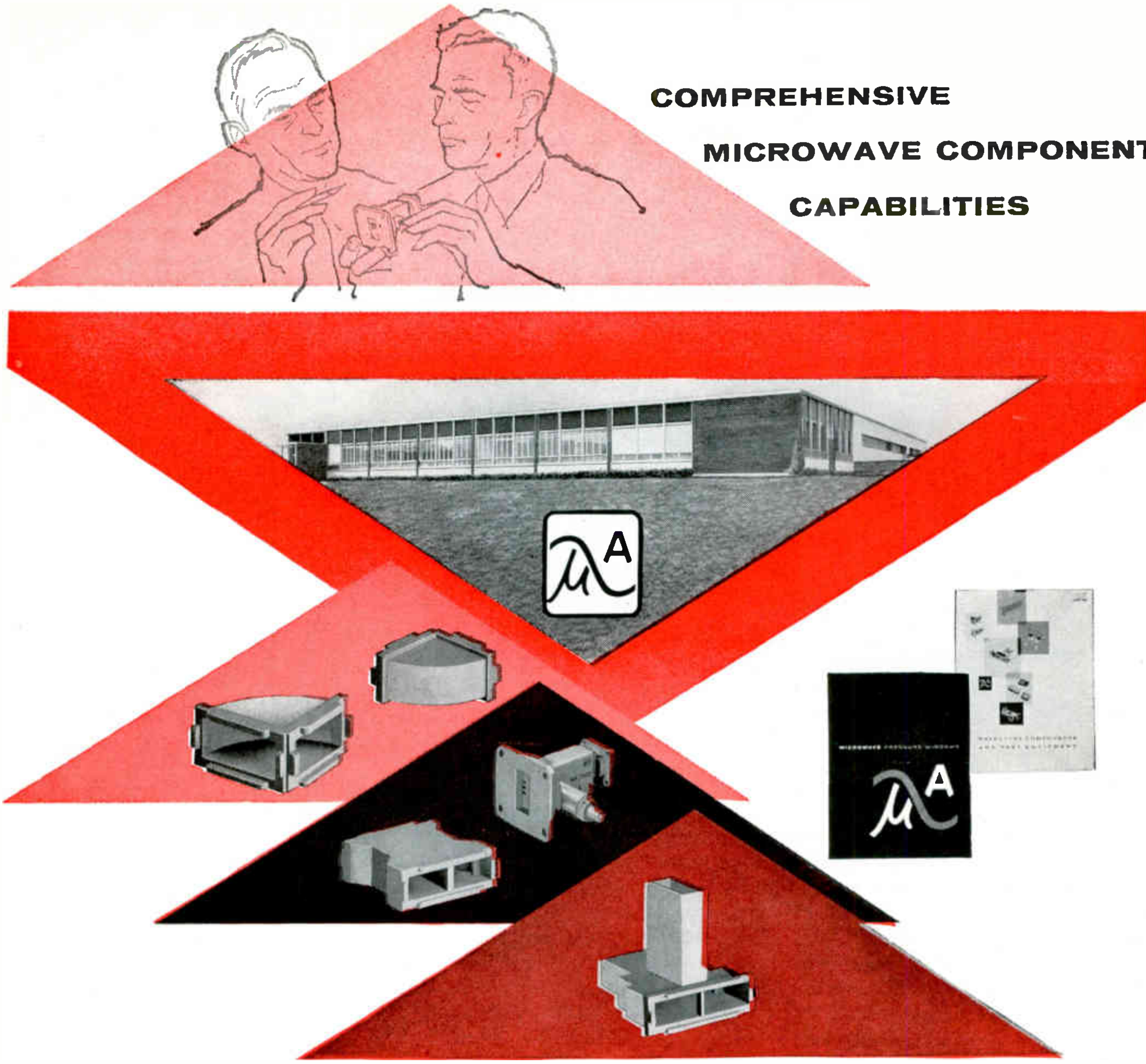
FEATURES PORTABILITY

A DIRECT-READING, completely transistorized gaussmeter, combining portability with high sensitivity, has been developed by F. W. Bell, Inc., 1356 Norton Ave., Columbus, Ohio. Measuring direction and magnitude of magnetic flux density, the instrument reads from 1 gauss, full scale, to 30,000 gauss, full scale, in 10 ranges. An innovation in this Model (No. 110) is the zero center meter which indicates immediately the direction being read and eliminates the necessity for a reversing switch.

Model 110 is designed with an integral carrying handle that serves also as a probe rest providing protection of the vital probe when the instrument is not being used. Built-in probe calibration speeds interchanging of different types of probes. A thin wafer of indium arsenide, operating on the Hall Effect, is the sensing element of the instrument. This material has a temperature coefficient of 0.1 percent per degree C.

Included in applications of the new gaussmeter are: readout of magnetic ink and magnetic tape,

COMPREHENSIVE MICROWAVE COMPONENT CAPABILITIES



This modern three-quarter-acre plant has significantly expanded the services and production capabilities of Microwave Associates' experienced Waveguide Components Division. This new research and production facility is one of the most completely equipped on the east coast. A large 3′ x 2′ capacity dip-brazing unit as well as complete plating and other shop facilities are now handling both large volume and custom-engineered orders. Components are precision-machined and produced in beryllium-copper, cast and fabricated aluminum, and cast magnesium.

Over 500 microwave components for applications from 1.12 to 90.0 kMc/s are standard items. Our Sales Engineers will gladly discuss current work in sophisticated components and RF packaging with you.

A FEW OF THE MANY COMPONENTS MANUFACTURED HERE

New High-Power Varactor Harmonic Generators — excellent suppression of unwanted harmonics and record power levels are available from these solid-state harmonic generators.

New Cast Bends — Zero bend radius — 90° E and H plane bends in S through Ka bands . . . Each bend is compensated to a VSWR of 1.05 over its entire waveguide band.

Sidewall Hybrid Couplers (3db) and H-Plane Folded Hybrid Tees — Cast in aluminum and beryllium-copper are available in S through Ka-band models.

Two New Catalogs — Waveguide Components Short-form Catalog (CSF-60) gives data on over 500 items of waveguide components and test equipment.

Pressure Window Catalog (12 pages) contains electrical and mechanical data on a complete line of glass-kovar, mica, and special pressure windows plus valuable installation and testing tips.

MICROWAVE ASSOCIATES, INC. Burlington, Mass. • Western Union FAX • TWX: Burlington, Mass. 942 • BRowning 2-3000
Export Sales: Microwave International Corporation, 36 West 44th St., New York, New York

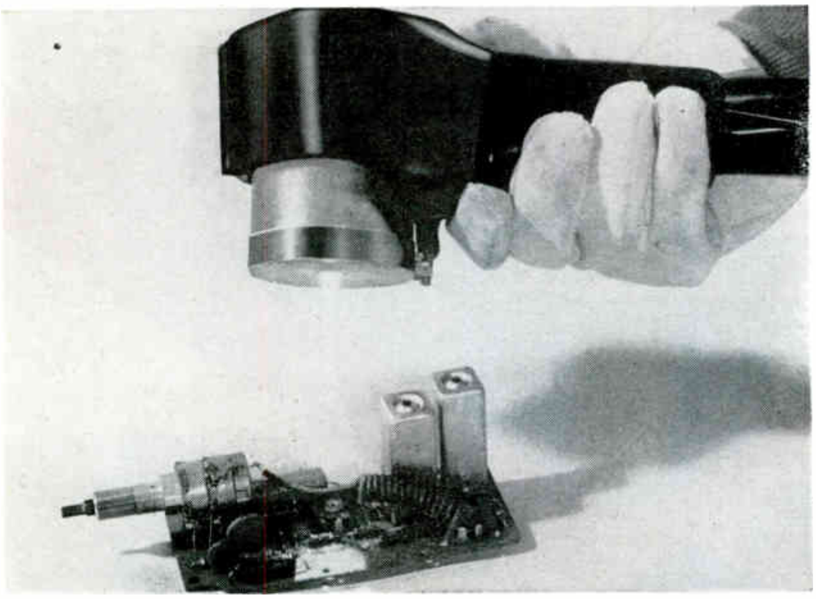
measuring and plotting the earth's magnetic field, meters, vibration pickups, d-c motors, magnets, tachometers, relay testing, solenoid and polarized relays.

Standard axial and transverse (radial) probes are available from stock. Other types of probes, as well as test fixtures for special applications, can be made to order.

CIRCLE 302 ON READER SERVICE CARD

A pulse-modulated radar system operating in the X-band frequency range, the WP-103 requires 320 watts a-c. The narrow beamwidth of the X-band radar provides the pilot with a sharp definition of targets.

CIRCLE 304 ON READER SERVICE CARD



Thinner Epoxy Coatings

BY SPRAY GUN

A HAND-HELD plasmatron plasma jet spray gun, capable of spray depositing epoxy resins onto any surface for coatings of any desired thickness, has been introduced by Plasmadyne Corp., 3839 S. Main St., Santa Ana, Calif., a subsidiary of Giannini Scientific Corp. Epoxy coating deposited by this technique is extremely durable and does not need further curing. The technique produces extreme penetration of the resin—an important factor in coating complex devices such as electric motor stators and rotors.

CIRCLE 303 ON READER SERVICE CARD

Weather Radar

LIGHT-WEIGHT UNIT

A NEW approach in lightweight airborne weather radar is offered by Collins Radio Company, P. O. Box 1891, Dallas, Texas, in the WP-103 weather radar system which will be available early next year. The small size and weight (under 50 pounds) and power economy are possible because of the extensive use of transistorized, printed circuitry. The WP-103 is about one-sixth as big and only one-eighth as heavy as the WP-101.

The WP-103 covers the general sky area with a stabilized antenna up to 150 nautical miles ahead of the aircraft. The antenna makes a 120 degree sweep with 60 scans per minute using either the 12- or 18-inch dish antenna. It can sweep a full 360 degree area with the 30-inch antenna. Simplified circuitry has eliminated the need for a sweep resolver or a servo driven rotating yoke. The presentation of weather conditions is on the indicator in terms of range and azimuth.

Five basic units comprise the WP-103. They include: the 374A-3 receiver/transmitter housed in a $\frac{3}{4}$ Short ATR Case; 776C-3 synchronizer contained in a $\frac{3}{8}$ Short ATR Case; 561G-3 control kit; 493A-4 indicator and 537F-7 12-inch dish antenna. The 18-inch and 30-inch antennas are offered as optional equipment. Picture presentation in the 493A-4 indicator uses a $3\frac{1}{4}$ inch sweep line in a box with a $4\frac{1}{4}$ inch square face. A polarized filter permits dimming for night operation.

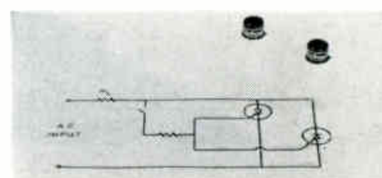
High-Speed Transistor

FOR COMPUTERS

DEVELOPMENT of a computer mesa transistor capable of handling 100,000,000 signals a second has been announced by the Radio Corporation of America, Semiconductor and Materials Division, Somerville, N. J. The device, which will be in commercial production soon, is available for engineering sampling.

Designated TA 1882, the new transistor is a double-diffused germanium *npn* mesa type, with a 500 megacycle gain-bandwidth product, minimum beta of 40, and a switching speed of 10 millimicroseconds. It is housed in the TO 18 case.

CIRCLE 305 ON READER SERVICE CARD



Complimentary SCR's

REDUCE COMPLEXITY

AVAILABILITY of a line of complementary silicon controlled rectifiers is announced by the Semiconductor Division, Hoffman Electronics Corp., Los Angeles, Calif. The new line features both *pnpn* and *npnp* types. The *npnp* types use negative gate current triggering, a characteristic previously unavailable in controlled rectifiers, according to Hoffman. The *pnpn* types are triggered by positive gate currents. Allowing direct positive and/or negative operation in controlled rectifier circuits, the devices reduce circuit complexity, resulting in decreased system cost, space, and weight requirements and increased reliability.

Encased in TO-5 transistor packages, the new units consist of five *npnp* types and seven *pnpn* types. All units are rated at 1 amp, aver-

How many of these B&A Electronic Chemicals do *you* need?

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As America's foremost producer of laboratory and custom chemicals, General Chemical has the wide range of products, the versatile production facilities, and the specialized experience to meet virtually every electronic chemical need! Write today for our free information folder, "B&A Electronic Chemicals." Gives specifications plus other valuable information.

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- ☐ Ammonium Bifluoride—Technical
- ☐ Ammonium Fluoride—Reagent
- ☐ Bromine—Reagent, A.C.S.
- ☐ Glycerin—Reagent, A.C.S.
- ☐ Hydrochloric Acid—Reagent, A.C.S.
- ☐ Hydrofluoric Acid—Electronic Grade
- ☐ Hydrogen Peroxide (Stab.)—Electronic Grade
- ☐ Nitric Acid—Reagent, A.C.S.
- ☐ Potassium Hydroxide Pellets and Solution—Electronic Grade
- ☐ Sodium Carbonate—Electronic Grade
- ☐ Sodium Hydroxide Pellets and Solution—Electronic Grade
- ☐ Sulfuric Acid—Reagent, A.C.S.

As Solvents:

- ☐ Acetone—Electronic Grade
- ☐ Alcohol, Ethyl—Reagent
- ☐ Carbon Tetrachloride—Electronic Grade
- ☐ Ether—Electronic Grade
- ☐ Methyl Alcohol—Electronic Grade
- ☐ Propyl Alcohol Iso—Electronic Grade
- ☐ Trichloroethylene—Electronic Grade
- ☐ Xylene—Reagent, A.C.S.

In the Production of TV Tubes:

- ☐ Barium Acetate—Electronic Grade
- ☐ Barium Nitrate—Electronic Grade
- ☐ Calcium Nitrate—Electronic Grade
- ☐ Strontium Nitrate—Reagent, A.C.S.
- ☐ Aluminum Nitrate—Electronic Grade

For Semiconductor Production:

- ☐ Germanium Dioxide—Electronic Grade
- ☐ Germanium Metal—Electronic Grade
- ☐ Nickel Chloride—Reagent, A.C.S.
- ☐ Nickel Sulfate—Reagent, A.C.S.
- ☐ Sodium Hypophosphite—N.F.

For Post Treatment of Semiconductors:

- ☐ Hydrogen Peroxide—Electronic Grade

For Capacitors:

- ☐ Ammonium Hydroxide—Reagent, A.C.S.
- ☐ Boric Acid—Reagent, A.C.S.
- ☐ Manganous Nitrate—Reagent, A.C.S., Electronic Grade
- ☐ Oxalic Acid—Reagent, A.C.S.

For Phosphor Production:

- ☐ Zinc Sulfide

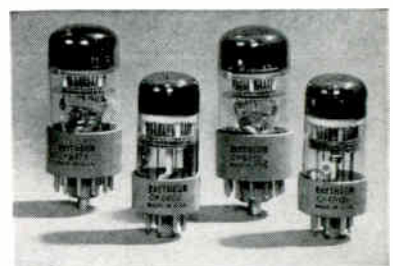
For Gaseous Insulation:

- ☐ Sulfur Hexafluoride

age rectified forward current, and 1.4 amp, d-c, at plus 80 C. Voltages for the *npnp* devices range from 30 to 200 volts; for the *pnpn* units, 30 to 400 volts. Operating and storage temperature range for all types is from minus 65 C to plus 150 C. Maximum junction temperature is plus 150 C.

Prices for the *npnp* devices range from $8.40 to $22.50 in quantities of 1 to 99, and from $5.60 to $15 in quantities from 100 to 999. The *pnpn* units are priced from $5.60 to $60 (1-99) and $3.70 to $40 (100-999). All are available for immediate delivery in sample quantities.

CIRCLE 306 ON READER SERVICE CARD



Electron Tubes

FOR COUNTING USES

ELECTRON TUBES that count up to 100,000 units per second and visually display the total on their faces have been announced by Raytheon Company, Industrial Components Division, 55 Chapel St., Newton, Mass. Possible applications are in assembly-line packaging, in measuring pipeline flow and in programming elapsed-time intervals, such as sequency welding, and in nucleonics, for plotting the spectrum of isotopes over a time-period or the energy level of radiation impinging on such nuclear energy detecting devices as scintillometers.

Called decade counters, the tubes record and indicate the count on ten glowing cathodes in luminescent dials within the tubes. With numbered face-plates, placed on series connected decade counters, the total can be read visually in units, tens, hundreds, etc., during operation.

The CK6909 and CK6910 decade counters operate up to 100 Kc and the CK6802 and CK6476 operate up to 4 Kc. The tubes are a cold cathode, bidirectional, ring-stepping de-

vice featuring low dissipation and short resolution time. The CK6476 and CK6910 offer electrical readout from any cathode lead while the CK6802 and the CK6909 offer electrical readout at th 0, 5, 8, and 9 cathode leads.

CIRCLE 307 ON READER SERVICE CARD

Power Supply
ULTRAMINIATURE

VICTORY ELECTRONICS, INC., 50 Bond St., Waterbury, L. I., N. Y., announces a new line of tiny, lightweight, plug-in power supplies, actuated by sources as small as a 1.5-v penlight cell or a 1.3-v mercury cell, and delivering output voltages as high as 20,000 v. Output currents range as high as 120 μa, depending on the model and the external circuit parameters. This power is capable of operating high-voltage instruments used in both terrestrial and in spaceborne, telemetered instrumentation and control, including: Geiger tubes, infrared detectors, ionization chambers, scintillation counters, maser frequency meters, cathode ray tubes and photomultipliers.

CIRCLE 308 ON READER SERVICE CARD

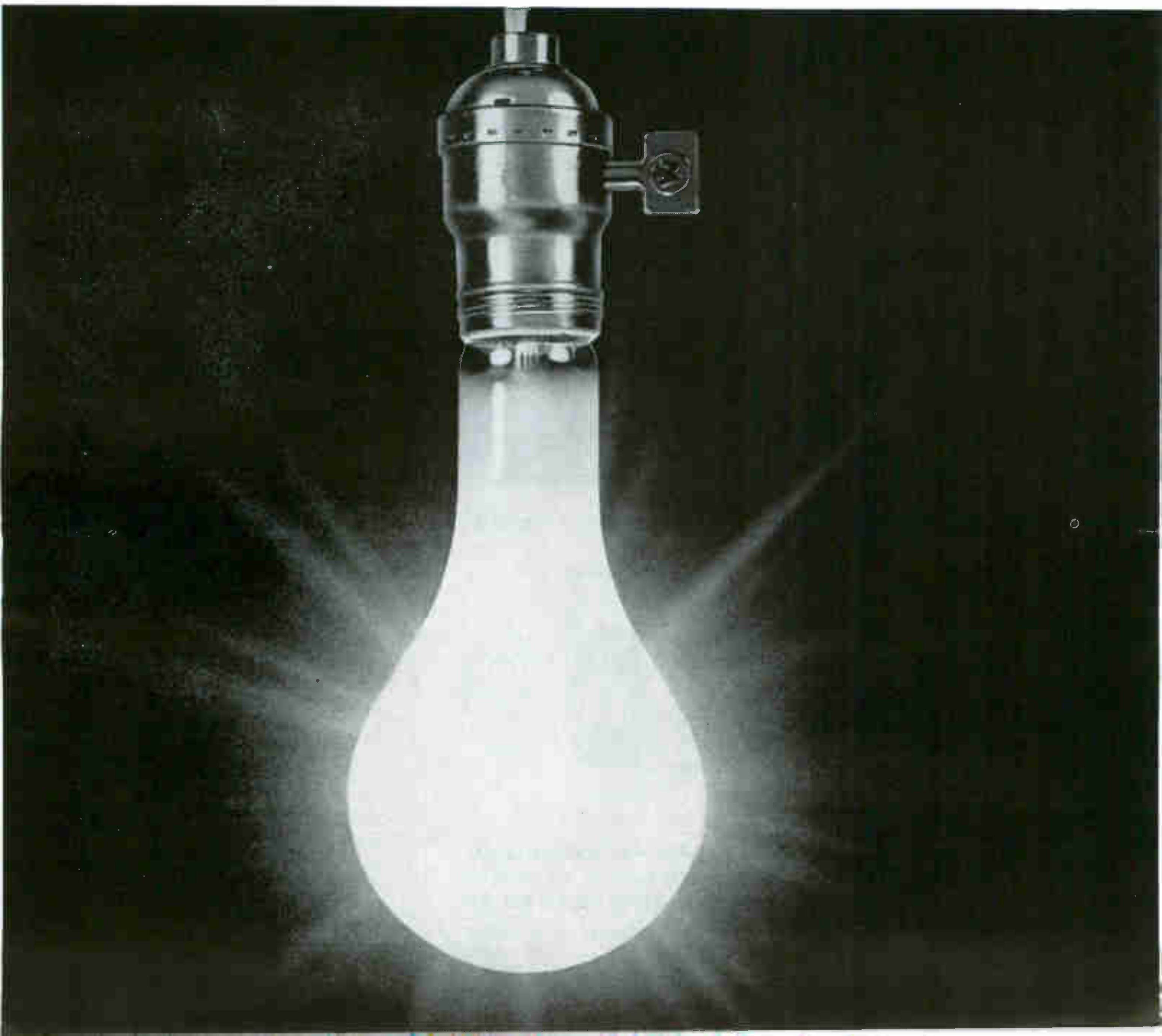
Synthetic Material
REDUCES VIBRATION

LOWELL INDUSTRIES, INC., Allston Station, Boston 34, Mass., is producing Vibra-Check, a highly efficient anti-vibrational material designed to be placed under the base or feet

CIRCLE 207 ON READER SERVICE CARD

 CIRCLE 116 ON READER SERVICE CARD

CIRCLE 117 ON READER SERVICE CARD →



of machines to prevent their transmission of vibration and noise to surrounding areas. Actual service conditions have proved this material will eliminate up to 90 percent of vibration. Vibra-Check is very simple to install. No lagging or cementing to the floor is necessary. Creeping or crawling of vibrating machinery is impossible on Vibra-Check pads because of the high coefficient of friction (0.8) and the vacuum suction cup pattern of Vibra-Check's surface. The material conforms to rough or uneven floors.

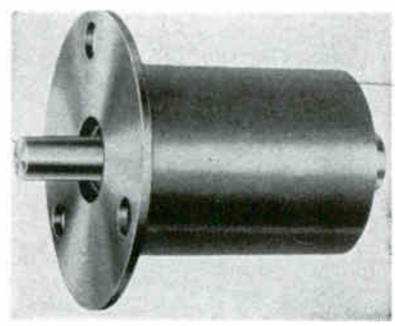
CIRCLE 316 ON READER SERVICE CARD

Multiplexer

SOLID STATE

EPSCO INC., 275 Massachusetts Ave., Cambridge, Mass., announces the TMX841 multiplexer, a solid state high speed switching instrument used for scanning a multiplicity of channels. Transfer accuracy of ± 0.01 percent, crosstalk down 120 db, and flexibility of channel capacity provided by plug-in printed circuit cards, make this unit ideal for precision instrumentation systems. Its utility for the system designer is further enhanced by patch board programming and high input impedance.

CIRCLE 317 ON READER SERVICE CARD



Ratio Drives

SMALL, PRECISE

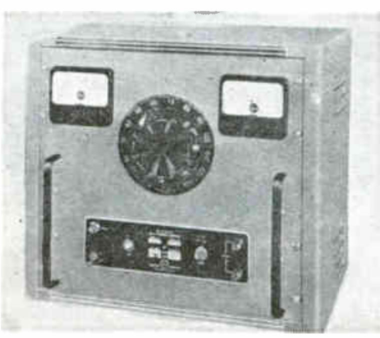
JAN HARDWARE MFG. CO. INC., 38-01 Queens Blvd., Long Island City 1, N. Y. This new series employs unique mechanical principles utilizing combinations of ball-bearings to replace conventional gears. Small, precision ratio drives are useful in servomechanisms and electronic instruments. Ruggedly built and permanently lubricated, these units provide rotary control between input and output shafts which are directly in-line. Models with concentric shafts are especially useful to meet critical space problems. These units are available in a range of driving ratios from 2.66:1 up to 19.65:1. Panel mounting is provided by an integrally cast flange.

CIRCLE 318 ON READER SERVICE CARD

Precision Pot
SUBMINIATURE

NEW ENGLAND INSTRUMENT CO., INC., 1334 Main St., Waltham, Mass. New 55M precision subminiature 10-turn pot features all metal construction with sleeve or instrument ball bearings. The mechanical stop, a special rugged, stainless steel device, will withstand up to 15 lb in. of torque. Company will furnish servo, bushing or special mount to customer's specifications. The unit is available in resistance values of from 25 ohms to 200 K ohms with linearities as close as ± 0.15 percent.

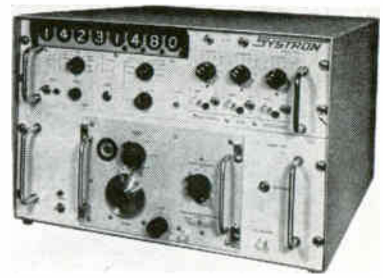
CIRCLE 319 ON READER SERVICE CARD



Power Supply
NEW RATINGS

OPAD ELECTRIC CO., 43 Walker St., New York 13, N. Y. The d-c output voltage range of the model RS40B has been extended to cover 0-125 v at the full load rating of 20 amperes. Maximum rms ripple is held to within 1 percent of the average d-c output. The voltage regulation has also been reduced to provide a maximum change of 6 v when the load current changes from 2 to 20 amperes. A proportionally smaller output voltage charge results for a lesser load current swing.

CIRCLE 320 ON READER SERVICE CARD



Frequency Extender

FOR LABORATORY USE

SYSTRON-DONNER CORP., 950 Galindo St., Concord, Calif., announces the model 1290 extender which permits frequency measurements to 220 Mc when used with the model 1039 solid state counter-timer and existing plug-in units. The model 1039 provides fully transistorized circuitry, 0.1 v rms sensitivity, 1 megohm input impedance on three d-c amplifiers and Nixie in-line readout. The model 1039-1290 can be utilized for measurements of frequency-period-time-ratio-phase as a universal laboratory instrument.

CIRCLE 321 ON READER SERVICE CARD

Double Scaler

FAST RESOLVING TIME

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 61 East North Ave., Northlake, Ill. Model 49-15 double scaler, which occupies 8¾ in. of rack space, has two scales of 10^4, each followed by a four digit electrically reset Sodeco register. The two scaling sections may be operated individually or simultaneously. The fast resolving time of 0.8 μsec permits counting rates in excess of one million counts per minute. It includes a linear non-overloading amplifier with a gain of 25. Provision is made for remote control of count and of reset operations. The revised model 49-15 uses a single electronically regulated low voltage power supply.

CIRCLE 322 ON READER SERVICE CARD

Gold Alloy Preforms
FOR SEMICONDUCTORS

ALPHA METALS, INC., 56 Water St., Jersey City 4, N. J., has available gold 99.99+ percent pure alloyed with antimony, silicon, germanium, gallium or tin and fabricated into spheres, foil, washers, disks, rectangles and squares for semiconductor devices. Dimensions of these materials are as follows: spheres range from 0.005 in. with tolerances as close as 0.0001 in.; disks, from 0.005 in. up; foil, from 0.0005 in. thin; rectangles, from 0.040 in. to 0.015 in.; squares, 0.020 in.; washers from 0.020 in. i-d and a land of 0.005 in.

CIRCLE 323 ON READER SERVICE CARD

Sensitive Relay
CLOSE DIFFERENTIAL

ELECTRO-MECHANICAL SPECIALTIES CO., INC., 528 West Lambert Road, Whittier, Calif. Series No. 10,000 relay has been designed to meet stringent requirements for airborne and missile applications per MIL-R-6106C and MIL-R-5757C. Relays are available in spdt or dpdt configurations with contacts rated at 2 amperes. The unit shown operates at 22 v d-c ± 1 v d-c and the release voltage is 16 v d-c ± 1 v d-c. Other operate and release voltages are available from 5 to 150 v d-c with accuracy maintained throughout temperature extremes of − 65 F to + 200 F. Units will withstand vibration of 20 g's from 10-2,000 cps, and 50 g's shock with only one watt operating power.

CIRCLE 324 ON READER SERVICE CARD

Literature of

CONTROL PANELS Bodnar Products Corp., 238 Huguenot St., New Rochelle, N. Y. A four-page folder illustrates and describes illuminated plastic control panels for the aviation, electronics and computer industries qualified to MIL-P-7788A.
CIRCLE 363 ON READER SERVICE CARD

THREE-WAY DATA CONVERTER Electronic Engineering Co. of California, 1601 East Chestnut Ave., Santa Ana, Calif., has published a bulletin describing the ZA-753 all solid state three-way data converter (paper-to-magnetic tape, magnetic-to-paper tape, paper-to-paper tape).
CIRCLE 364 ON READER SERVICE CARD

LOW CAPACITY BRIDGE Marconi Instruments, 111 Cedar Lane, Englewood, N. J. Data sheet 1342 illustrates and describes a low capacity bridge that measures capacities down to 0.002 $\mu\mu$f with speed and 0.2 percent accuracy.
CIRCLE 365 ON READER SERVICE CARD

COMPUTING RESOLVERS Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J. A recently issued 16 page, illustrated monograph describes the characteristics of computing resolvers. Such definitive properties as function error and axis error are explained and the techniques of measurement are set forth in great detail.
CIRCLE 366 ON READER SERVICE CARD

SHIELDED CHAMBERS Emerson & Cuming, Inc., Canton, Mass., has published a 24-page brochure on Eccoshield r-f shielded chambers and describing the complete service which the company is prepared to furnish in connection with shielded chambers from engineering design through erection and testing.
CIRCLE 367 ON READER SERVICE CARD

MICROWAVE PRODUCTS Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y., has available a new brochure listing 250 available microwave products by frequency band.
CIRCLE 368 ON READER SERVICE CARD

ACCELERATION SWITCHES The Instrument Division of W. L. Maxson Corp., 475 Tenth Ave.,

the Week

New York 18, N. Y., has available a new bulletin covering eight damped-type acceleration switches. Both unidirectional and bidirectional switches are included with complete technical description, test and performance data.

CIRCLE 369 ON READER SERVICE CARD

TERMINAL BLOCKS Excellex Electronics Inc., 88-06 Van Wyck Blvd., Jamaica 18, N. Y., has available catalog XLX-7a describing a complete line of terminal blocks for all purposes with information on how to specify.

CIRCLE 370 ON READER SERVICE CARD

RTV SILICONE RUBBERS General Electric Co., Silicone Products Department, Waterford, N.Y. A new publication describing product and application data on the complete family of RTV (room temperature vulcanizing) silicone rubber compounds is now available.

CIRCLE 371 ON READER SERVICE CARD

R-F CONNECTORS General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass. A 32-page catalog is a comprehensive effort to provide complete information on TNC and TM series r-f connectors. For a copy, write on your letterhead.

CIRCLE 372 ON READER SERVICE CARD

SILVER-ZINC BATTERIES Yardney Electric Corp., 40-50 Leonard St., New York, N. Y., has issued a new, 10-page illustrated brochure on the compact Silvercel secondary batteries.

CIRCLE 373 ON READER SERVICE CARD

SPECTRUM COVERAGE PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y. Four page, 2 color, bulletin 400 categorizes hundreds of the company's products by frequency range, waveguide size, and price.

CIRCLE 374 ON READER SERVICE CARD

VHF POWER GENERATOR Pacific Semiconductors, Inc., 10451 W. Jefferson, Culver City, Calif. Circuit details of a high-power solid state vhf power generator are disclosed in a new publication now available.

CIRCLE 375 ON READER SERVICE CARD

Carpenter: Solve, don't trample

YOU CAN'T TELL IT from his youthful appearance, but John J. Carpenter has spent more than 20 years untangling production snarls in the electronics industry.

Named to a vice presidential post early this year by Bulova's board chairman Gen. Omar N. Bradley, Carpenter now runs the company's industrial and defense operations, is a director of Bulova Research & Development Laboratories, and of the firm's subsidiary, American Time Products.

Born in Newark, N. J., in 1918, his grade school career was an active one in that he attended "about eleven of them" because of frequent family moves.

An interest in ham radio at an early age gave him a taste for electronics, taught him perseverance. From this interest, the path led to the Newark College of Engineering where he studied electrical engineering at night, worked days gaining practical experience.

In 1937, Carpenter took a job at Bell Laboratories, working on crystal units for frequency controls which at that time were still laboratory-produced devices. It was during this phase of his career that he evolved an axiom that has served him well since: "Solve your problems, don't trample them to death."

During his 15-year stay at Bell Labs, he took on the job of teaching representatives of other companies the techniques and practices he and his fellow engineers had evolved in the laboratories. Besides this, he also began teaching engineers some functions of accounting in the electronics industry and teaching accountants enough about engineering processes to allow the two groups to understand each other.

During the war years, crystal filter work took on added importance because these devices were needed in combat tank radio gear. The main task was to beef up production. It was during these years that Carpenter developed his approach to unsnarling production lines.

In 1952, Carpenter took a job with Bulova to set up a crystal production facility, only to run head on into problems arising from the Korean emergency. That year he helped set up production lines for quartz crystals and communications devices needed by the Signal Corps.

Carpenter's next challenge came with the missile age. Initially, his attentions were devoted to crystal production. Soon his group began producing ovens for the crystals, then crystal oscillators, finally entire filter asemblies.

The men who work with him seem to share his enthusiasm for hard jobs. Some say this is because of his ability to hand them a challenge and rely on them to see it through. "In this group, when we have nothing to worry about, we're worried," says one of his associates.

Summers still find him spending vacations at the Jersey shore. The rest of the year is spent at home in Lynbrook, N. Y., where he and his wife, Pat, live with their three sons aged 16, 12, and 3. To ease off from professional strains, Carpenter lives up to his name: his hobby is woodworking.

Polarad Sets Up French Subsidiary

FORMATION of a French manufacturing facility of Polarad Electronics Corp., Long Island City, N. Y., has been announced. The new company, located in Montrouge, a suburb of Paris, will manufacture Polarad's industrial line of microwave instrumentation for the European Common Market and maintain close contact with the new techniques under development in France in the millimeter range.

Formation of the new French subsidiary is in line with an overall expansion program which envisages an increase in the demand for microwave instruments abroad. At the present time, a substantial portion of Polarad's sales of industrial products are foreign. Such sales are handled by 70 sales engineers resident abroad.

Polarad will have a substantial majority interest in the new subsidiary with minority interests represented by French sales, management and technical personnel

Herman Sondov Takes Board Chairman Post

HERMAN SONDOV, executive vice president of Specialty Electronics Development Corp., Syosset, N. Y., manufacturer of communications equipment, radiation detectors and

Precise

DELTA PORTABLE TEMPERATURE CHAMBERS

Model 1060W
Test Volume 16"x7"x7"

Model 1060R,
Rack Mounted
Test Volume 10"x7"x7"

Temperature Control ±½° F From -100°F to +500°F

ACCURATE TEMPERATURE CONTROL, without overshoot and without drift.

SAVES TIME by bringing the environment to the engineer instead of scheduling time in large, slow chambers.

VERSATILE—test for high and low temperatures in the same chamber.

AUTOMATIC CYCLING timer is available as auxiliary equipment.

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21 Franklin St., Seymour, Conn.

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Over 100 O.E.M.s have standardized on AMPERITE

Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +80° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived, and—inexpensive!**

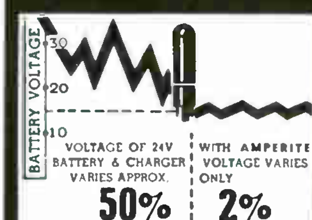
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . List Price, $4.00.

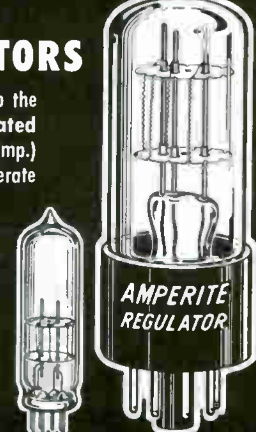
Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . List Price, $3.00.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

561 Broadway, New York 12, N. Y. . . . CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 127 ON READER SERVICE CARD

related electronic devices, has been named chairman of the board, a post that had not been filled before. He continues as executive vice president, while H. Russell Cammer continues as president and chief executive officer.

Sondov was a partner in Specialty's predecessor firm, Specialty Engineering and Electronics Co., before a merger last year resulted in formation of the present company.

Magnetico Appoints Works Manager

STANLEY L. RUBIN has been named works manager of Magnetico, Inc., East Northport, N. Y.

He had previously been the senior engineer in charge of methods and packaging for ITT Kellogg, communications division.

Since 1933 Rubin has had continuous and progressive management experience in the transformer and amplifier fields. In his new position he will be responsible for intensifying Magnetico's production engineering and control for their new developments in the magnetic and control fields and their recently expanded toroidal winding facility.

Vitramon Names Three Officers

VITRAMON, INC., Bridgeport, Conn., electronic components manufacturer, has named three of its key managers as officers of the company.

Alexander J. Groves, former plant manager, has been advanced to vice president, manufacturing; William Osowski, assistant treasurer, to treasurer; and Clifford H. Tuttle, Jr., sales manager, to vice president, sales.

The appointments coincide with the opening of a new 48,000 sq ft production and administration facility in Monroe, Conn. The firm manufactures several types of capacitors, all of which are extensively used in missile, rocket and satellite programs.

J. A. Maurer, Inc. Picks Engineering V-P

APPOINTMENT of James M. McCarty as vice president in charge of engineering of J. A. Maurer, Inc., Long Island City, N. Y., has been announced. He has had many years of extensive experience with photo reconnaissance systems. Most recently he served in the capacity of chief engineer and marketing manager of Chicago Aerial Industries, Chicago, Ill.

J. A. Maurer, Inc., manufactures aerial reconnaissance and missile guidance systems.

ITA Appoints Head Engineer

JOSEPH ROBERTS, formerly transmitter project engineer for RCA, Camden, N. J., has been appointed chief engineer of Industrial Transmitters & Antennas, Inc., Lansdowne, Pa.; manufacturer of f-m broadcast and communications equipment.

He will be responsible for the design and development of high power f-m transmitters, and for expansion of engineering facilities at the new plant in Lansdowne, where other transmitter activities are contemplated.

Before joining ITA, Roberts was active for several years in a-m, f-m, and tv transmitter design, and also has served as broadcast chief engineer.

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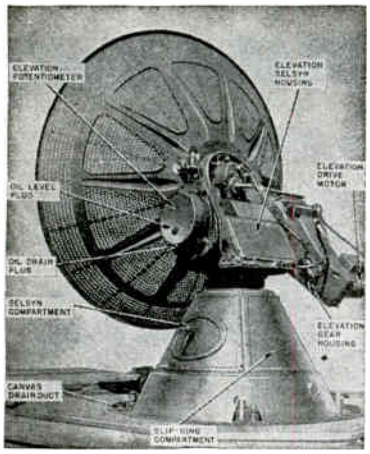

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MIT Radiation Lab Model 9 pulser. Desc. in "Rad Lab Series" Vol. 5 pps. 152-160. Supplies 1 megawatt output using 6C21 tubes. Complete modulator 115v 60 cycle input enclosed in single cabinet. Also 22000v power supply for magnetron in second cabinet. As new condition. In stock for immediate delivery.

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Complete RF head including transmitter, receiver, modulator. Uses 2J42 magnetron. Fully described in MIT Rad. Lab. Series Vol. I, pps. 616-625 and Vol. II, pps. 171-185, $37500. Complete X band radar system also avail. inclu. 360-deg antenna, PPI, syn pwr supply. Similar to $17,000 weather radar now in use by airlines. $750 complete.

10 CM. WEATHER RADAR SYSTEM

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Self supporting, rect. 14 ft. platform atop. New $1500.

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AN/APW-11A transmitter cavity for 2C40. Complete S band coverage at max. power. Temperature compensated. New $77.50 ea.

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Mfg. Gen'l. Mills. Met. data computer and recorder. Readout: Rel. Humid, Press., Altitude, etc. Direct. $1500 ea.

AN/AAS-6 Infra Red Detection System Complete. New. $5500.

VD-2 PPI REPEATER

Floor standing console with rotating yoke PPI. 7BP7CRT. 4, 20, 80, 200 mile ranges. Will display or repeat any PPI info locally for remote. New & complete. With inst. book. $375 ea.

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Desk top size projection type PPI Repeater as plotting board. As new. $325.

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Fully insulated, wired for 110vac with lights and outlets. Includes heater thermostat controls. 20 ft. long apx, 8 ft. wide, 10 ft. high. Fifth wheel for hauling by std. truck tractor. Buttressed walls for handling high roof torsion. 1 entrance door, 2 equipment doors. 4 wheel rear axle. Will hold 10 tons of equipment. Elevator from van floor to roof incl. in some units. Exc. condition $1500 ea. Mfg. Freuheuf. Large quantity in stock.

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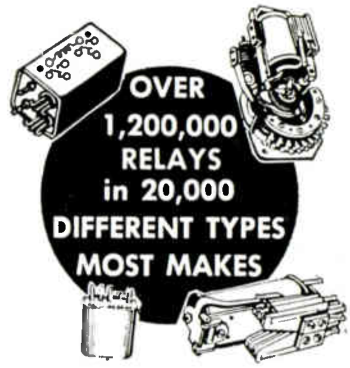

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Sigma	7-JOZ-80030 None Pile Up Cont.	SPDT	5000 Ohm	28VDC	2.50
		3A3B	144 Ohm	12VDC	1.00
		3B	144 Ohm	12VDC	1.00
		1A1B2C	39 Ohm	6VDC	1.00
Phillips Control	2QA316A	1C1A	200 Ohm	12VDC	1.50
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Clare	B65369	1A1B	125 Ohm	12VDC	1.50
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5D Diff. Mtr. 90/90V 60 cy............. 34.50
5DG Diff. Gen. 90/90V 60 cy............. 34.50
5F Syn. Mtr. 115/90VAC 60 cy............. 34.50
5G Syn. Gen. 115/90VAC 60 cy............. 34.50
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FPE 49-7 Diehl servo motor, 115 volts, 60 cycle, 10 watts............. 30.00

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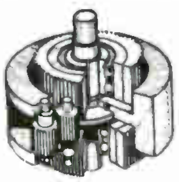

The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. 1/4" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115.................each $15.00

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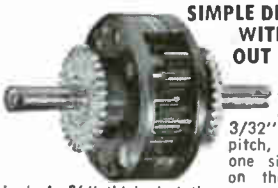
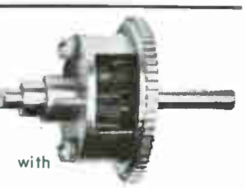


1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is 3/4" thick, but the sun gears are spaced out so that they are 1 1/2" apart. 1/4" dia. shaft on each side is 23/32" long. OA length 3 1/8". Requires 1-23/32" dia. to clear the body.
Stock no. A6-124.................each $4.50

SIMPLE DIFFERENTIAL



1:1 reverse ratio, 60 teeth on large gear; 1/4" shaft. Size: 3" long with 1-15/16" dia.
Stock no. A6-104.................each $3.95

DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3 1/4" long x 1-7/16" dia. Shaft size: 1/8" and 5/32".
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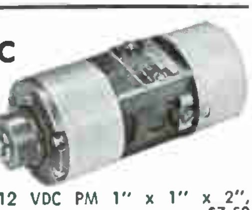
SMALL DC MOTORS



(approx. size overall 3 3/4" x 1 1/4" dia.:)
5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm. $7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled 15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm 12.50
#5069625 120 rpm, mfr. Delco, 27 VDC governor controlled $15.00
5069230 Delco PM 27.5 VDC 145 rpm 15.00
5068750 Delco 27.5 VDC 160 rpm w. brake 6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") 5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled 15.00 ea.
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Mfgd. by T K M Electric Corp.
Model #A-12
120/208 volts, 400 cycle, 1 or 3 phase, 1 kva, pf 0.8, rpm 8,000. Approx. dim. 6" x 5 1/2". Internal spline drive. Price $100.00

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115 VAC. 3 KVA. Mfg. Bogue Elect. Mod. 2800S. External excitation 107 VDC. 1.1 amp. 3450 rpm. 1" shaft. $200.00

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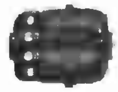


B-35 Elinco; 2 volts per 100 rpm; max. rpm 10,000.......$22.50
B-68 Elinco; 1.2 V.A.C. per 100 rpm; max. rpm 10,000..$17.50

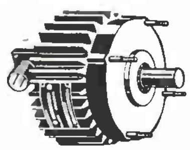
400 CYCLE, 3 PHASE GENERATOR

BY MASTER ELECTRIC Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20".

Price $395.00 each

400 CYCLE PM GENERATOR

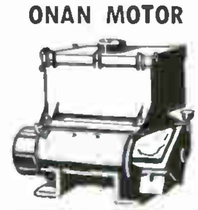
115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4 3/4" dia.; 3" long; 1/2" shaft, AN connector. $75.00



400 CYCLE MOTOR GENERATOR

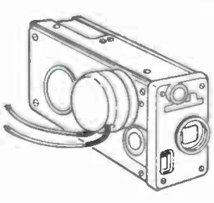
Mfgd. by General Electric
Model #5ATB324E5
Output 120/208 volts AC, 400 cycle, 11.75 kva, 32.6 amp., pf .85. Input 220/440 volts AC, 60 cycle, 3 phase, 15 h.p. Unit complete with motor starter and controls. Price $750.00

ONAN MOTOR GENERATOR SET



MG 075-G-1
Generator 115 VAC; 480 cycle; 5.3 amps; .6KW; PF 1.0; also 26 VDC; 100 watt; 3.8 amps; Driven by 115-230 VAC —2hp motor; 60 cycle; single phase; 3450 rpm; 10.5 amps.
Price $135.00

16mm SINGLE FRAME CAMERA



mfgd. by Bell & Howell (200 series) 50 ft. magazine load operates on 12 volt DC, has rotary solenoid, standard C mount, less lens and view finder; excellent for photographing records, nature study, etc.
Price $35.00 each

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SPECIAL PURPOSE TUBES

OA2	.70	4X150A	8.85	348A	2.50	5528/C6L	1.50	5896	1.50
OA3	.85	4X250B	30.00	349A	2.00	5545	12.50	5899A	2.50
OB2	.50	5BP1A	12.50	350A	3.50	5552/FG-235	45.00	5902	2.35
OB3	.70	5C22	16.00	350B	3.50	5557/FG-17	4.25	5903	4.00
OC3	.50	5CP1A	10.50	352A	6.50	5558/FG-32	7.50	5932/6L6WGA	5.00
OD3	.30	5LP1A	20.00	354A	10.00	5559/FG-57	10.00	5948/1754	150.00
1AD4	1.25	5R4GY	1.00	355A	10.00	5560/FG-95	15.00	5956/E36A	10.00
1B24A	8.85	5R4WGY	2.50	393A	3.50	5586	100.00	5963	.75
1B35A	3.00	5RP1A	10.00	394A	2.50	5632/C3J	8.50	5964	.85
1B63A	12.50	5Y3WGT	1.15	396A/2C51	2.50	5636	1.25	5965	.75
C1K	6.00	6AC7W	.35	398A/5603	4.00	5639	2.00	5975	2.00
1P21	25.00	6AG7Y	1.00	401A/5590	1.50	5642	1.25	5977/6K4A	1.50
1P25	10.00	6AK5W	1.00	403A/6AK5	1.00	5643	4.50	5981/5650	25.00
1P28	20.00	6AN5WA	3.00	403B/5591	3.00	5644	2.50	5992	2.00
2-O1C	12.50	6AS7G	2.35	404A/5847	10.00	5646	2.00	5993	4.00
2AP1A	2.50	6BL6	30.00	407A	3.50	5647	2.25	6005/6AQ5W	1.25
2BP1	7.00	6BM6	30.00	408A/6028	2.00	5651	.70	6012	5.00
2C36	25.00	6BM6A	30.00	409A/6AS6	2.00	5654/6AK5W	1.00	6021	2.00
2C39	2.50	6C21	10.00	412A	4.00	5656	3.50	6032	25.00
2C39A	7.50	C6J	12.50	415A	3.00	5665/C16J	28.50	6037/QK-243	25.00
2C40	7.00	6J4WA	1.50	416B/6280	30.00	5670WA	1.35	6045	1.25
2C43	7.50	6J6W	.60	417A/5842	10.00	5675	7.50	6072	1.75
2C50	5.00	6L6GAY	1.00	418A	15.00	5676	1.25	6073	.80
2C51	1.50	6L6WGB	1.75	420A/5755	5.00	5678	1.25	6080	2.85
2C52	1.75	6L6Y	1.25	421A/5998	7.50	5684/C3J/A	11.80	6080WA	5.00
2C53	8.50	6Q5G	2.50	422A	10.00	5685/C6J/A	15.00	6080WB	10.00
2D21	.50	6SJ7WGT	1.00	423A/6140	5.00	5686	1.85	6082	3.00
2D21W	1.00	6SL7WGT	1.00	429A	9.00	5687WA	2.50	6087/5Y3WGTB	3.00
2E24	2.50	6SN7WGT	.75	450TH	30.00	5691	5.00	6099	.75
2E26	2.85	6V6GTY	.75	450TL	30.00	5692	2.00	6100/6C4WA	1.25
2J42	35.00	6X4W	.75	575A	12.50	5693	3.50	6101/6J6WA	1.00
2J51	50.00	6X5WGT	1.00	631-P1	4.25	5702WA	2.75	6111A	2.00
2K25	7.50	SRL7F-H	150.00	673	12.50	5703WA	3.00	6112	2.50
2K26	25.00	7MP7	17.50	676	27.50	5704	1.00	6115/QK-351	50.00
2K29	25.00	10KP7	25.00	677	32.50	5718	1.00	6130/3C45	8.50
2K30	75.00	HK-24	1.00	714AY	10.00	5719A	1.50	6136/6AU6WA	1.25
2K34	100.00	25T	7.50	715C	10.00	5720/FG-33	17.00	6137/6SK7WA	1.50
2K35	250.00	26Z5W	1.25	719A	7.50	5721	125.00	6146	3.75
2K41	25.00	35T	7.50	721B	3.00	5725/6AS6W	1.00	6152	4.50
2K42	125.00	35TG	2.50	723A/B	2.50	5726/6AL5W	.75	6186/6AG5WA	1.75
2K43	125.00	FG-105	33.35	725A	5.00	5727/2D21W	1.00	6189/12AU7WA	1.50
2K44	125.00	FG-172	17.50	726B	3.25	5728/FG-67	7.50	6197	1.75
2K47	125.00	212E	25.00	750TL	87.50	5740/FP-54	50.00	6199	35.00
2K50	65.00	244A	2.50	802	3.50	5744WA	2.75	6201/12AT7WA	1.50
2X2A	1.00	245A	3.50	804	15.00	5749/6BA6W	.75	6202/6X4WA	1.50
2X1000A	95.00	249B	10.00	805	3.00	5750/6BE6W	1.35	6211	.65
3AP1A	10.00	249C	5.00	807	1.25	5751/12AX7W	1.35	6216	2.50
3B24W	3.50	250R	7.50	809	3.75	5763	1.50	6263	9.00
3B25	3.00	250TH	25.00	810	12.50	5777	100.00	6264	9.00
3B28	4.00	252A	6.00	811A	4.75	5778	150.00	6265	2.25
3BP1A	7.50	254A	2.00	813	8.50	5783	2.00	6282/BL-11	50.00
3C22	30.00	257A	3.50	814	1.50	5784WA	3.50	6299	37.50
3C23	4.50	259A	3.50	815	1.50	5787	2.50	6336	7.50
3C24/24G	2.50	262B	3.50	816	1.75	5799/VX-21	3.00	6336A	10.00
3C45	3.00	267B	7.50	828	7.00	5800/VX-41	3.50	6352	8.50
3D22	9.50	271A	10.00	829B	7.25	5801/VX-33A	3.00	6364	150.00
3E29	3.50	272A	4.00	832	2.00	5802/VX-32B	3.50	6390	175.00
3J21	35.00	274A	2.50	833A	33.00	5803/VX-55	1.50	6438	4.00
3J31	50.00	275A	4.00	836	1.00	5814A	1.25	6463	1.25
3K21	150.00	283A	3.50	837	.90	5819	45.00	6517/QK358	500.00
3K22	150.00	287A	2.50	845	7.50	5824	2.50	6533	6.50
3K23	250.00	293A	4.50	866A	1.95	5828	3.00	6544	250.00
3K27	185.00	300B	5.00	872A	1.75	5829WA	1.50	6550	4.25
3K30	75.00	304TH	30.00	884	1.00	5836	60.00	6626/OA2WA	2.00
3KP1	10.00	304TL	30.00	913	7.50	5837	60.00	6627/OB2WA	2.00
4-65A	9.50	310A	3.50	927	1.25	5839	2.50	6655	40.00
4-125A	20.00	311A	2.50	931A	3.00	5840	2.00	6754	10.00
4-250A	30.00	313C	1.00	959	.50	5845	4.85	6784	250.00
4-400A	32.50	323A	6.50	1000T	97.50	5852	2.50	6897	18.75
4-1000A	100.00	328A	2.50	1500T	150.00	5854	1.50	6901	10.00
4AP10	10.00	329A	3.50	1603	4.75	5876	5.00	8005	5.00
4B31	15.00	336A	2.50	1614	2.50	5879	1.00	8013A	3.00
4C35	15.00	337A	3.50	1620	3.50	5881/6L6WGB	1.75	8020	1.50
4E27	7.50	339A	4.00	1624	.75	5886	3.00	8025	3.00
4J52	25.00	347A	1.50	2050	1.10	5894	15.00	9002	.35
								9005	3.00

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western engineers

Orders for less than $10 cannot be processed

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AN/APT-5 Transmitters, 50 watt CW-RF 300-1625MC, 115v60cy fils (send for data). new surplus sld pkg, $185.00; used svcbl $135.00.
AN/SPT-6A Navy version of AN/APT-5 with built-in 115v60cv plate & fil supply, new surplus in sealed packing w/accys & manual $285.00.
AN/APT-9 Transmitter, 200-2500MC (2-2C39A's, etc.), cavity motorized for remote tuning. new surplus sld pkg $185.00, used svcbl $135.00.
CHOPPERS, Stevens-Arnold CH-268, octal base 0-500cy, interchangeable with CH-364, now priced $51.30, our price new surplus sld pkg $18.00.
ATTENUATORS, Daven RFA-541 0-70DB in 10DB steps 0-225MC, 50 ohms coax "N" connectors, now priced $50, our price new surplus sld pkg $20.00.
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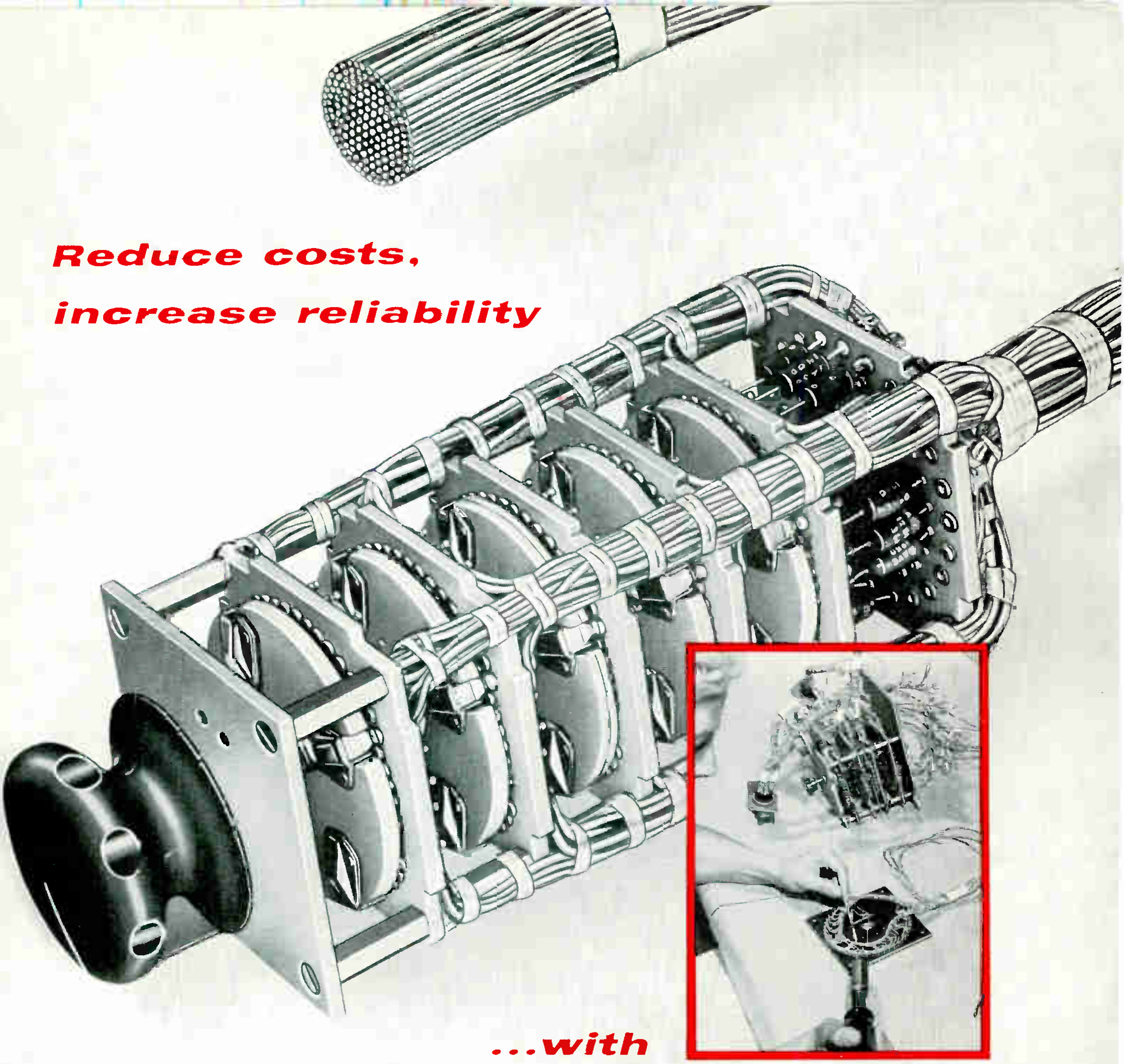

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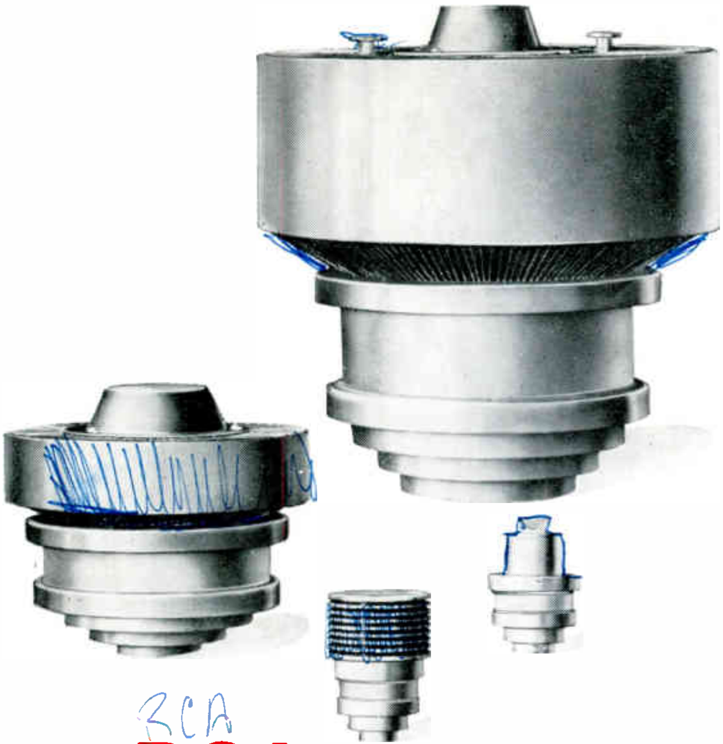

RCA

RCA CERMOLOX TUBES...

A NEW CONCEPT IN BEAM POWER TUBE TECHNOLOGY

a new concept in Beam Power Tube technology

To meet the increasing demand for dependable UHF power, RCA has developed Cermolox Tubes, a wide line of coaxial, ceramic-metal beam power tubes with precision-aligned grids. These Cermolox tubes are especially well suited to the requirements of aircraft, missile and guidance applications in CW, Pulse, and Hard-Tube-Modulator service.

Already they have set an enviable record of performance in such exacting applications. In Pioneer V, for instance, Cermolox tubes were used in the guidance systems, and in the satellite's high-power transmitter.

Some outstanding features of RCA Cermolox tubes which contribute to long life and reliability are:

- Precise alignment of grids for outstanding efficiency.
- Coaxial-electrode structure adaptable for use either in coaxial-cylinder or parallel-line circuits.
- Exceptionally sturdy structure.
- Low rf-loss ceramic insulation.
- High temperature operation.
- Brazed construction involves no spot welding and assures low rf losses and low internal stresses.
- Compact, ceramic-metal construction.
- Flexibility of cooling techniques: conduction, liquid, and forced air (with RCA's high-efficiency radiator).

The family of RCA Cermolox tubes is shown in the adjacent table. For more information, contact the RCA Field Office nearest you.

The Most Trusted Name in Elec

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

RCA CERMOLOX BEAM POWER TUBES

Type	Max. Plate Input Watts	Max. Freq. at Max. Ratings	Max. Plate Diss. Watts	Heater Volts/ Amperes
CW APPLICATION				
A-2678*	50	3,000	25	6.3/1
A-2582-A*	50	3,000	25	12.6/.49
6816	180	1,215	115	6.3/2.1
A-2261* Conduction Cooled	180	1,215	115	6.3/2.1
A-2673* Ruggedized Conduction Cooled	180	1,215	115	6.3/3.0
7457 Ruggedized	180	1,215	115	6.3/3.0
A-2635* Conduction Cooled	180	2,000	115	26.5/.52
6884	180	1,215	115	26.5/.52
7650	1,250	1,215	600	6.3/7.5
A-2663* Conduction Cooled	1,250	1,215	600	6.3/7.5
7213	2,500	1,215	1,500	5.5/[illegible]
A-2545-A*	28,000	400	10,000	[illegible]
PULSED RF APPLICATION				
A-2587-A*	3,750	3,000	25	12.6/.41
7649 Ruggedized	9,000	1,215	115	6.3/3.0
7651	72,000	1,215	600	6.3/7.5
7214	180,000	1,215	1,500	5.5/17.5
A-2581-A*	2,000,000	600	10,000	18/12
HARD-TUBE-MODULATOR APPLICATION				
A-2638*	8,000	–	115	6.3/3.0
A-2624* Ruggedized	60,000	–	600	6.3/7.5
A-2627-A* Ruggedized Conduction Cooled	300,000	–	1,500	5.5/17.5
A-2625* Conduction Cooled	1,500,000	–	10,000	18/12
SSB APPLICATION				
A-2681*	650	500	250	6.3/2.6

*Development Type—Available on Sampling Basis

RCA ELECTRON TUBE DIVISION FIELD OFFICES

INDUSTRIAL TUBE PRODUCTS SALES: NEWARK 2, N. J., 744 Broad St., HUmboldt 5-3900 • DETROIT 2, MICHIGAN, 714 New Center Building, TRinity 5-5600 • CHICAGO 54, ILLINOIS, Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900 • BURLINGAME, CALIF., 1838 El Camino Real, OXford 7-1620 • LOS ANGELES 22, CALIF., 6355 E. Washington Blvd., RAymond 3-8361. GOVERNMENT SALES: NEWARK, N. J., 744 Broad St., HUmboldt 5-3900 • DAYTON 2, OHIO, 224 N. Wilkinson St., BAldwin 6-2366 • WASHINGTON 6, D.C., 1725 "K" St., N.W., FEderal 7-8500.