

REFERENCE SHEET

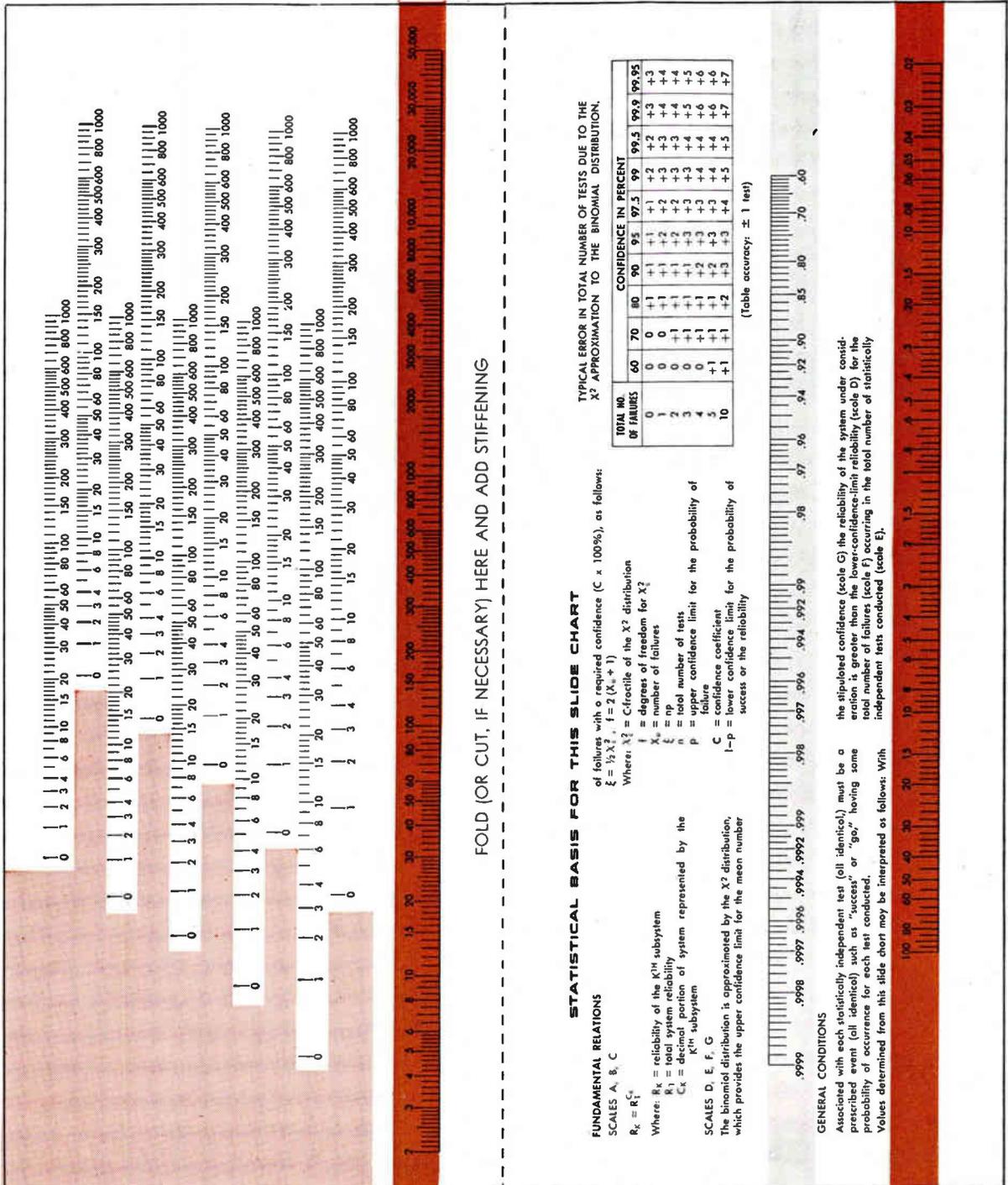
missiles are fired and 14 hits are recorded: 3 failures out of 17 tests. These tests demonstrate for 90 percent confidence, that the reliability of the missiles in the batch from which the 17 were fired is at least 0.60.

The binominal distribution reliability is not limited to one-shot items; it is equally applicable to long-term durable equipment. Consider a sampling of radar sets tested for 200 hours. The number of sets that failed during this 200-hour interval, in conjunction with the total number of sets tested, leads

directly to a reliability-confidence figure. For example, 15 radars were turned on (after adequate burn-in time as determined by failure rate analysis). Fourteen were still operating at the end of the 200-hour period. Thus, for 95 percent confidence, one failure in 15 tests indicates a reliability of 0.68 for the remainder.

According to the error chart on the slide portion of the slide rule, however, 95 percent confidence figures overstate the total number of tests by two.

(Continued)



TEMPLATE for slide can be folded or cut along dashed line. Table on slide provides correction factor for figuring number of tests required

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	MODEL 3900	MODEL 3907
Time delay range:	0.1 to 200 Seconds	0.1 to 200 Seconds
Nominal voltage:	20 to 30 VDC	20 to 30 VDC
Life (min):	10^5 cycles	10^6 cycles
Output:	DPDT Relay	SPST NO - Solid State
Contact rating:	1 ampere resistive at 26.5 VDC, 120°C	0.05 amperes resistive at 26.5 VDC, 120°C ; 0.250 amps at 25°C
Ambient temp. range:	-55 to $+120^{\circ}\text{C}$	-55 to $+120^{\circ}\text{C}$
Size:	.4" x .8" x 1.31"	.4" x .8" x 1.0"



ACTUAL SIZE



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Therefore, $15 + 2 = 17$ is the scale E value under which the reliability is found; opposite 17 is found 0.72. The slide rule is conservative if the error chart is ignored. Error chart use when the total number of tests is desired is illustrated in a following example.

SUBSYSTEM RELIABILITY—Scales A , B , and C apply to the failures likely to occur in the over-all system, and how these failures are to be apportioned among series connected subdivisions which are defined as subsystems. The failure of any one of these subsystems is assumed to disable or no-go the entire system.

Suppose, for example, a particular subsystem is allowed by design to contribute only a small percentage of the failures occurring in the entire system. For this to happen, the reliability of the particular subsystem must be higher than that of other subsystems that are allowed a greater portion of likely system failures. Based on the relative complexity of the subsystems, or on any other design basis or decision, the percentage of overall system failures likely to occur in any subsystem may be assigned.

The reliability of any one subsystem (scale C) is related to the over-all system reliability (scale A) by the percentage of failures assigned the subsystem under question (scale B) according to the equation

$$R_k = R_T^{C_k}$$

presented on the sliding portion of the slide rule. The derivation of this simple closed form expression is given at the end of this article, since it has not been found in previous literature.

EXAMPLE—The following problem is relatively complex, but it illustrates a variety of applications.

A missile is proposed. When a series of this missile is manufactured, a sample portion must demonstrate a reliability of at least 0.92, with 99 percent confidence for the remainder of the series. The reliability of certain missile sections have already been established, as follows

Warhead and fuze	0.992
Rocket motor	0.995
Airframe and power supply	0.993

The parts to be produced are the autopilot and guidance sections, so the first problem is to determine the reliability requirements for these sections.

(1) Set 0.92 on scale A under the arrow.

(2) Read off the percentages on scale B over the appropriate values on scale C for the established portions of the system. For the warhead fuse, with a reliability of 0.992, the allowed failures are 9.5 percent; for rocket motor, 6 percent; for airframe and power supply, 8.5 percent; total, 24 percent.

(3) Subtracting the sum of other section percentages from 100, leaves 76 percent. This is the portion of likely failures that will be allocated to both the autopilot and guidance sections. Suppose the guidance system is three times as complex as the autopilot, based on the number and nature of the components

used. Apportioning the 76 percent accordingly ($Z + 3Z = 76$; $Z = 19$), we choose 19 percent for the portion of likely failures allowed the autopilot and 57 percent allowed the guidance section.

(4) With 0.92 on scale A under the arrow, read off opposite 19 percent failures a reliability of 0.984; opposite 57 percent read 0.954.

(5) Thus 0.984 and 0.954 are, respectively, the reliabilities required of the autopilot and guidance sections.

The second problem is to determine the minimum number of tests required to demonstrate the stipulated 0.92 reliability with 99 percent confidence.

(1) Set 0 (zero) on scale F in the 99 percent window of scale G .

(2) Read on scale E , opposite to 0.92 on scale D , the minimum number of tests required: 59.

(3) According to the error chart on the back of the movable slide, the answer in the step above is in error by + 2 tests (0 failure, 99 percent confidence); therefore, 57 tests are required—assuming no failures—to demonstrate a reliability of at least 0.92 with 99 percent confidence.

APPENDIX—The expression for the reliability associated with a specified portion of the total is easily derived.

Let C_k = decimal portion of the overall system failures allowed the k th subsystem
 n = total number of subsystems considered
 R_T = reliability of overall system
 R = reliability of k th subsystem

The system chain reliability expression is

$$R_T = \prod_{k=1}^n R_k$$

Then $R_k = r^{nC_k}$ because, in accord with the definition above

$$\sum_{k=1}^n C_k = 1$$

Therefore

$$R_T = r^n = \prod_{k=1}^n r^{nC_k} = r^{n(C_1 + \dots + C_k + \dots + C_n)}$$

and

$$R_k = \frac{r^n}{r^{n(C_1 + \dots + C_k + \dots + C_n - C_k)}} = r^{n[1 - (C_1 + \dots + C_k + \dots + C_n - C_k)]} = r^{nC_k}$$

Finally

$$R_k = R_T^{C_k}$$

REFERENCES

- (1) Slide charts have been produced by the Perrygraf Corp., for General Dynamics/Pomona, a Division of General Dynamics Corporation. They are available on a controlled basis from company representatives.
- (2) J. M. Carroll, Reliability: 1962, *Electronics*, p 55, Nov. 30, 1962.

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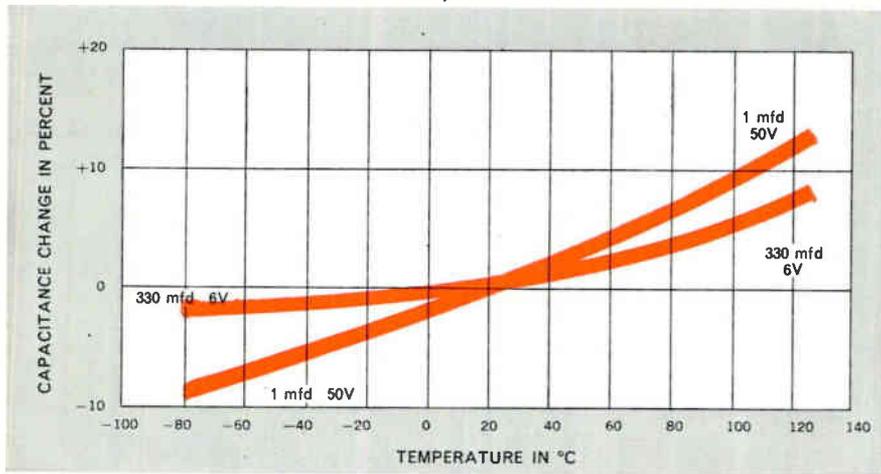
- Harald Cramer, "Mathematical Methods of Statistics," Princeton University Press, Princeton, N. J., 1946.
- A. Hald, "Statistical Theory With Engineering Applications," John Wiley & Sons, Inc., New York, N. Y., 1952.

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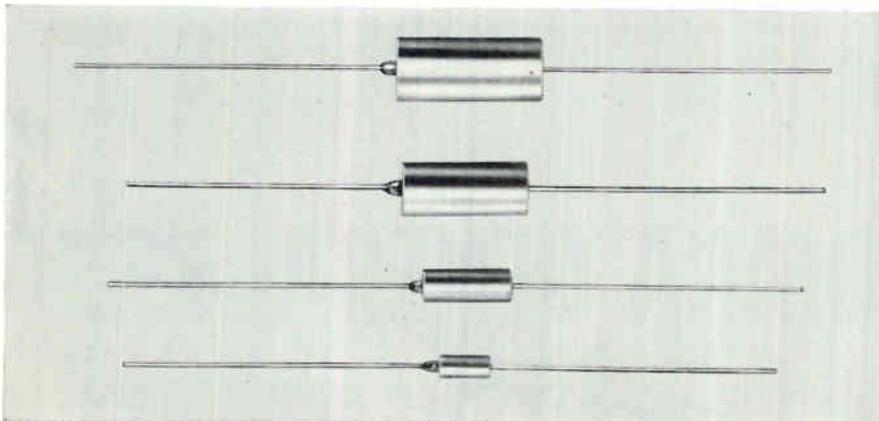
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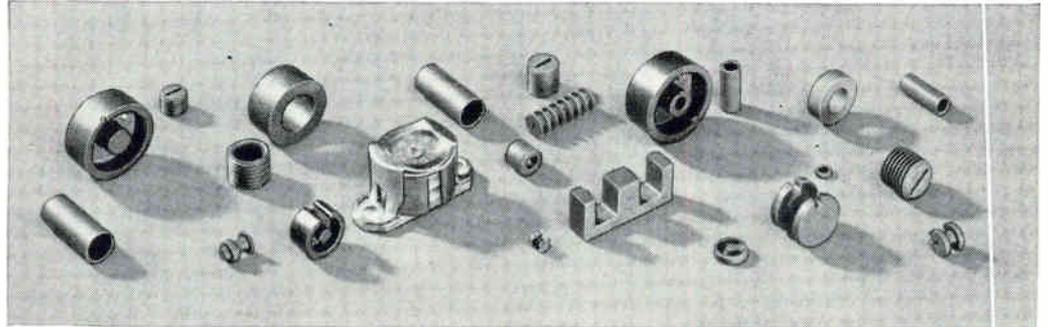


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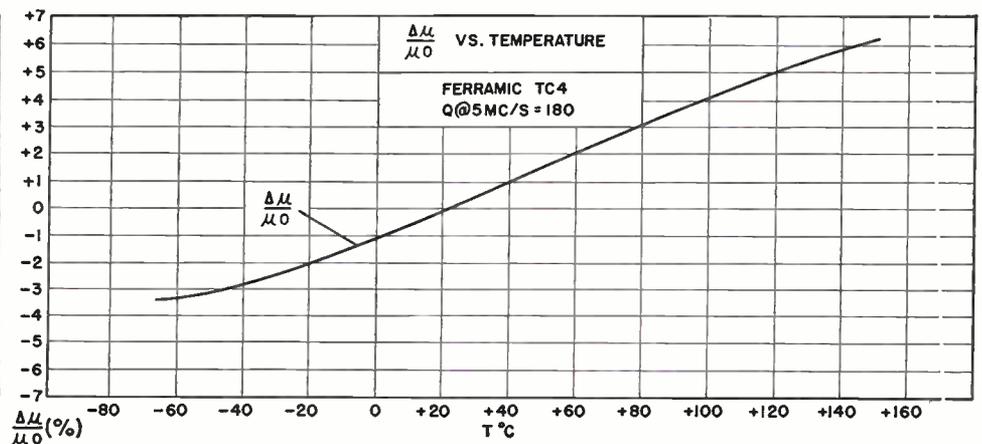
VOLTAGE	MAXIMUM MFD.	MINIMUM MFD.
100	2.7	.47
75	3.3	.47
50	22	.47
35	47	.0047
20	100	.0047
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10	220	.0047
6	330	.0047

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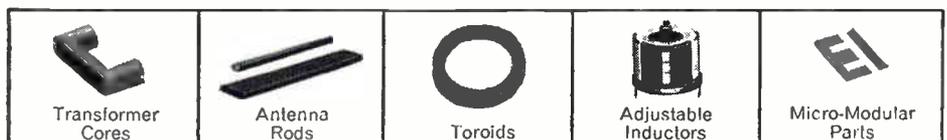


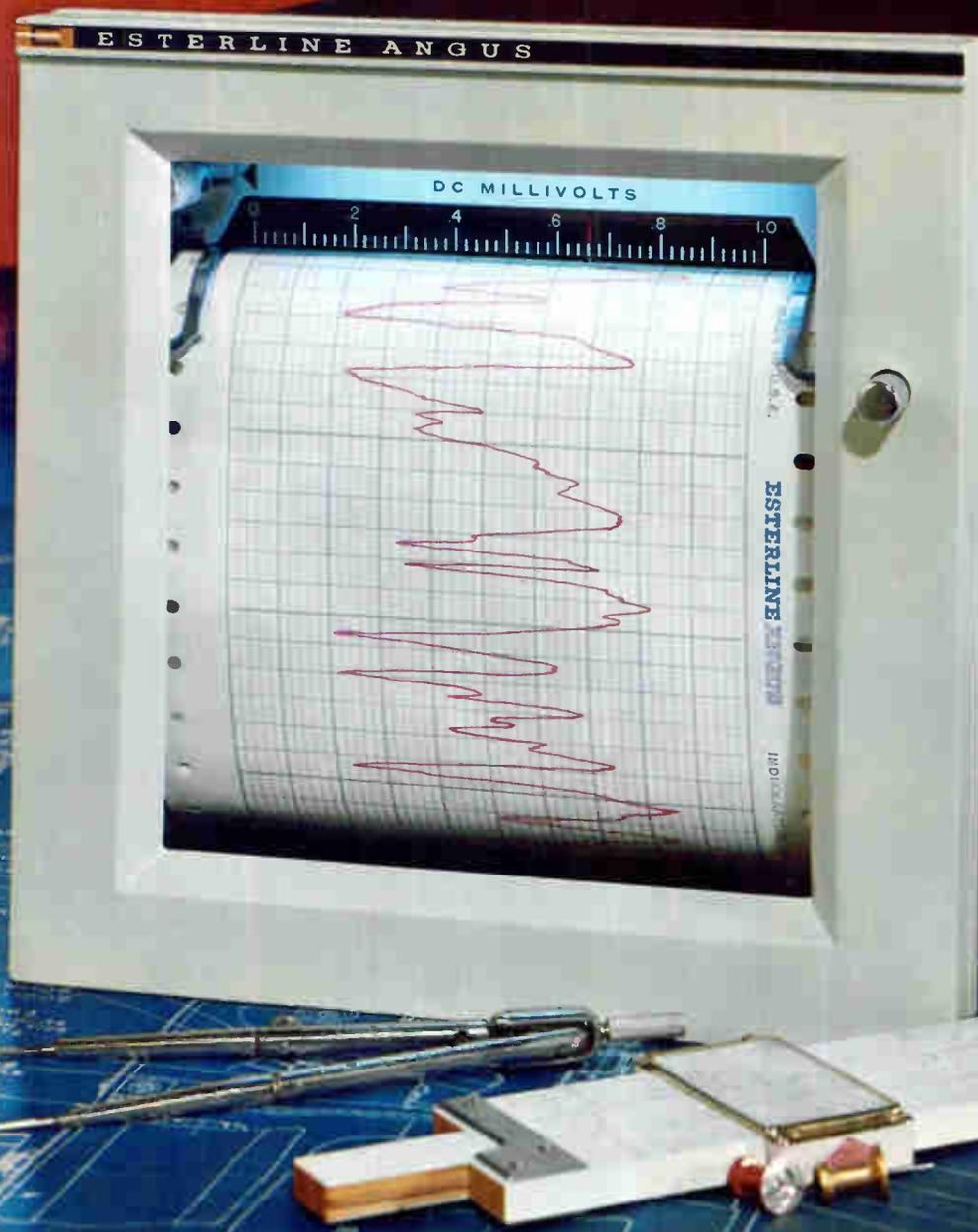
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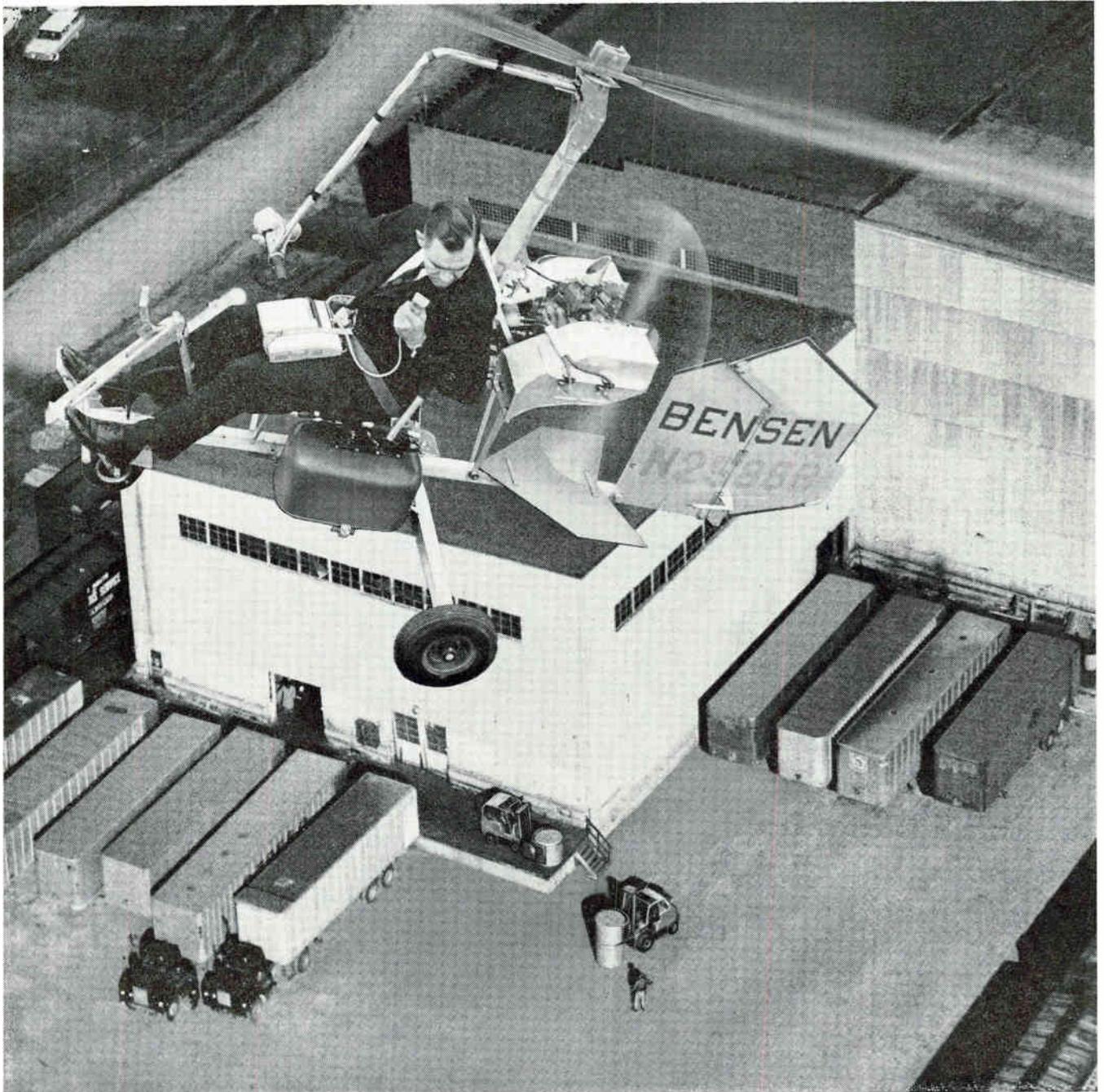
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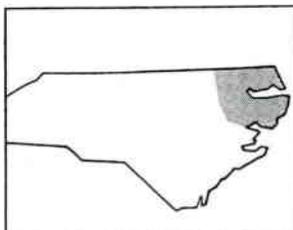


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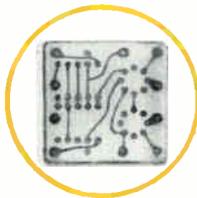
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DISARMAMENT

WHAT CHANCE? WHAT IMPACT?

If it comes, arms-control sales could not offset loss of defense contracts

By **WARREN KORNBERG**
McGraw-Hill World News

WASHINGTON—Chances of real disarmament are very slim. No informed Washingtonian expects it. Yet disarmament is being discussed increasingly because of the test-ban treaty (*ELECTRONICS*, p 18, Aug. 2) and other signs of a cold-war thaw.

One of the many facets of the disarmament question is the potential economic impact on electronics and

other industries heavily dependent on defense contracts, and whether disarmament control and monitoring equipment sales could offset reductions in defense production.

Since no realistic timetable for disarmament exists, the question is hypothetical. But the best available answers at present are negative—disarmament controls alone would not take up the slack.

CAN WE DISARM?—State Department and Disarmament Agency officials are becoming more and more concerned about the U. S. position if the Soviets agree to general and complete disarmament on our terms. The President, at a recent press conference, put it succinctly

when he named China as the major overseas threat in the foreseeable future. The power growth anticipated from a militant China could mean a more or less permanent cold war.

At any rate, besides being a long way off, disarmament when and if it comes would be a long-term process. Percentage cuts would be spread out over months and years to insure against economic disruption and serious one-shot weakening of the national security.

MONITORS—Any firm expecting to cash in on arms-control needs is in for a rude shock. The \$12-billion annual figure reported elsewhere as the disarmament surveillance equipment need is broadly discredited in the Arms Control and Disarmament Agency, Defense Department and Electronics Industries Association.

Surveillance would depend on the kind of disarmament agreement. Considering present Soviet intransigence on inspections by teams in Russia, surveillance is expected to lean toward the more expensive, mechanized, heavily electronic devices. But even these would not cost more than \$5 billion to \$7 billion over a period of several years.

Remote sensors being considered include satellite-borne photographic, electronic and infrared scanners; rail and road traffic monitors; remote temperature, chemosensitive and radiosensitive water monitors for evaluating industrial processes by their waste products, similar air-pollution monitors, and the like.

Some impetus—still small—has already been given electronics development by existing diplomatic efforts to relax tensions. The search for devices to detect and identify underground nuclear explosions geared up geophysical companies. Now the search is on for more sophisticated equipment to monitor space, air and ocean—the environments prohibited under the proposed test-ban treaty.

LOTS OF SLACK—Monitoring sales would be small compared to

Disarmament Studies Growing

SINCE the U. S. Arms Control and Disarmament Agency was established in September, 1961, it has awarded 25 contracts and 8 grants for various study projects. Many more studies are planned by the agency and the size and number of contracts will undoubtedly grow if Congress approves the \$15 million budget the agency has asked for the 1964 fiscal year. Until now, the agency has been operating under a \$10-million ceiling.

Here are the major contracts previously awarded by the agency:

Bendix, \$159,900, techniques for monitoring the production of strategic delivery vehicles; Raytheon, \$125,000, progressive zonal inspection for verifying arms control agreements; Market Research Corp. of America, \$47,461, application of statistical methodology to inspection systems; Institute for Defense Analyses, \$120,000, inspection and control of disarmament agreements; Bendix, \$95,000, verification requirements for agreements; Hudson Institute, \$147,000, political and strategic implications of civil defense programs; Sylvania, \$354,000, verification arrangements on bans for placing weapons of mass destruction in orbit and restricting or halting missile flight tests.

Aerospace Corp., \$217,000, ballistic missile and military space systems developments; Bendix, \$218,500, additional studies on monitoring production of delivery vehicles; Historical Evaluation and Research Organization, \$162,000, analysis of the historical patterns of treaty violations; Washington Center

of Foreign Policy Research, \$87,308, measures to strengthen the means of keeping the peace; Sylvania, \$202,000, limiting conventional arms and forces; Stanford Research Institute, \$267,688, effect of disarmament on the military balance in Europe; Massachusetts Institute of Technology, \$65,000, Soviet motivations and interest in arms control; MIT, \$145,000, regional arms control.

Research Analysis Corp., \$177,300, impact of arms control measures on Western and Communist Bloc ground forces; North American Aviation, \$136,600, data collection equipment; Burroughs, \$203,999, automated data processing methods; Columbia University, \$91,000, factors affecting Soviet attitudes on disarmament; Arthur D. Little, Inc., \$159,000, ground inspectable features of Soviet armaments production; Washington Center of Foreign Policy Research, \$139,000, future role of UN peace observation arrangements; Yale University, \$90,000, political trends in Western Europe.

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present defense electronics sales. The \$50-billion fiscal 1964 defense budget contains some \$8.3 billion for electronics, mainly: RDT&E, \$2.1 billion; aircraft, \$1.4 billion; missiles, \$1.5 billion, and electronics-communications, \$1.1 billion.

Disarmament-control requirements may hold the electronics-communications spending up, but aircraft, missiles and ship construction, and RDT&E accordingly, would be cut back sharply during disarmament stages.

Of the \$10.2 billion or so in electronics sales to the government, \$1.6 billion goes to NASA for the space program. The NASA budget should continue to climb in the next few years, even if the defense budget levels off or drops. The space budget will probably double again in 10 years. Of NASA's major items, tracking and communications are 90 percent electronics, vehicles are 50 percent electronic and spacecraft are 70 percent electronic. Anticipated growth in these areas will help take up the slack.

CIVILIAN ELECTRONICS—The areas reportedly being explored as additional alternate markets include surface transportation, biomedical electronics, communications and the like. Arms-control specialists, in

considering economic impact of disarmament, cite the shock-cushioning effects of industrial-commercial electronics. The release of skilled manpower, imagination and facilities, they say, will create undreamed of transformations in the economy.

Industry specialists, however, are less sanguine. They don't expect automation to become the bread-and-butter market that defense is. Some new area of consumer needs, running off into the science fiction of a decade ago, is probably the ultimate answer. Nobody, however, will speculate on it.

Though the electronics industry is expected to survive any armaments cutback better than airframe and ordnance industries, government and industry observers think there would be a substantial shake-out of electronics firms, without—over a period of time—substantial loss to the industry as a whole. The firms in best position to survive are seen as the old-line radio-electronics outfits which do 25 to 40 percent, or less, of their business with the government.

Several major military electronics firms are already reported as reexamining major available markets with an eye toward shifting their dependence away from government work.

Tv Now Briefs Air Force

NEW MANAGEMENT AID to one of the biggest organizational complexes in the world—the U.S. Air Force—is disseminating "in-house" information faster, more effectively, and cheaper than before.

The new facility consists of a closed-circuit television studio with 11 viewing locations—all equipped with 21-inch compatible television re-

AIR FORCE SECRETARY Eugene M. Zukert can speak "live" to 11 private conference rooms in the Pentagon, and later, by video tape, to major commands throughout the world. Ultimately, the system will transmit direct to other commands



Meanwhile, in Peking



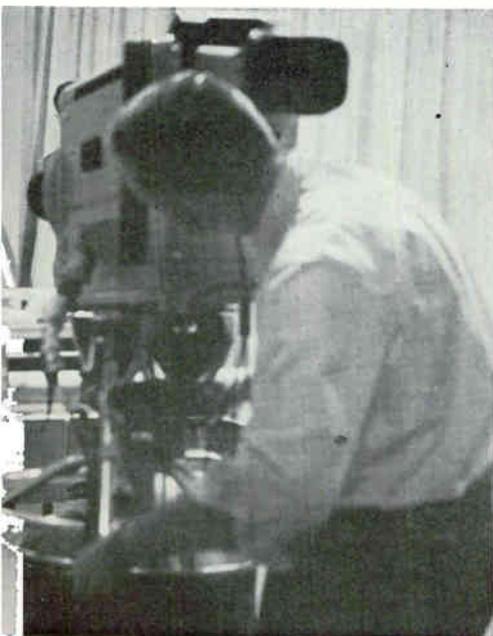
CHINESE communists claim 15,000 students are enrolled in Peking university tv courses. Programs like the one shown are reportedly viewed in "hundreds of centers" in the city, suburbs and factories

ceivers for color or black-and-white viewing.

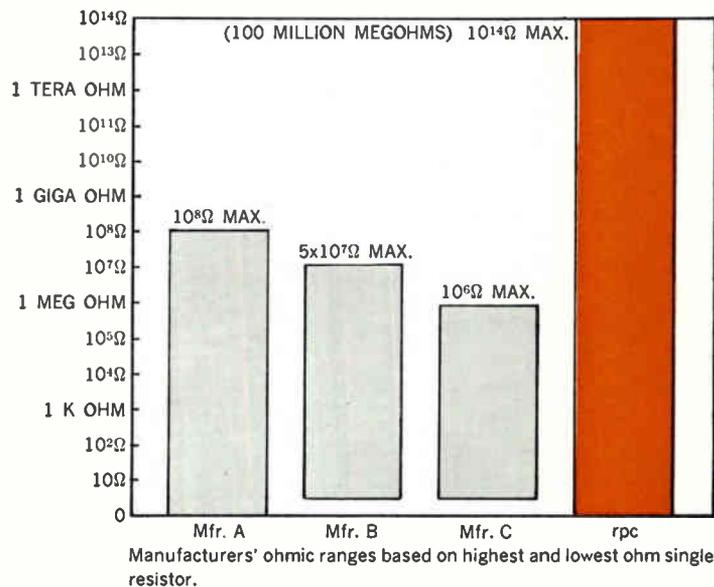
The biggest room also contains a tv projector which displays a 6×8-foot color or black and white picture.

Besides the conference rooms in the Pentagon, where both live and taped briefings are presented, U. S. bases throughout the world also get in on the network by videotapes sent through the mail or by courier.

In time, Air Force hopes to pro-

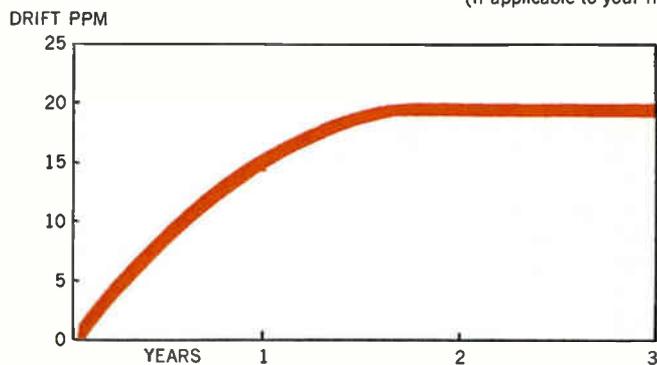


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PENTAGON SYSTEM can distribute four different programs simultaneously to different viewing areas

vide live transmission to commands by cable, troposcatter, or even satellite relay. The problem will be in assuring secure communications. The system now in the Pentagon is secure.

At present two 4½-inch black-and-white image-orthicon cameras, and two standard image-orthicon color cameras are used. Cost of the entire system is about \$½ million.

Swedes Building

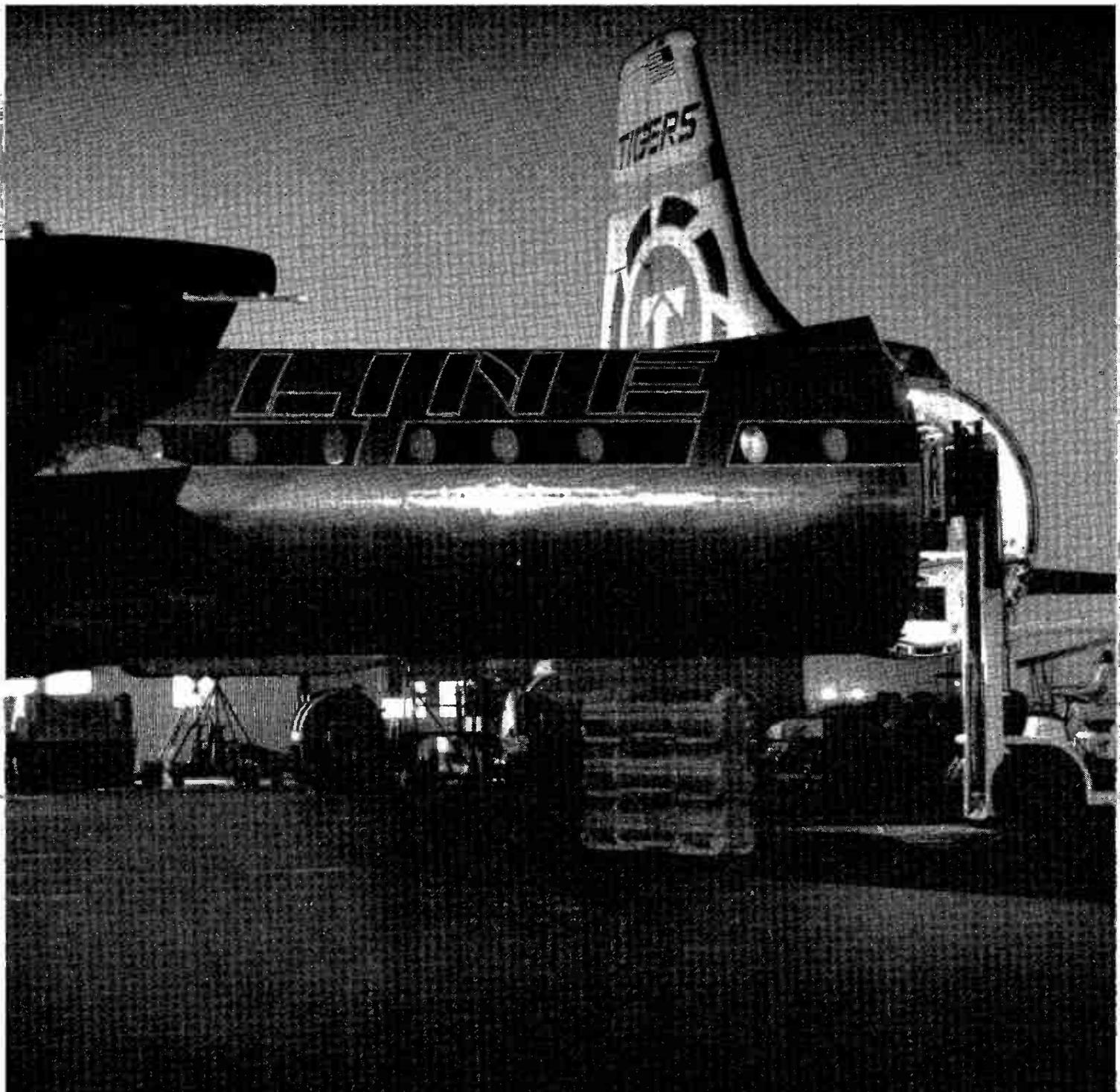
Big Radiotelescope

STOCKHOLM—Scandinavia's largest radio telescope is at present under erection at Rao near Gothenburg on the Swedish west coast. Intended for galactic research and for tracing space signals, the telescope will be equipped with a light-metal reflector close to 26 meters in diameter.

Under construction work is a five-story conical tower. One story will house the electronic equipment of the Scandinavian Telesatellite Committee, another will house equipment for measuring the volume and speed of hydrogen clouds in the milky way, while still another will contain equipment to receiver data from space rockets.

The parabolic reflector is to be mounted in September. Made of 56 sections of perforated light metal, it is provided with a hyperboloid subreflector. When signals from space hit the big reflector they are deflected towards the subreflector and then focused towards the center of the reflector where there is a one-man receiving laboratory.

There is no access to the lab from the reflector tower. The man in charge will be lifted into it from the outside by a mobile cherry-picker crane.



What do big carriers charge for little packages?

Answer: 25 lbs. Los Angeles to New York

Airline X	\$18.50
Airline Y	\$18.50
Airline Z	\$17.00
Flying Tigers	\$ 9.25

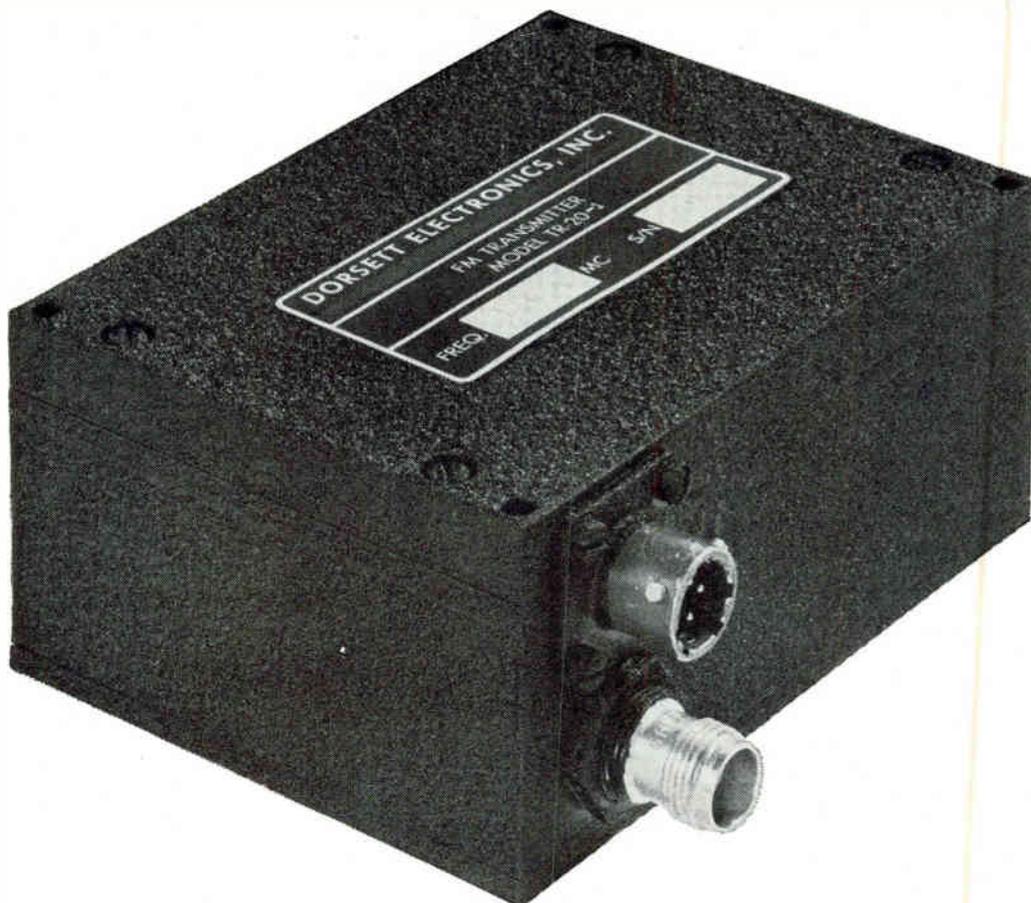
Your minimum shipment via Tigers costs about half of what most other airfreight carriers charge. Most carriers figure a

minimum shipment at 50 lbs. Tigers' minimum is 25 lbs. multiplied by the established commodity rate, or \$4.00 for the shipment . . . whichever is greater.

How can Flying Tigers do it? Simple. They're the Airfreight Specialists. Big shipment or minimum shipment, always specify Flying Tigers—world's largest all-cargo airline.

first in airfreight with airfreight first **FLYING TIGER LINE**





It's only a five watt, solid state, FM telemetry transmitter

We started development on this one four years ago. Last January we put it into production, and have made regular shipments since. In the past four years we breadboarded about a thousand different circuits. We found one that really works. We also found 999 others that almost did. When you're designing for high reliability space communications almost is not good enough.

We call it the TR-20. It transmits a five-watt true FM signal in the standard telemetry band, 225-260 mc. The power consumption is low — one ampere from a 28 volt input. Our lab tests shows that rfi and spurious radiation levels are well below current specs for missile range use.

The photo above is full size. The package is small. It measures 1.75 x 3.0 x 4.0 inches. It weighs 14 ounces.

Electronically it's what you'd expect from a very good telemetry transmitter: Modulation range, 20 to 100,000 CPS \pm 1 db. Deviation, \pm 125 KC. Input sensitivity, one volt RMS for full deviation. Frequency stability, 0.01% (-20° to + 90° C). Distortion, less than 1%. Power supply stability, 0.01% or better for \pm 15% change in supply voltage. Output impedance, 50 ohms. Input impedance 100,000 ohms.

Environmental specs are good too: Shock, 100 G for 11 milliseconds in any plane. Acceleration, 100 G. Vibration, .4 inches D. A. displacement 5 to 50 cps and 20 G from

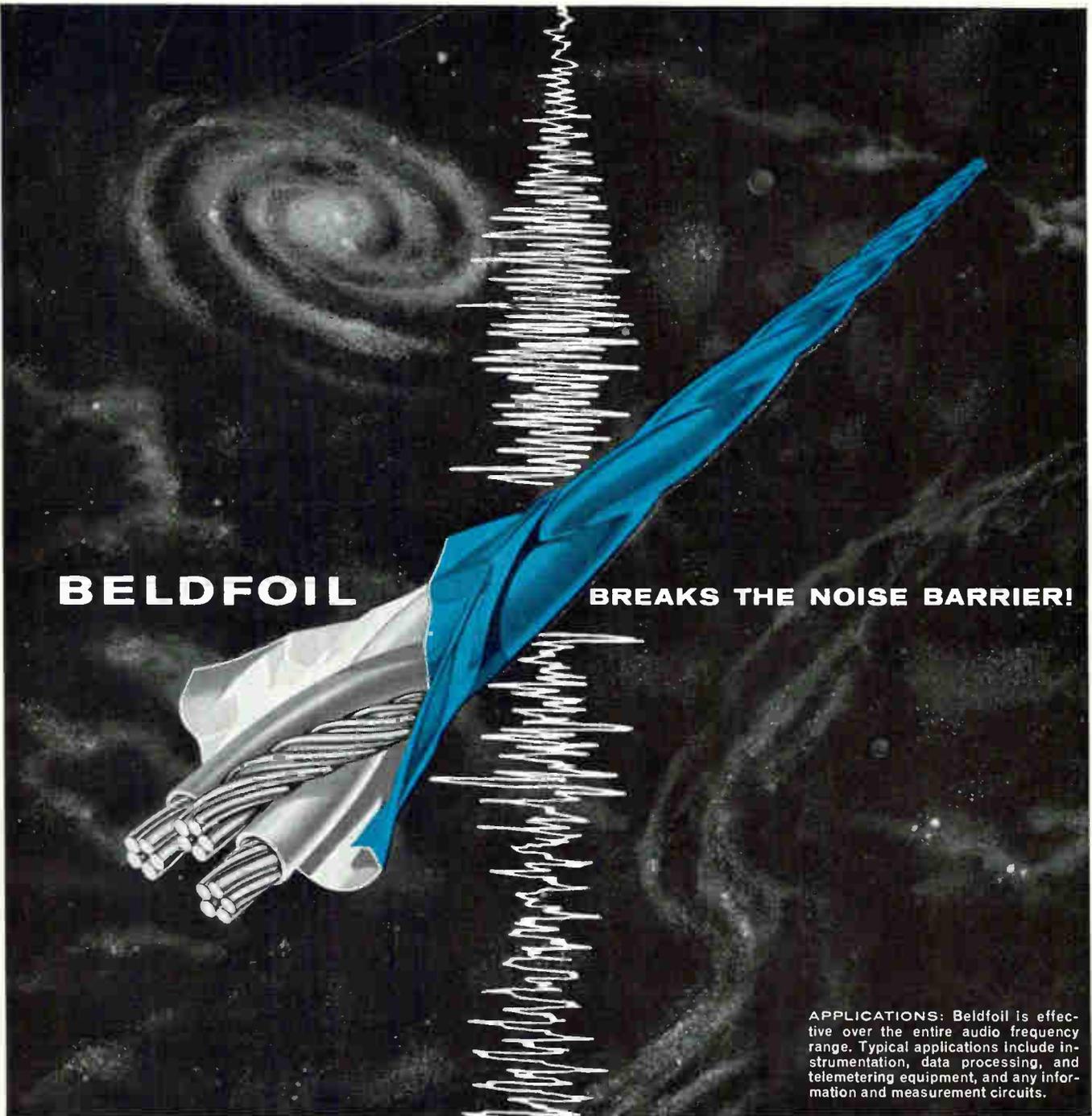
50 cps to 2 KC in each major axis. Temperature, operational from -40°C to + 100°C.

The TR-20 is compatible with any modulation system . . . PCM, PDM, PAM, FM or any combination thereof. It's also compatible with the full line of telemetry components built by Dorsett Electronics including: Subcarrier oscillators, millivolt oscillators, mixer amplifiers, and PDM keyers. And it's compatible with components and systems built by other manufacturers.

Will it meet reliability requirements for long term space flight? To our knowledge, it hasn't been flown into space yet. Has anyone's? Our customers, the list reads like a Who's Who in the aerospace industry, seem pleased and reports from the field are most favorable.

The TR-20 is a good telemetry transmitter, in fact we think it's the best available today. It should be, the engineers who designed and developed it have as much experience in designing telemetry equipment for space application as anyone in the industry, and more than most. You can order it today for delivery in evaluation quantities in 30 days. Large orders will take a little longer. Want more information? Write us. We'll send a sales engineer if you request. Our address is P. O. Box 36, Tulsa 1, Okla.

Dorsett Electronics, Inc.



BELDFOIL

BREAKS THE NOISE BARRIER!

APPLICATIONS: Beldfoil is effective over the entire audio frequency range. Typical applications include instrumentation, data processing, and telemetering equipment, and any information and measurement circuits.

QUIET PERFORMANCE!

Yes, Beldfoil* shielding definitely breaks the noise barrier. It breaks the noise barrier by *being* a noise barrier. Beldfoil gives *total* shielding . . . 100% isolation between adjacent pairs. For audio and radio frequency, it completely eliminates cross talk, spurious signal impulses . . . and it's ideal for stationary or limited flexing. Beldfoil is lighter in weight, requires less space, and is usually lower in cost.

MINIATURIZES!

Beldfoil shielding reduces the diameter of multi-conductor cables . . . by as much as 66 $\frac{2}{3}$ %. It gives design engineers extra space . . . extra conduit space, extra raceway space, extra console and rack space. Beldfoil shielding means that you can "think small."

ASK FOR DATA SHEET. Get your copy of newly published bulletin 8-63-A and technical data sheet. They give complete information on Beldfoil shielding. Write Belden Manufacturing Company, 415 South Kilpatrick Avenue, Chicago 44, Illinois.

WHAT IS BELDFOIL? It's a lamination of aluminum foil with Mylar** that provides a high dielectric insulation. A patented Belden method of folding*** gives definite benefits. An inner fold creates a continuous metallic path around the surface of the cable. This eliminates any possible inductive effects. An outer fold tucks the cut edge of the aluminum under the Mylar. This gives complete isolation from other adjacent shielded cables.



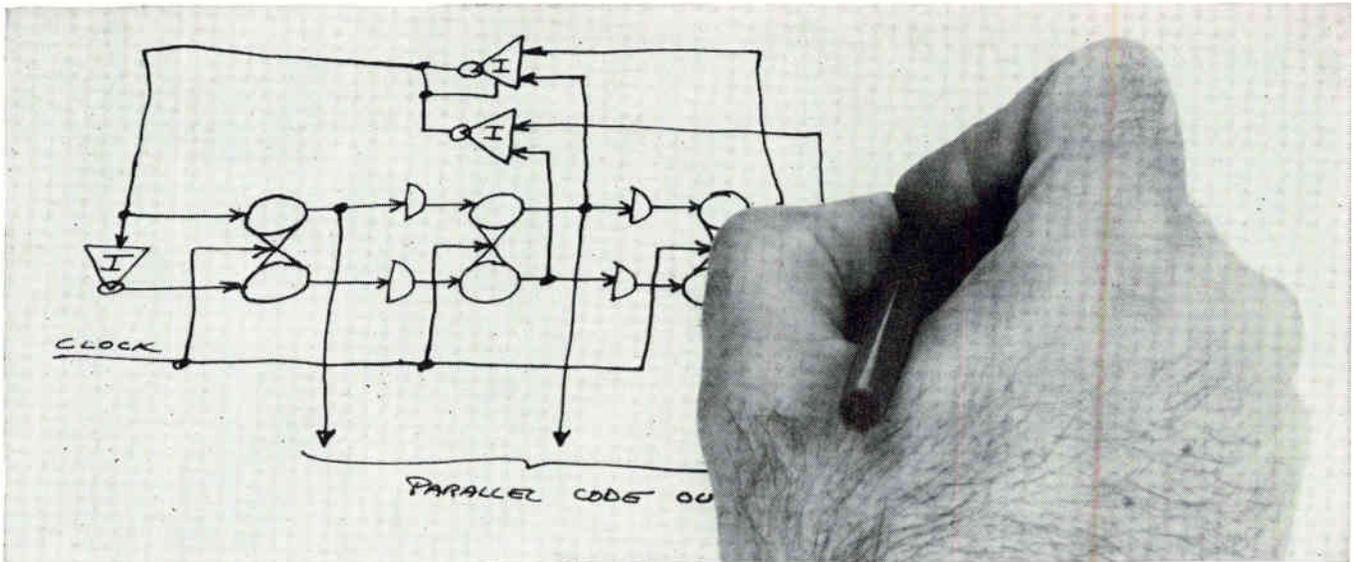
Typical cross section looks like this.

*Belden Trademark Reg. U. S. Patent Office

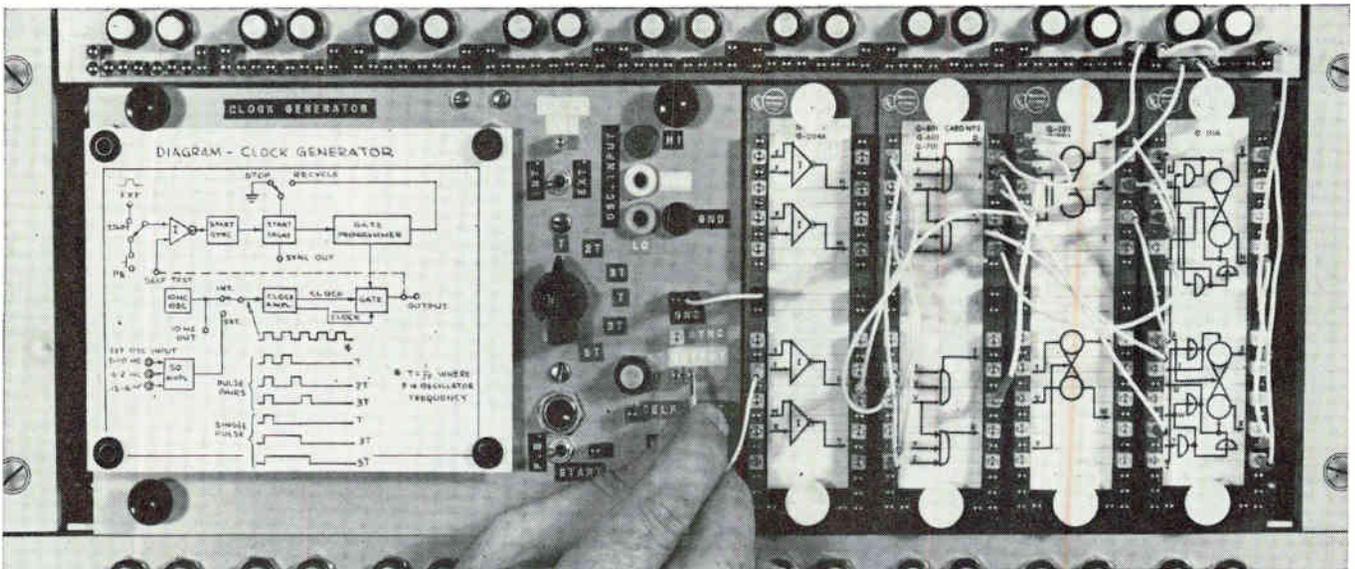
du Pont Trademark *U. S. Patent 3,032,604



8-1-3



WILL IT WORK AT 10 MC?



FIND OUT FAST WITH AN EECo HIGH-SPEED DIGITAL SYSTEM BREADBOARD

It looks good on paper. Now—what will be the effect of clock duty cycle? Wiring? Propagation delay?

You can get the answers *fast* with EECo system breadboard equipment—an exceptionally simple means of formulating and testing digital electronic circuits at clock speeds to 10 Mpps.

This versatile transistor equipment lets you patch up trial circuit combinations with the same catalog modules that go into the final system, perform tests at operating frequencies by pushing a button on the control panel, and get a “stop-action” look at the over-all logic flow.

The built-in clock generator permits fast set-up of a wide range of test conditions, and indicators give you an immediate reading on any part of the circuit. Plastic symbol cards

further speed your work by giving you a road map of the system as you put it together.

You may operate the system slowly to check individual operations or at end-system speeds, introducing high-speed pulses either singly or in pairs. If you want to try an alternative design idea, a few minutes of patching will make your brainstorm a reality.

Discover for yourself this speedy route from paper to prototype. Write for our new breadboard brochure today.



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STORED PROGRAM PCM GROUND STATION



Now a new system by Dynatronics offers automatic control of format selection and distribution of PCM data!

The Dynatronics Stored Program PCM Decommulator is designed to provide a real-time data reduction facility and to permit rapid changes to data distribution as required during a particular mission. This unique system employs magnetic core storage and computer control principles to realize the high flexibility and convenience necessary in high capacity telemetry processing requirements.

■ Universal format capability ■ Rapid format switching ■ Distribution switching on command ■ Bit rates to 1 megacycle ■ Word rates to 125 kc—with simultaneous format changes ■ Variable word length capability—any channel.

WRITE FOR A TECHNICAL BULLETIN that describes how this system can speed your PCM data handling.

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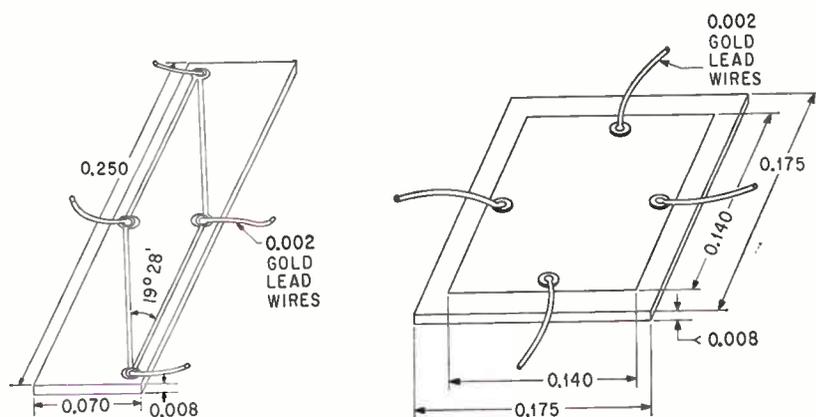
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13



ALL DIMENSIONS ARE IN INCHES

EPITAXIAL piezoresistive devices are claimed to have the advantages of diffused strain gages plus greater process reproducibility. Skew-bridge sensor (left) and sheet-shear sensor are two of the silicon epitaxial devices described by E. G. Carson, of GE Semiconductor Products dept

Future Keyed to MATERIALS

New devices such as lasers and semiconductors demand closer control

By **MICHAEL F. WOLFF**
Senior Associate Editor

BOSTON—Successful development of the host of new devices now undergoing exploratory research will depend largely upon understanding and controlling materials properties considerably more subtle than those dealt with in the transistor era.

Concern with this problem and its possible solutions dominated the conference on advanced electronic materials, sponsored here last week by the Metallurgical Society of AIME. It was generally agreed that besides requiring more work in such basic areas as crystal growing and impurity control, institutions will have to provide an environment where the materials scientist and electronic device and circuit designer can work together almost as one man.

FUTURE TRENDS—A panel discussion on trends in electronic materials agreed that this interdisciplinary coupling was essential to future progress and would be lead-

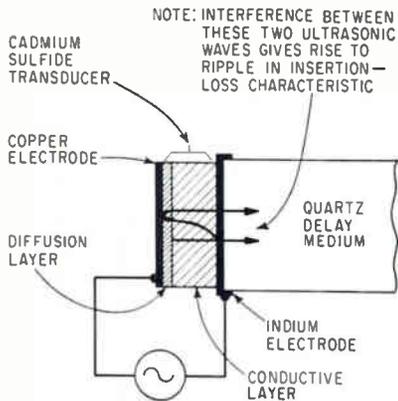
ing to even more team effort. Motorola vice president C. L. Hogan pointed out that in semiconductor microelectronics you can't design a circuit anymore without going back to the basic limitations of the material, since the circuit properties are determined in the materials fabrication step.

"We need people who know materials and can specify materials," Hogan said, adding that while these people will have to invent new circuits compatible with the microelectronics technology, such circuits will, in the foreseeable future, remain based upon silicon and the processes of diffusion and epitaxy.

Materials available for such new devices as the injection laser and ultrasonic amplifier are primitive compared to what will be needed for useful applications, according to Morris Tanenbaum, director of Bell Labs' solid-state laboratory. He cited several areas that require work, including:

- Laser crystals, where optical quality is a major problem. Here it may be necessary to impose specifications on the uniformity of impurity doping several orders of magnitude more demanding than in current semiconductor technology

- Piezo-optic materials, where a similar situation exists — optical properties are sensitive to strain and



DIFFUSION-LAYER ultrasonic transducer has thin, highly resistive layer formed by diffusing copper into CdS (Bell Labs)

PROPERTIES

losses occur from trace impurities

- Magnetoelastic resonators and delay lines, where single crystals of ferromagnetic garnets are needed that are of high quality and several times larger than are now available.

- Piezoelectric ultrasonic amplifiers, which will require fabrication techniques more sophisticated than those used in present germanium and silicon devices.

The rate at which experimental devices are converted to useful devices will depend upon the skill of the materials man in solving such problems and also in his gaining an understanding of such subtle materials properties as electron lattice interactions, Tanenbaum concluded.

Technical reports at the three-day meeting emphasized materials problems related to lasers, ultrasonic devices and thermoelectrics. Here are the highlights:

LASERS—Epitaxially grown GaAs laser diodes were described by Herbert Nelson, of RCA. Preliminary tests indicate these may be better than the conventional diodes using zinc diffused into *n*-type GaAs. Technique allows: 1) more freedom in choosing the dopants, 2) fabricating diodes whose *n* and *p*-type impurity distributions vary considerably from those possible with diffusion, and 3) achieving

"A GUY COULD GET KILLED IN HERE"...

... this place is like a roller-skating rink! What's all the traffic? I had to *fight* my way into the instrument room!

Oh, hello, Rip! Yes, we're doing a rush business here today! Every instrument in the joint's been in and out of here at least twice. Particularly amplifiers — just can't get 'em back here fast enough to meet all the requests!



Amplifiers? Any special types really hot right now?

Dunno. All my data-acquisition types have been out for about a week now. And all my audio amplifiers are down the hall in Dept. 23. Video amplifiers have been on the most-wanted list, too. And here are three requests for RF amplifiers I can't even fill until tomorrow at the earliest!

What you need are more amplifiers like Krohn-Hite's DCA-10 — a stable ten watts, tenth-percent distortion, wide band!

We're always using the DCA-10's you sold us — as audio amplifiers, mainly. But how about the other applications I've got to fill?

But nothing! You're short on data-acquisition types? Look — the DCA-10's direct-coupled, goes all the way down to dc. Only 0.2% distortion at .01 cps. Perfect on data circuitry. And talk about video amplifiers — the DCA-10 is one in disguise! No droop on a step function from a DCA-10, as you'd get from a capacitor-coupled amplifier! And with a megacycle bandwidth, you get a rise time in the order of 0.1 microseconds.

Yeah, the top end of a megacycle would serve the needs of many of the requests for RF amplifiers.

Now you're thinking Krohn-Hite! Actually, there's really nothing like it for the money — frequency response flat within a db all the way up, stable dc level, too, and low hum and noise.

You certainly don't have low hum and noise!

What do you expect — *I'm a rep!* Just one more thing — when you need 20 watts push-pull — two DCA-10's cascaded, one in the unity gain position, will give it to you. For more power, its big brother, the DCA-50 gives 50 watts single-ended or 100 watts push-pull, up to 500kc, with the same clean specs of the DCA-10. Now, anything else I can tell you about the DCA-10?

Yeah — price and delivery on twenty!



**KROHN-HITE
CORPORATION**

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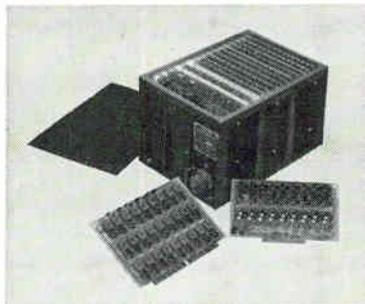
Pioneering in Quality Electronic Instruments

IDS PROGRESS REPORT

252 CHANNEL AIRBORNE PCM TELEMETRY

Model 12-10 was developed and delivered in 90 days. This 420 cubic inch solid-state system features $\pm .2\%$ accuracy from -20°C to $+85^{\circ}\text{C}$ and $\pm .1\%$ accuracy from $+10^{\circ}\text{C}$ to $+50^{\circ}\text{C}$.

The package includes a 90-channel primary multiplexer, a 135-channel subcommutator and a 45-channel subcommutator. Of the total 252 channels, 245 are data channels and 7 are used for frame



synchronization. Sample-and-hold is provided for accurate measurement of ac signal voltages, and remote low-level subcommutation can be added with minor modifications.

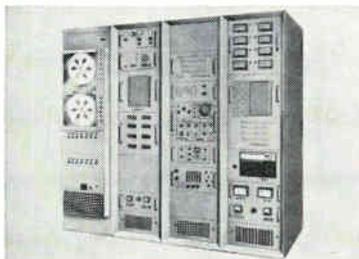
The digital data output — obtained from a compact A-D converter — is a 10-bit serial binary code which includes a nine-bit data sample plus a single bit for odd parity. The system weighs just 15 lbs. and consumes only 7 watts power. An optional r-f package designed specifically for Model 12-10 is available on request.



An IDS Technician checks out the PCM package using specially designed IDS test equipment. Each unit is individually checked for performance and workmanship and copies of test data are submitted with delivery.

COMPATIBLE GROUND PCM STATION

Design considerations for a modular, solid-state PCM ground decommutation station compatible with the Model 12-10 airborne equipment and other IRIG systems have been completed. The station accepts serial, PCM/FM telemetry data and furnishes digital, analog and quick-look readouts. It is capable of operation in subcommutation or supercommutation modes and each major assembly is designed for mounting in standard 19-inch relay racks.



These examples have been selected from a broad capability. For further information, please write or contact our Marketing Manager.

more perfect junctions, Nelson said.

Method is epitaxial growth from the liquid phase. A *p*-type GaAs wafer whose major surfaces are (100) planes is placed at one end of a graphite boat and a tin-GaAs melt at the other. The boat is in a quartz tube furnace tipped so as to keep the melt and wafer separate. Temperature is raised until the tin is saturated with GaAs and the furnace is then tipped to bring the melt in contact with the wafer. The tin dissolves a slight amount of the wafer to leave a mirror-like (100) plane.

As temperature drops epitaxial regrowth sets in and a tin-doped *n* region is formed on the *p*-type GaAs substrate. This is then cleaved into laser diodes whose junctions will be perpendicular to the (110) cleavage planes. Junctions formed in this manner are expected to have less imperfections and therefore lower thresholds for laser action.

An example of how laser operation depends on perfect crystals was provided in a paper by M. H. Pilkuhn and H. Rupperecht, of IBM. They reported c-w operation at only 8.2 ma from an unsilvered GaAs diode with four sides cleaved and a perfectly planar junction. This was at 77 deg K in a diode whose junction area was on the order of only 10^{-5} sq cm.

ULTRASONIC AMPLIFIERS—

Equations to evaluate performance of piezoelectric semiconductors in ultrasonic amplifiers were presented by W. E. Newell, of Westinghouse Electric. At a power density of 10 w per cu cm the equations give maximum gains for CdS and ZnO of approximately 70 db per cm at around 50 Mc.

In a statement from the floor, G. C. Gerhard, of GE, said he felt geometry could be designed for better heat transfer so that at, say, 100 w per cu cm it might be possible to reach 155 db per cm at 150 Mc.

Latest data for a new ultrasonic transducer was reported by N. F. Foster, of Bell Labs. He said 200-Mc bandwidths at 300 Mc, and 47-db insertion loss had been measured in a CdS diffusion layer transducer (see figure). Foster is presently investigating ways to remove ripple so the device can be used as a delay line with quartz as the delay medium.



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NEWS

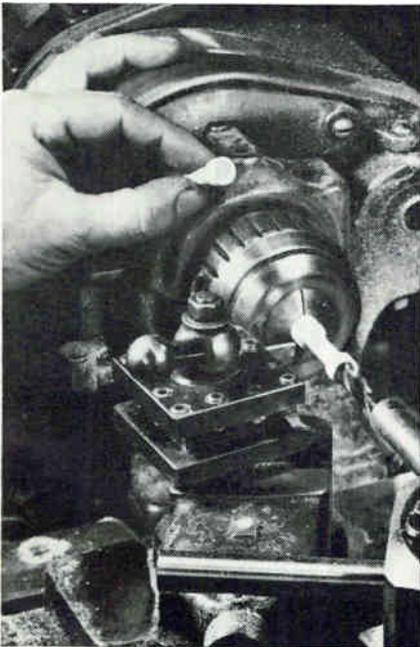
Boron nitride: the better solution to high-temperature dielectric problems

If you need just one of the exceptional properties of our boron nitride, chances are you'd be better off with another material. BN isn't cheap.

But when you need a material that gives you two or more exceptional properties like these—a 4+ dielectric constant and high dielectric strength and high thermal capability and excellent thermal shock resistance and easy machinability into the shape you want—then boron nitride becomes a bargain.

Some pertinent data:

A 1" diameter disc of our BN, 10 mils thick, gives you dielectric strength up to 1450 volts/mil.



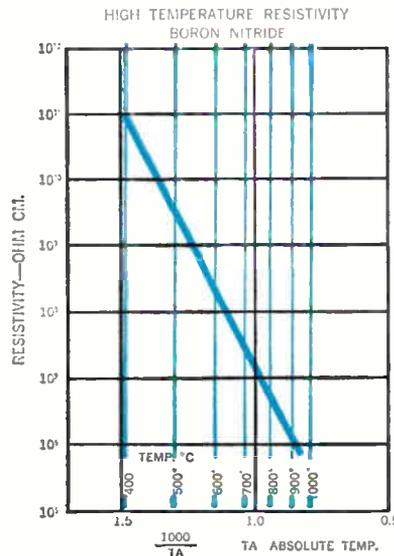
You can easily machine boron nitride into intricate shapes with standard tools.

In a non-oxidizing atmosphere, you can use our solid BN forms at temperatures as high as 5000 F. That's because it's a refractory. In an oxidizing atmosphere, the forms will work for you up to 1800 F.

You can just about forget thermal shock, because boron nitride has exceptionally low thermal expansion perpendicular to molding direction and exceptionally high heat conductivity and mechanical strength.

Match all these properties against what you'd ask for in a high-temperature dielectric and you'll see why boron nitride is at work now in tough applications—like these:

- **magneto hydrodynamic generator**—a BN tube encloses a beryllium oxide tube to insulate against 20,000-30,000 volts. Our material withstands the high temperatures generated through the beryllium oxide tube by jet engine thrust, and its lubricity permits slipping of the tubes as they expand and contract.



- **arc jet engines**—boron nitride finds varied uses in ion engine chambers, most of them involving its dielectric strength and its ability to stand up in the 3000 F range.

- **hydrogen gas heater**—boron nitride sections support and contain a tungsten element which heats the hydrogen to about 5000 F in an apparatus to test what happens to other materials at elevated temperatures. Portions of the boron nitride pieces reach 5000 F while other portions are at only 2000 F. No thermal failures.

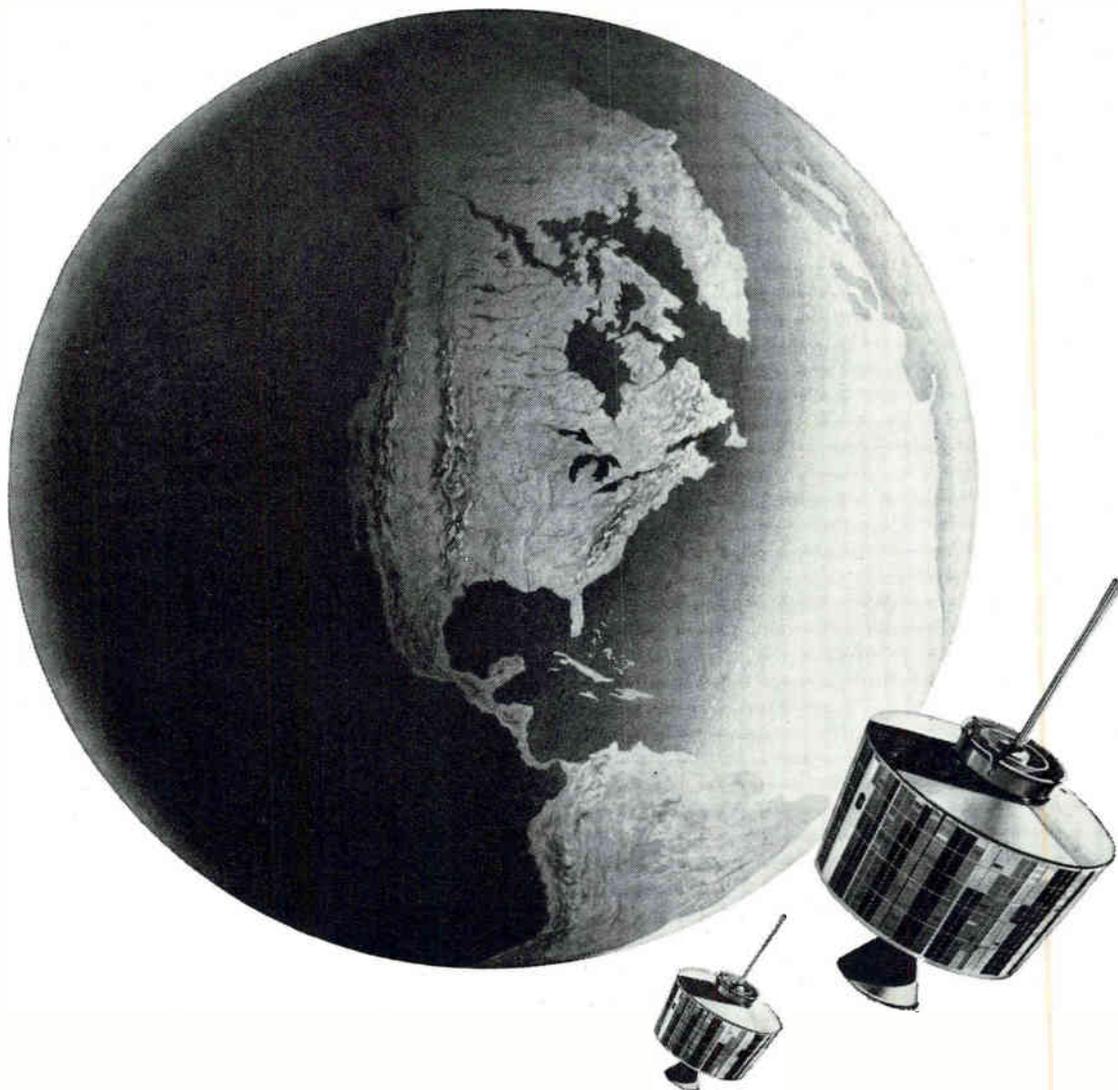
- **electron beam gun spacers**—boron nitride spacers are used because of their thermal shock resistance, their electrical insulating properties, and because they're non-reactive with most vaporized metals.

- **coil form**—its electrical resistivity and thermal shock resistance made BN the choice for a wire-wound form that measures jet and rocket engine housing temperatures.

Can boron nitride solve a high-temperature dielectric problem for you? Does the fact you can machine it yourself into the part you want have interest? Write for our boron nitride technical bulletin to Electronics Division, Dept. E-09, The Carborundum Company, Latrobe, Pa.



CARBORUNDUM



circuit designers...is your appointment in space with Hughes?

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This vigor promises the qualified engineer or scientist more and bigger opportunities for both professional and personal growth.

Many immediate openings exist. The engineers selected for these positions will be assigned to the following design tasks: the development of high power airborne radar transmitters, the design of which involves use

of the most advanced components; the design of low noise radar receivers using parametric amplifiers; solid state masers and other advanced microwave components; radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits; high efficiency power supplies for airborne and space electronic systems; telemetering and command circuits for space vehicles, timing, control and display circuits for the Hughes COLIDAR (Coherent Light Detection and Ranging).

If you are interested and believe that you can contribute, make your appointment today.

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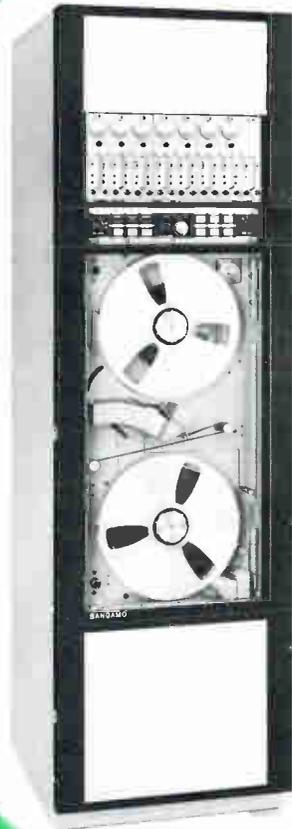
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Sangamo 4700 Series...unparalleled (flexibility and convenience in data acquisition and reduction. Eight speeds are instantly available with the turn of a switch. Get reel-to-reel or continuous tape loop by turning another. Four automatically selected speeds of FM (dc to 20 kc) and Direct (300 cycles to 300 kc) record/reproduce electronics are in a single module. Adjust a knob for variable search from



40 ips to 150 ips. And these controls are right before your eyes, on the *front* of the cabinet. Tape width?... $\frac{1}{4}$ " to 2".

With all this convenient versatility, Sangamo's unique light-mass speed-control system provides undistorted data reduction...unsurpassed recording/reproducing accuracy. And, the 4700's ability to handle *your* instrumentation data is backed by the industry's first one-year warranty.



ELECTRONIC SYSTEMS

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SPRINGFIELD, ILLINOIS

MAGNETIC TAPE



INSTRUMENTATION

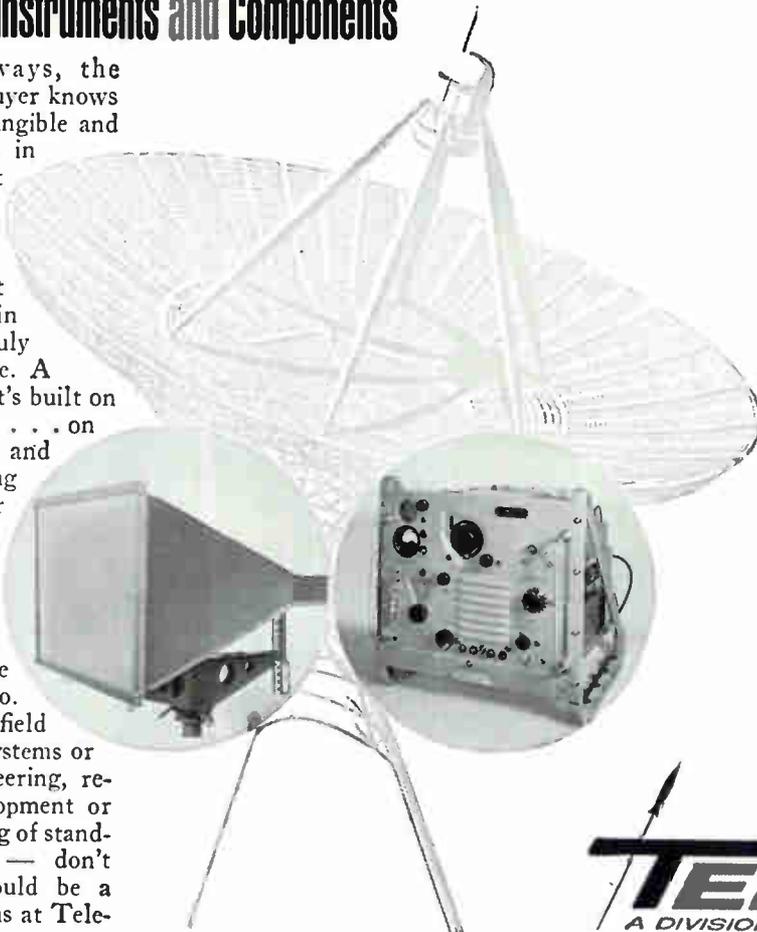
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Today, as always, the knowledgeable buyer knows there are both tangible and intangible values in every product purchased. ■ At Telerad, we believe in stressing those factors that will establish us in your mind as a truly dependable source. A dependability that's built on creative research . . . on rigid electrical and mechanical testing as the standard for quality control . . . on our being customer-minded so that you get precisely what you require and on time, too.

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Origin

SILICON SMALL STACK SP MODEL

The Silicon small stack, a single phase, full-wave rectifier, is composed of four silicon diodes, Model SE-05,

sealed into synthetic resin case as a unit for use in a single phase, full-wave rectifying system.

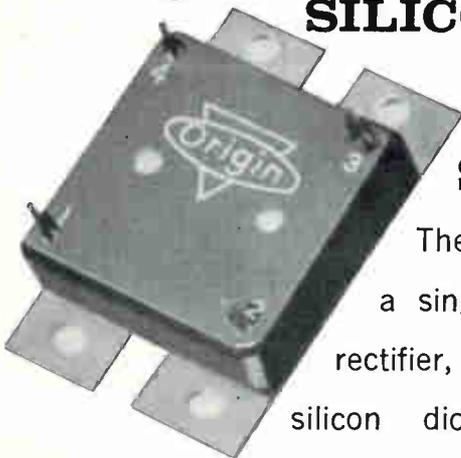
Outstanding features:

1. Wide temperature tolerance -55°C ~ +130°C
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(1.5 A when mounted on chassis)

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SM-150: Available in 4 physical configurations. PIV: 400-1000 Volts. Max. AC input voltages (RMS) of 280, 420, 560 and 700 Volts. Max. Reverse Leakage Current (PIV) 10A. Max. Average Rectified Current (Single-phase, half-wave) 150 mA. Surge Current (for 1 cycle) 10A.

SW-05(SE-05): Available in 4 physical configurations. PIV: 400-1000 Volts. Max. AC input voltages (RMS) of 280, 420, 560 and 700 Volts. Max. Average Rectified Current (Single-phase, half-wave) 500mA. Surge Current (for 1 cycle) 16A.

S-3: Available in 5 physical configurations. PIV: 300-1000 volts. Max. AC input voltages (RMS) of 210, 280, 420, 560 and 700 Volts. Max. Average Rectified Current (Single-phase, half-wave) 3A. Surge Current (for a half cycle) 300A. Ambient temperature: -55 to +130°C for all types.



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PCM

TELEMETRY GROUND STATION

A BENDIX/CORRELATED DATA PRODUCT

*from
Bendix-Pacific*



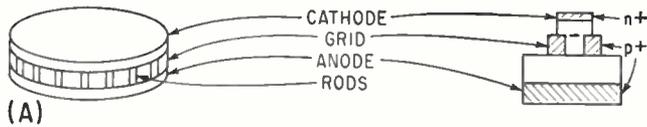
The latest from Bendix-Pacific — Model DDS-1000 solid-state Pulse Code Modulation ground station. This is a digital decommutation station capable of demodulating and processing all serial digital information. Outputs are available in a wide variety of serial or parallel digital formats, as well as analog signals for real time visual analysis of data. Flexibility is implemented with self-powered modular sub-assemblies for universal applications, as well as mechanization for special requirements. Silicon semiconductor devices are used throughout the system for high reliability and optimum performance over a wide temperature range.

The DDS-1000 is adaptable to all bit, word, frame, and code formats now in use or planned for the future. The station incorporates an advanced bit synchronizer and signal conditioner for processing serial PCM video signals, as well as a signal simulator for complete self-check. The complete station occupies only a single seven-foot instrumentation rack.

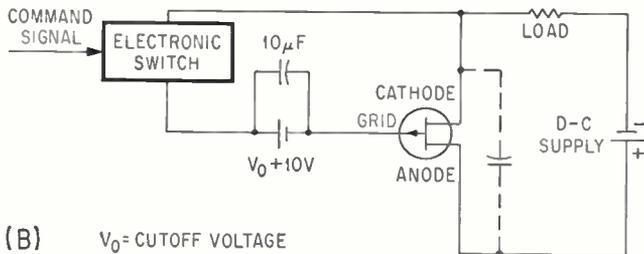
Model DDS-1000 is a development of Correlated Data Systems Corporation and available exclusively from Bendix-Pacific. Contact Bendix-Pacific, North Hollywood, for complete information.

Bendix-Pacific Division

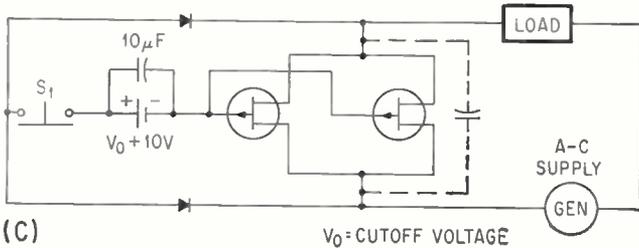




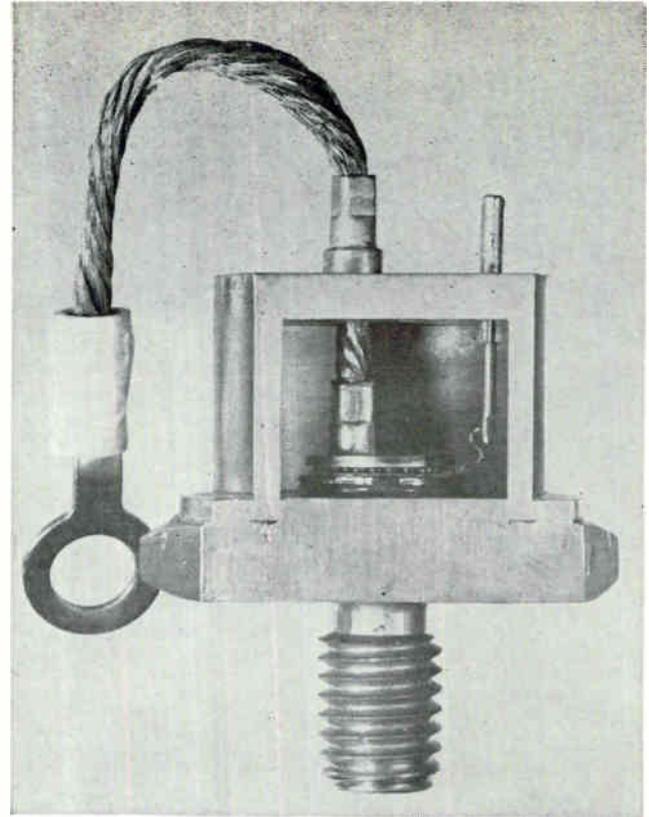
(A)



(B) $V_0 =$ CUTOFF VOLTAGE



(C) $V_0 =$ CUTOFF VOLTAGE



CUTAWAY view of new high-power Tecnetron. Note gear-like rod arrangement

ROD ARRANGEMENT and cross-section through rod (A). Basic circuits for d-c switching (B) and a-c switching (C)

New Tecnetrons Switch 15 Amp

French now planning field-effect devices to switch 50 amp

By **ARTHUR ERIKSON**
McGraw-Hill World News

PARIS—A French-developed field-effect semiconductor device that can switch high d-c currents made its official debut today at the International Exhibition of Industrial Electronics held at Basle, Switzerland.

Prototype versions of the device, called the high power Tecnetron, have nominal continuous ratings of 10 amp and break capability higher than 15 amp. They handle a-c or d-c to 150 v, with forward drop less than 2 v and residual current of 20 ma or less. Peak-inverse voltage rating is 300 to 400 v.

The device switches fast, too; on time is in the order of 1 μ sec and off time is 10 times faster. And since it acts as a diode in the conducting

state but as a cutoff pentode in the pinched condition, the high-power Tecnetron can be used for proportional control as well as on-off applications.

Slated to follow the 10-amp versions that will be in pilot production by early next year are 50-amp units both in germanium and silicon. The silicon units will have voltage ratings to 500 v and piv of 1,000 to 1,200 v (see table). But most important, the power-handling potential of this family of devices is practically unlimited—units can be connected in parallel directly with no special matching.

DESIGN—The high-power Tecnetron differs from the high-frequency communications version (ELECTRONICS, p 18 May 17) in structure and operation. Instead of a single *n*-type germanium rod, it has many rods sandwiched between a common base or anode plate and a cathode plate. The rods are *n*-type germanium of relatively high resistivity with a *p*+ layer at one end and an *n*+ layer at the other. A grid of *p*+ material surrounds the *n*-type rods

over part of the height between the plates.

With a forward voltage applied between the anode and cathode plates, but no voltage applied to the grid, the device acts as a diode with carrier injection at both electrodes. But when a negative cutoff voltage is applied to the grid, it extracts minority carriers and a donor space charge develops to block carrier flow between anode and cathode.

For complete cutoff, grid bias ranges from -60 to -90 v. Up to cutoff, the I-V curve flattens out as bias increases so the family of curves resembles that of a pentode. With no grid bias, however, the curve has a diode-like look. Bias for complete cut-off will be reduced to -30 to -60 volts for the future 50-amp versions.

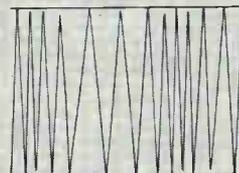
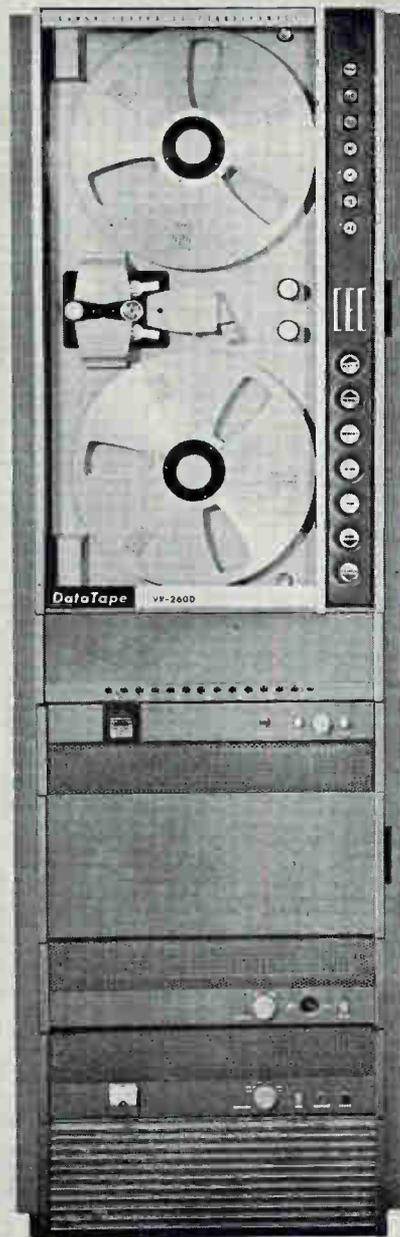
SWITCHING CIRCUITS — Basic circuit for using the high-power Tecnetron as a d-c switch is shown. The electronic switch in the grid circuit can be built around a fast low-power silicon controlled rectifier, or

FM

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DIRECT

PCM



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When it comes to versatility, there isn't a better recorder/reproducer in its class than CEC's VR-2600. This six speed, push-button-controlled multi-channel wide band data system handles d-c to 40 kc and d-c to 80 kc FM, 400 cps to 600 kc Direct, IRIG PDM and 1000 bit/inch parallel PCM recording/reproducing... the four languages of magnetic tape storage.

Embodying unique concepts of accuracy, simplicity and reliability, the VR-2600 is excellent for environmental testing, structural or transient studies, radar recording or telemetry. It's at home in laboratory, mobile, shipboard, trailer or blockhouse environments.

Designed using all solid state electronics for low power consumption, the VR-2600 is actuated by color coded, back-lighted pushbuttons. A complete 7- or 14-channel record and playback system is housed in a single or dual cabinet (optional) with conditioning amplifiers available for Direct, FM, PDM and PCM techniques. Exceptionally

low skew allows parallel PCM recordings of 1000 bits per inch. Six speeds in two ranges (1 $\frac{1}{2}$ -60 ips; 3 $\frac{3}{4}$ -120 ips) are available as standard equipment.

Need further information about the VR-2600? Call or write for Bulletin CEC 2600-X21.

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Need further information about the VR-2600? Call or write for Bulletin CEC 2600-X21.

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Easy to operate, CEC's TD-2903 Automatic Tape Degausser degausses magnetic tapes to a nominal 90 db below saturation level in only 120 seconds. The TD-2903 accepts all reel sizes, can be used with CEC, EIA or MIL-R-22842 reel-hubs utilizing 5/16 inch or 3 inch center holes. Over-all reel diameter can be from 3 inches to 14 inches. Tape widths from 1/4 to 2 inches (including television tapes) are accommodated. Weighing only 90 lbs. (15"x16"x23") the TD-2903 can be operated on a bench top, in a RETMA rack or cabinet. Need more information? Call or write your CEC office for Bulletin 2903-X4.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of Bell & Howell • Pasadena, Calif.

CIRCLE 77 ON READER SERVICE CARD

electronics • SEPTEMBER 6, 1963

CHARACTERISTICS OF BIPOLAR HIGH-POWER TECNETRON

	Available Now	Projected	
	Germanium	Germanium	Silicon
Continuous current rating (I_n)....	10 amp	> 50 amp	> 50 amp
Circuit break rating.....	≥ 15 amp	> 100 amp	> 100 amp
Forward voltage drop (at I_n).....	≤ 2 v	≤ 2 v	≤ 2 v
Residual current.....	$0.002 I_n$	$0.001 I_n$	< $0.0001 I_n$
Grid bias (V_{g0}) for complete pinch-off.....	60-90 v	30-60 v	30-60 v
Peak energy drawn by grid (transient).....	$\approx I_n V_{g0} 10^{-6} \text{ j}$	$0.5 I_n V_{g0} 10^{-6} \text{ j}$	$0.5 I_n V_{g0} 10^{-6} \text{ j}$
Average power drawn by grid....	$2 I_n V_{g0} 10^{-3} \text{ w}$	$I_n V_{g0} 10^{-3} \text{ w}$	$< I_n V_{g0} 10^{-4} \text{ w}$
Peak inverse voltage.....	300-400 v	400 v	1,000-1,200 v
Duty voltage rating.....	≈ 150 v	150-200 v	400-500 v
Intrinsic OFF switch time.....	$\approx 0.1 \mu\text{sec}$	$\approx 0.1 \mu\text{sec}$	$\approx 0.1 \mu\text{sec}$
Intrinsic ON switch time.....	$\approx 1 \mu\text{sec}$	$\approx 1 \mu\text{sec}$	$\approx 1 \mu\text{sec}$

a power transistor, switched by a low-power bistable Tecnetron or a unijunction transistor.

To function properly in the grid switch, the scr must be able to pass in the conducting state during an interval of 2 to 3 μsec a peak current equal to one-third of the load current. In the blocking state, the scr must withstand the Tecnetron's cutoff grid voltage. An scr rated for 0.5 amp and 100 v, for example, could handle a Tecnetron with 30-amp breaking capacity.

Requirements are the same for a power transistor used to switch the cutoff voltage onto the Tecnetron grid. A Texas Instruments' 2N1046, for example, would suffice for Tecnetrons with breaking capacity up to at least 30 amp.

For highly inductive loads, an R-C network is added in the grid circuit to control the speed of applying cutoff voltage to the grid. Otherwise, the inherent 0.1- μsec off time of the Tecnetron is so fast overvoltages may develop across the load. At the same time, so that injection of minority carriers at the anode won't upset cutoff, the speed of voltage buildup across the anode and cathode must be matched to the slower breaking time by a capacitance shunt (indicated by dotted lines in the basic schematic).

A-C SWITCH—To switch a-c, the basic circuit is two Tecnetrons inverted in parallel with a common grid circuit. The grid source is connected through two diodes so that the voltage between the grid and the cathode-anode connection at each end is always at least equal to the cutoff voltage. The two diodes also isolate the grid and power circuits. No special circuit tricks are neces-

sary for a-c switching, but the Tecnetrons must be mounted on separate heat sinks insulated from each other. An electronic switching circuit would in actual practice replace the mechanical switch shown for simplicity's sake in the grid circuit.

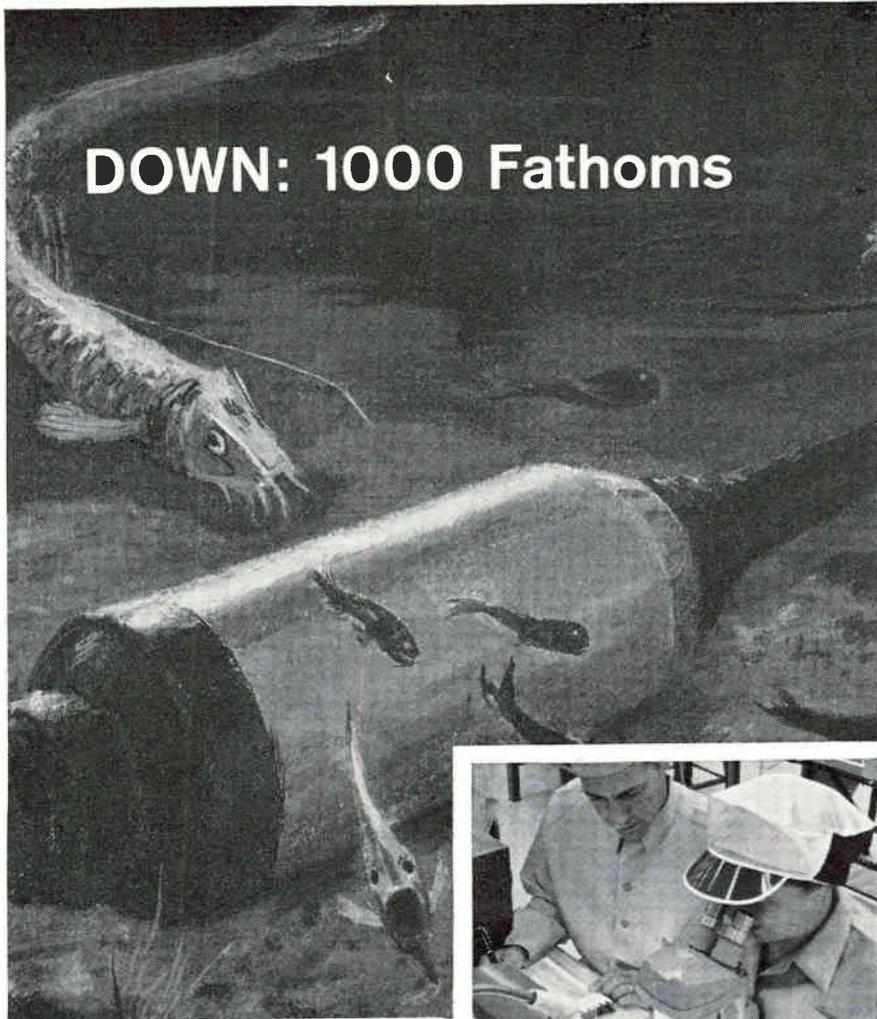
The high-power Tecnetron (*Te* for its inventor Dr. Stanislas Teszner, *cnet* for Centre National d'Etudes des Telecommunications where Teszner developed his original high-frequency communications field-effect devices, plus *ron*) was developed by a Franco-Belgian pair of electrical equipment manufacturers—Forges et Ateliers de Constructions Electriques de Jeumont and Ateliers de Constructions Electriques de Charleroi. In the United States, Atlantic Instruments and Electronics Inc. of Boston will produce and market the device under the tradename Fieldtron.

'Copters Try L-F Navigator

NEW YORK—New York Airways (NYA) is banking on becoming the first commercial helicopter service certified by FAA for instrument flight.

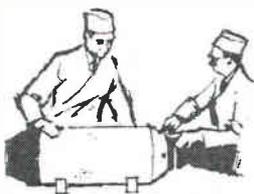
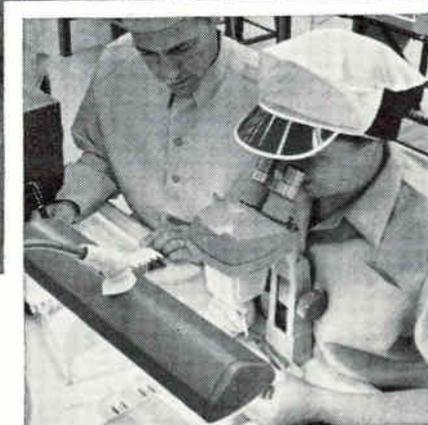
The airline, which runs ferry flights to airports around New York City, plans to use the short-range, British-built Decca navigation system instead of higher-frequency, line-of-sight equipment commonly used by airliners (for a comparison of systems, see *ELECTRONICS*, p 112, Aug. 7, 1959).

Decca operates at frequencies around 100 kc. NYA found that



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help transmit 128 two-way messages simultaneously.

To make sure, Bell System's Western Electric Company uses StereoZoom Microscopes for the assembly and inspection of the high-voltage capacitors. StereoZoom's big, bright, natural, 3-dimensional views make sure of alignment, bond, and freedom from flaws or foreign particles. Its shockproof, dustproof optical system shrugs off punishing industrial use.

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BAUSCH & LOMB 

the higher-frequency systems give erratic results at the low altitudes used for helicopter flights, particularly around the tall buildings near its Wall Street heliport.

In each helicopter, NYA uses twin Decca Mark 8 Navigators. The additional set increases reliability through redundancy. This model



TWIN installation in helicopter adds to reliability

also has an all-transistor computer that is less susceptible to vibration. Two of the computers have 500 hours flight time with only one malfunction—a broken wire.

The ground stations, operated by an NYA division, consist of a master and three slave stations.

FAA will start flight-testing the navigation system soon. Flight evaluation of the Boeing-Vertol 107 helicopters has been completed. An FAA spokesman says he sees no insurmountable obstacles to certification of the equipment and pilots, and he thinks that instrument flights will be possible next year.

**Infrared Sensors Map
Underground Water Sources**

Washington — Airborne infrared scanners are being used by the U. S. Geological Survey to survey the flow of ground water into surface streams. Underground water temperatures are more uniform than surface water temperatures. Scanners made by Lear-Siegler detect differences in temperature.



Five years in outer space prove reliability of **TEFLON**[®] under radiation ...hard vacuum

March 17, 1958: Vanguard I is placed into orbit. All insulators in the coaxial fittings are made of a Du Pont TEFLON TFE-fluorocarbon resin. So is the satellite's transmitter field-coil core, and insulation on internal hookup wire.

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In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

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3. For both groups details are given of Spatial Frequency Measurement — the recognized scientific and objective

method of measuring resolution. The 'setting up' procedures will enable the best performance to be obtained from these products.

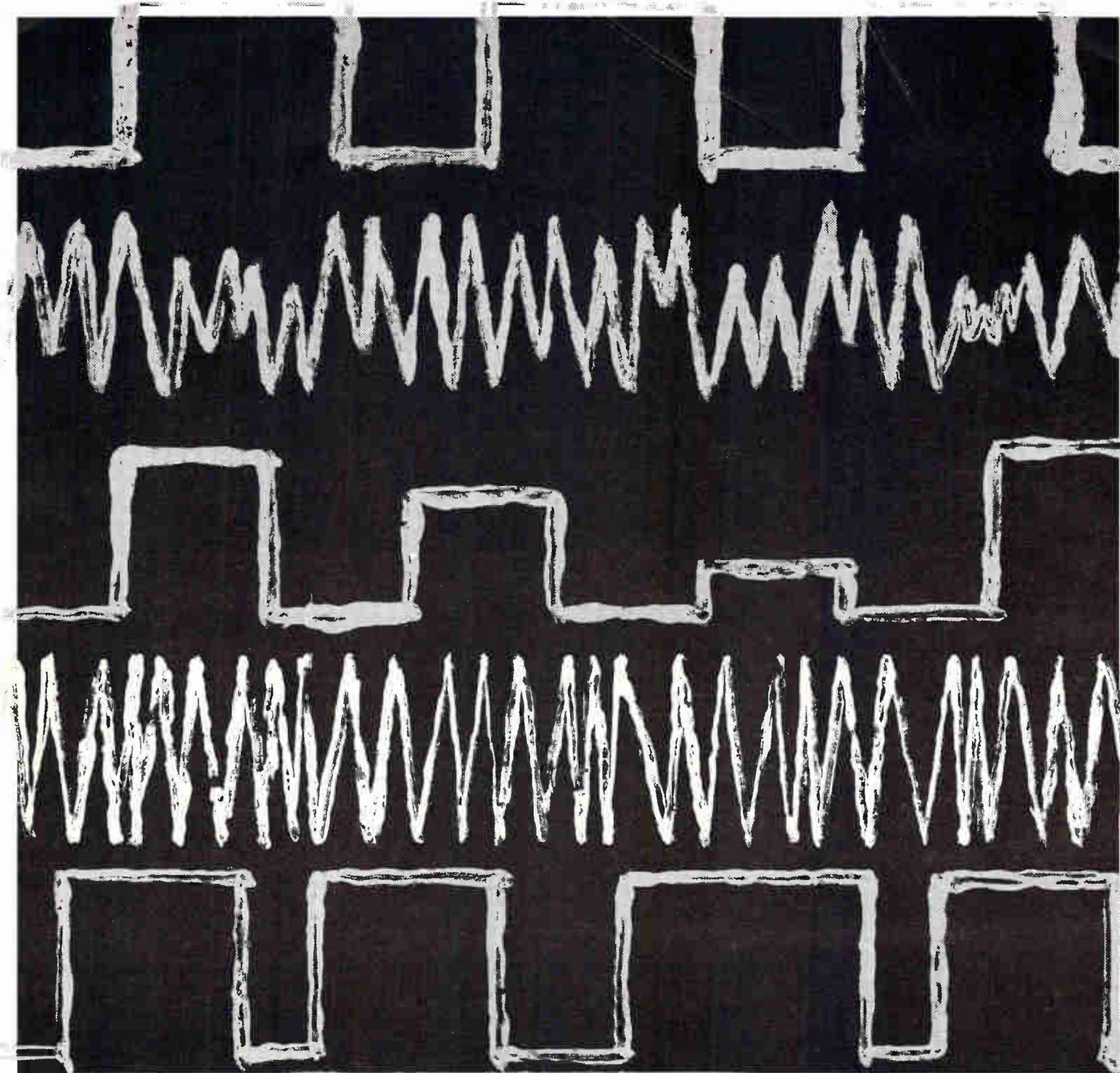
4. Finally, Ferranti will issue up-dating pages, and complete chapters as the state of the art advances. This up-dating service is available, at no extra cost, simply by completing and mailing the registration card at the front of the book.

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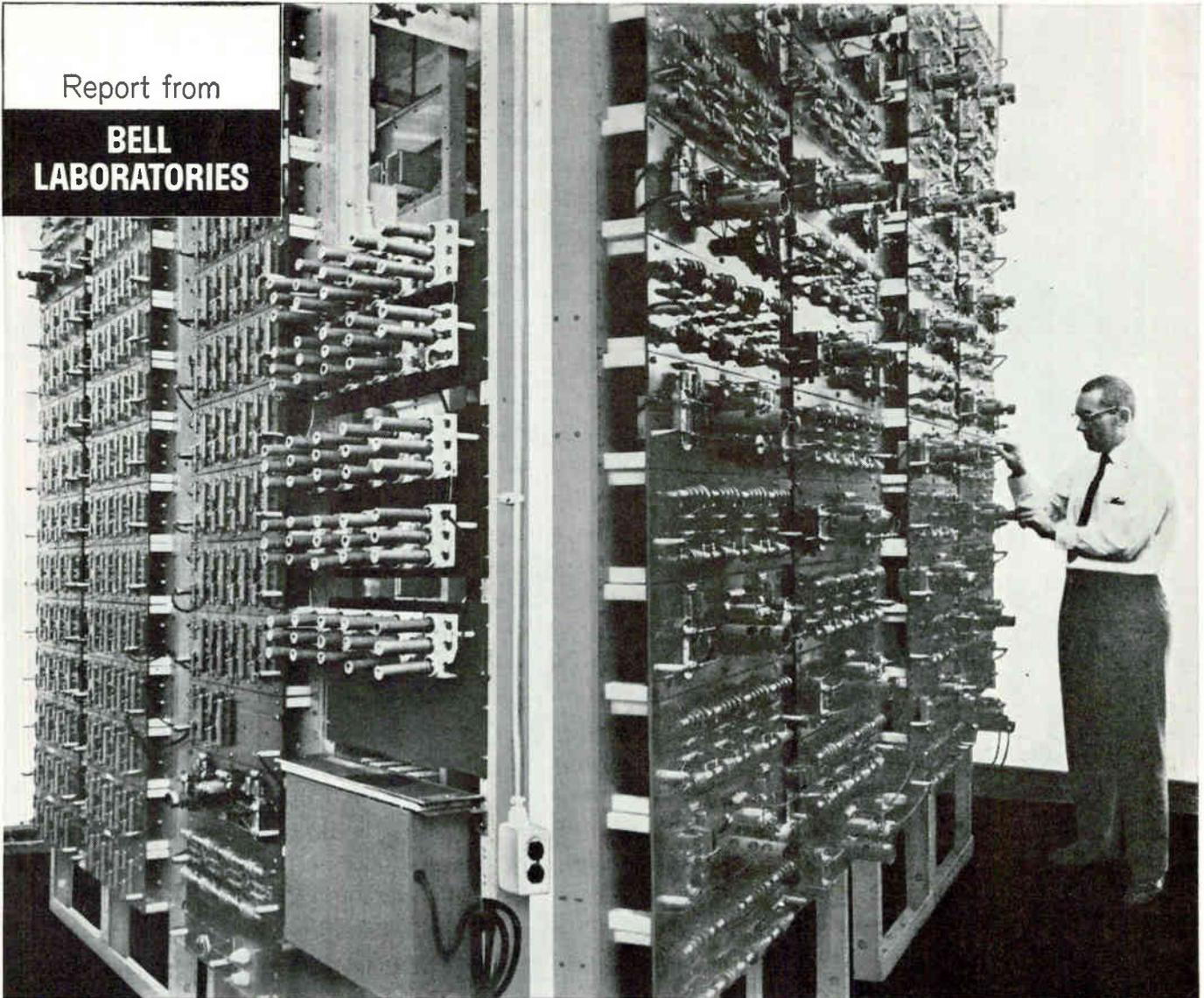
These systems include PCM, SS/FM, PAM, FM/FM, PDM, FM/FM/FM, time-sharing multiplexers, digital data processing systems, transmitter systems, decoders, calibrators, noise generators, and signal conditioners.

For further information contact Aerospace Programs Department, Brown Engineering Co., Inc., Industrial Research Park, Huntsville, Alabama.

BROWN ENGINEERING COMPANY, INC.

Report from

**BELL
LABORATORIES**



Engineer A. H. Evans measures the effect of voltage surges on Bell Laboratories' simulated undersea telephone cable. Simulating 180 amplifiers and 181 cable sections, with a total length of 3600 miles, the arrangement includes over 1100 electrical components. Photo merges two sides of the simulated cable so that both can be viewed at once.

THE UNDERSEA "CABLE" THAT NEVER GOES TO SEA

In undersea cable systems, electric power for the amplifiers is transmitted along the cable itself. To make this possible, precisely engineered circuits and devices must be designed into the system for protecting electron tubes and other components from sudden voltage surges which may result from accidental damage to the cable.

In systems such as these, the computation of the effects of such surges to establish the needed design parameters is extremely complex. Here, as in many other areas of our work, a solution to the problem has been found through electrical simulation.

Full-scale simulation is achieved by means of networks of electrical components. For the new 128-channel cable scheduled for transatlantic service this year, a network (above) was built to simulate the power path of a 3600-mile cable with its 180 amplifiers.

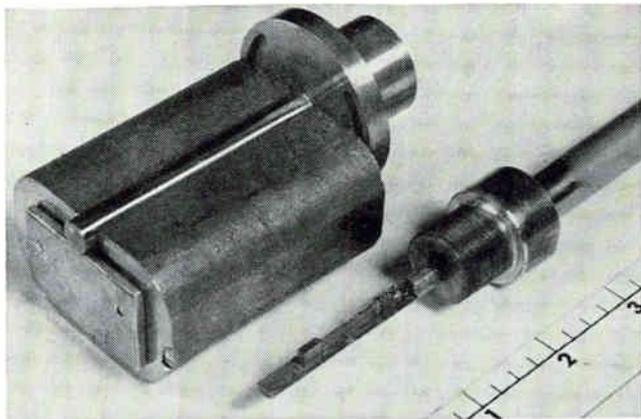
With the aid of this simulator, engineers can study the effects of voltage surges, the operation of electron tube protectors, and the performance of the power supply in the various contingencies that may occur in active service.

This study of unknown factors by means of electrical simulation is an example of how engineers at Bell Laboratories work to assure the performance and reliability of new communications systems before they are committed to service.

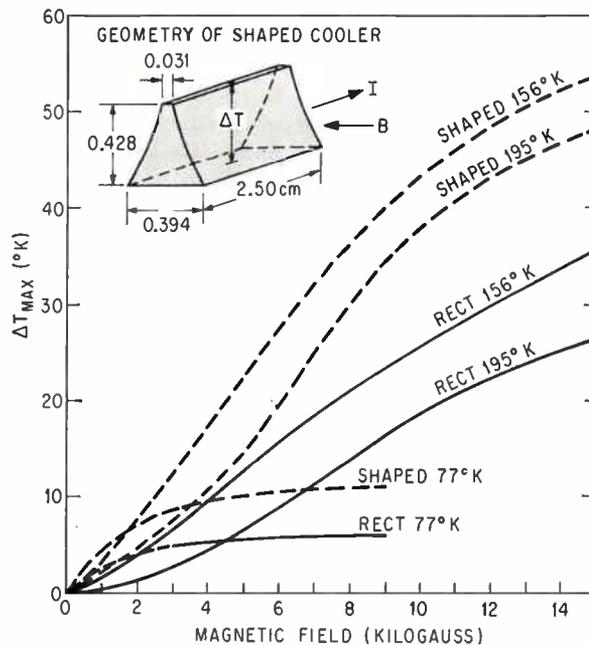


Bell Telephone Laboratories

World center of communications research and development



COOLING UNIT assembly, showing the permanent magnet, top, and the bismuth-antimony element, bottom, and copper sink. Current passing through element produces cooling effect—Fig. 1



MAXIMUM TEMPERATURE differential, plotted against magnetic field for rectangular and exponentially shaped Bi (97) Sb (3) Ettingshausen coolers, at heat sink temperatures of 77, 156 and 195 deg K—Fig. 2

New Cooler Uses Thermomagnetic Effect

Bismuth-antimony crystal with exponential shape efficiently cools at 77°K

ETTINGSHAUSEN EFFECT, a galvano-magnetic effect that has traditionally been obscure and considered very small, has been proved to be large in certain compounds, and points the way toward a new type of thermomagnetic solid-state cooler, one which is particularly efficient in the 77 to 200 deg K temperature range.

An experimental cooler based on the Ettingshausen effect has been built by the Research and Development Division, Lockheed Missiles and Space Co., Palo Alto, Calif. Shown in Fig. 1, the cooler uses a bismuth-antimony alloy crystal (97

and 3 percent, respectively). Current enters the device through the bus wire, flows through the cooling element and leaves through the copper heat sink. The hot side of the cooling element is electrically insulated from the heat sink by silicone grease. The performance, measured by a differential thermocouple for a number of different magnetic field values, is shown in Fig. 2. The Lockheed researchers, S. R. Hawkins, C. F. Kooi, K. F. Cuff, J. L. Weaver, R. B. Horst and G. M. Enslow achieved as much as 54 deg K of cooling with a heat sink temperature of 156 deg K and a field of 15 kilogauss.

PRINCIPLE—In order to use the Ettingshausen effect in a practical cooling device, it is necessary only to provide a heat sink to keep the

hot side of the element at a fixed reference temperature. This is shown schematically in Fig. 3. Since the electrodes and current leads in the picture must be good electrical conductors, they will in general have a much higher thermal conductivity than the thermomagnetic material. There are therefore two thermal losses caused by the electrode and current leads: one due to the thermal shorting through the electrode of the desired temperature gradient, the other the heat leak along the current leads.

For this reason the cooler element is made long compared to its height and width, and its principal cooling area is taken near the center, where it can be considered essentially isothermal in the direction of current flow.

Much work has been done recently on the determination of a figure of merit for thermomagnetic materials. It is now generally agreed that the material in which the Ettingshausen and Nernst effects are the largest are those with equal numbers of holes and electrons.

Refer to Fig. 4 (A), which illustrates the Ettingshausen effect in a

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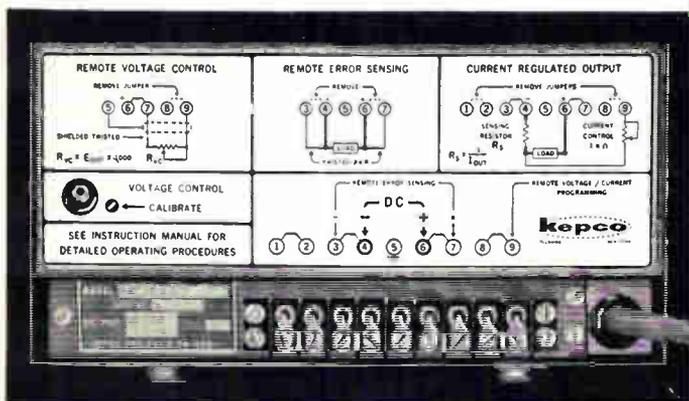
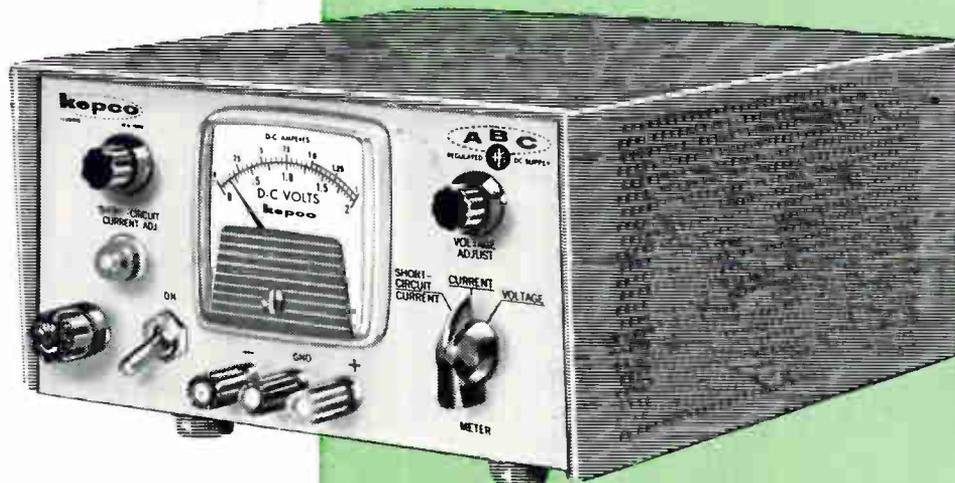
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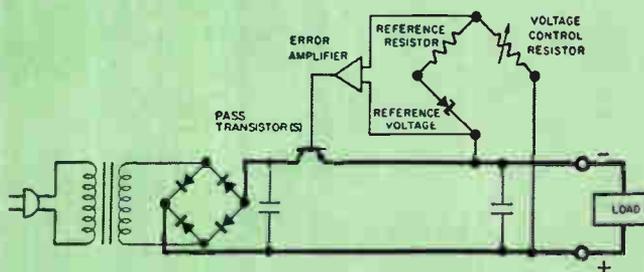
DC OUTPUT VOLTS	DC OUTPUT AMPS	RIPPLE RMS MV	PRICE	*METERED MODEL
0-2	0-1	0.25	\$ 179.00	ABC 2-1M
0-7.5	0-2	0.25	159.00	ABC 7.5-2M
0-10	0-0.75	0.25	119.00	ABC 10-0.75M
0-15	0-1	0.25	159.00	ABC 15-1M
0-18	0-0.5	0.25	119.00	ABC 18-0.5M
0-30	0-0.3	0.25	119.00	ABC 30-0.3M
0-40	0-0.5	0.25	159.00	ABC 40-0.5M

HYBRID MODELS

DC OUTPUT VOLTS	DC OUTPUT AMPS	RIPPLE RMS MV	PRICE	*METERED MODEL
0-200	0-0.1	0.5	199.00	ABC 200M
0-425	0-0.05	0.5	199.00	ABC 425M
0-1000	0-0.02	1.0	274.00	ABC 1000M
0-1500	0-0.005	1.0	274.00	ABC 1500M
0-2500	0-0.002	1.0	334.00	ABC 2500M

INPUT REQUIREMENTS: 105-125V AC, 50-440 cycles.

All-Transistor Circuit is illustrated below. The Hybrid Circuit is a unique design which achieves high efficiency and reliability through the use of Transistorized Reference and Amplifiers combined with a Vacuum Tube series pass element for reliable high voltage operation.



All models are designed for continuous operation without de-rating under all specified line, load and temperature conditions.

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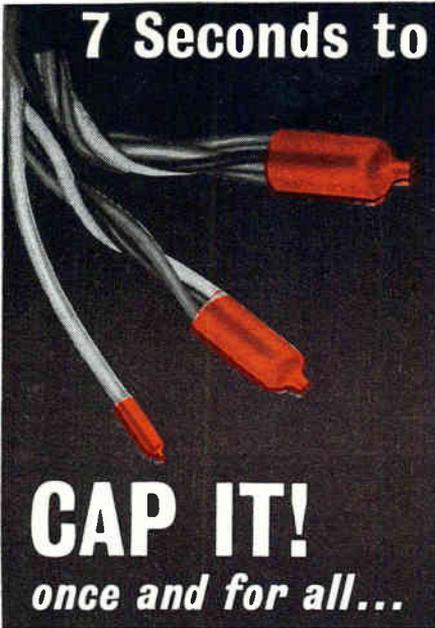
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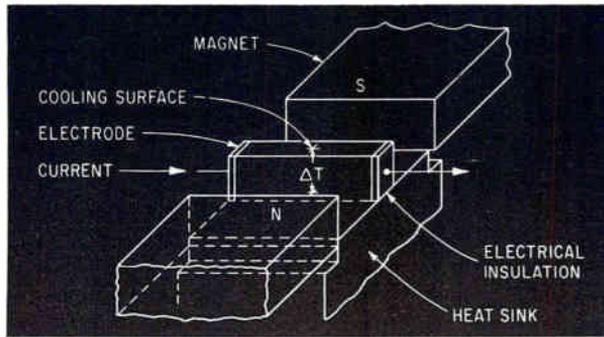


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SCHEMATIC DRAWING of Ettingshausen cooler shows mechanical configuration—Fig. 3

ETTINGSHAUSEN EFFECT in single and two-carrier systems showing a single-carrier system (A) and a two-carrier system (B)—Fig. 4

single-carrier system (electrons in this case). Due to the magnetic field, there is a net force on any electron given by $\vec{F}(\epsilon) = -e[\vec{v}(\epsilon) \times \vec{B} - \vec{E}_H]$ where e is the electronic charge, \vec{v} is the velocity, \vec{E}_H is the opposing Hall field and ϵ is the energy. For steady-state conditions, the net current flow in the x-direction vanishes and for some suitable energy ϵ necessarily $\vec{F}(\epsilon) = 0$. Thus electrons for which $\epsilon < \bar{\epsilon}$ will drift in one direction and those for which $\epsilon > \bar{\epsilon}$ will drift in the other, resulting in a net heat flow in the negative x-direction; the opposing Hall effect tends to limit this flow.

For the two-carrier system in Fig. 4 (B), thermal energy is transported by both holes and electrons, and the Ettingshausen effect is caused mainly by generation of hole-electron pairs at one side of the sample and by their recombination at the other side. In addition, transport theory indicates that if the number densities and mobilities of both holes and electrons are equal, the Hall effect and the opposing Hall field vanish; in this case the Ettingshausen effect can be expected to be large.

Thus, for maximum Ettingshausen

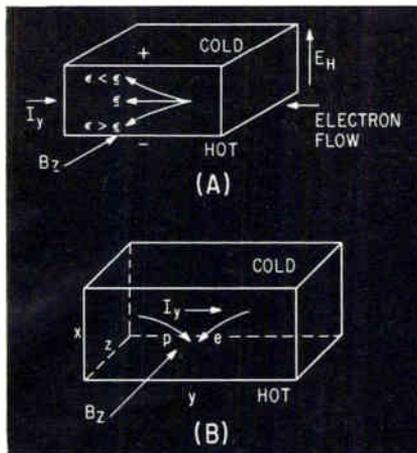
effect, the material should have a two-carrier system with equal numbers of holes and electrons (that is, it should be intrinsic or have a small overlap between the valence and conduction bands). The hole and electron mobilities should be equal; the larger their values the higher the figure of merit and the smaller the magnetic field required for operation. Also, the material should have low lattice thermal conductivity.

MATERIALS—The best material presently available is the bismuth-antimony crystal system. Pure bismuth has a slight overlap between the conduction and valence bands, and in proper orientation both carriers have similar mobilities. Adding a small amount of antimony greatly reduces the lattice thermal conductivity, although it also decreases the energy-band overlap; the optimum antimony content is about 3 percent.

In designing a practical Ettingshausen cooler element, as with Peltier coolers, the overall coefficient of performance and T_{max} can be greatly improved by staging or cascading a number of individual units. Each successive stage must pump

HOW THIS EFFECT WORKS

Ettingshausen effect, one of the four galvano- and thermomagnetic effects (the others are the Hall, Nernst and Righi-Leduc effects) is the temperature difference that appears in a direction perpendicular to both the longitudinal electric current and the applied magnetic field. Up to now it was thought too small an effect for practical applications; research has shown otherwise



an amount of heat equivalent to the input heat plus the input power to all of the colder stages, and so the size and heat pumping capacity of the individual stages must increase correspondingly toward the heat sink.

This can be done by increasing the cross-section area of each element, in the direction of heat flow. If the same electrical field is supplied to each stage of the cascade, no electrical insulation is needed between stages, since the electric field is constant in each rectangular stage. Thus the cooler can be made out of a single block of material. Since there is no limit to the number of stages that can be built of a single block, it is possible to achieve, in effect, infinite staging. The optimum shaping should be close to exponential. The Ettingshausen coolers, like Peltier effect coolers, have no moving parts and a high degree of reliability. They are ideally suited for cooling very small areas, without loss of overall efficiency.

APPLICATIONS — One obvious application is the cooling of infrared detectors. Another is temperature control of small components, relative to a low-temperature bath. Although the Ettingshausen cooler requires a magnetic field for its operation, at 77 deg K, using Bi(97)Sb(3), maximum cooling can be achieved at magnetic field strengths that are easily obtained with small permanent magnets.

The Ettingshausen cooler has several advantages over the Peltier cooler: It consists of only one type of material, while each Peltier junction requires an *n*-type and a *p*-type leg, with metal-to-semiconductor



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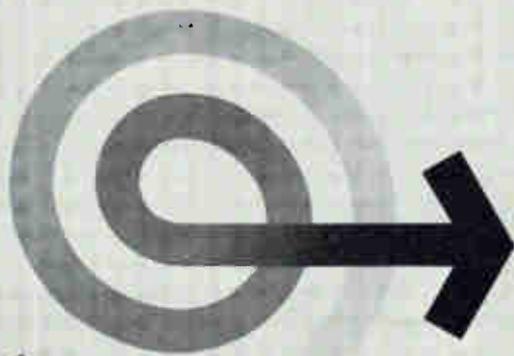
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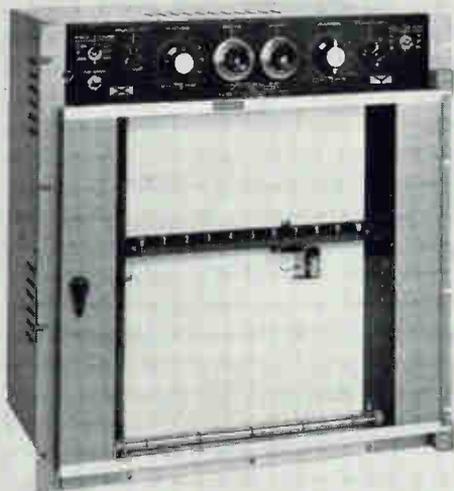
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contacts. The effect of infinite cascading can be achieved by merely shaping the cooling element appropriately, while cascaded Peltier coolers are complex multielement structures. The Ettingshausen cooler is most efficient below 200 deg K, while the Peltier cooler becomes inefficient below 200 K.

In cases where cooling to cryogenic temperatures from room temperature or temperature considerably above 200 K is desired, the combination of Ettingshausen-Peltier cooler is a good prospect. With the present state of art, cooling to temperatures below 150 K from room temperature should be possible by this method.

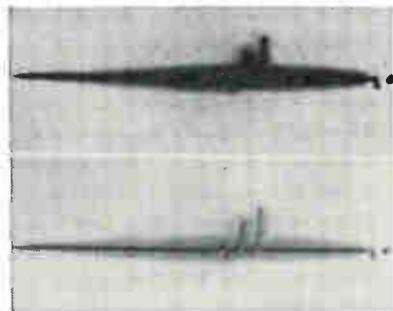
Prospects exist for the further development of Ettingshausen devices, and for new materials suitable for such coolers.

New Film Developed for CRO and Research Use

WIDE-RANGE film that can photograph the sun and the moon with the identical shutter speed and aperture setting without loss of detail or overexposure has been announced by Edgerton, Germeshausen and Grier in Boston.

The new XR (extended range) film, with a sensitivity range of one to a hundred million, is designed for extensive applications in the scientific and industrial recording of rocket exhaust phenomena, plasma and heat ablation investigations, and aerial and satellite photography.

XR film can take photographs of



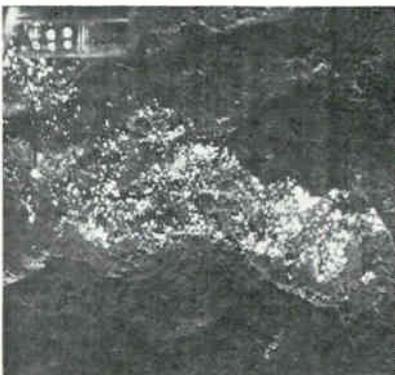
OSCILLOGRAM print, above, made with only the fast-emulsion layer of EG&G XR film, obscures detail by overexposure. Below, the same trace printed from both the fast and slow layer images, reveals detail of entire trace

an oscillograph tracing having a high risetime, retaining detail in all portions of the trace and the base line. It can also photograph a rocket exhaust and reveal detail of heat and material ablation that are unseen by conventional film. An example of an oscillograph tracing of a fast-risetime pulse made on the new film is shown in the photograph.

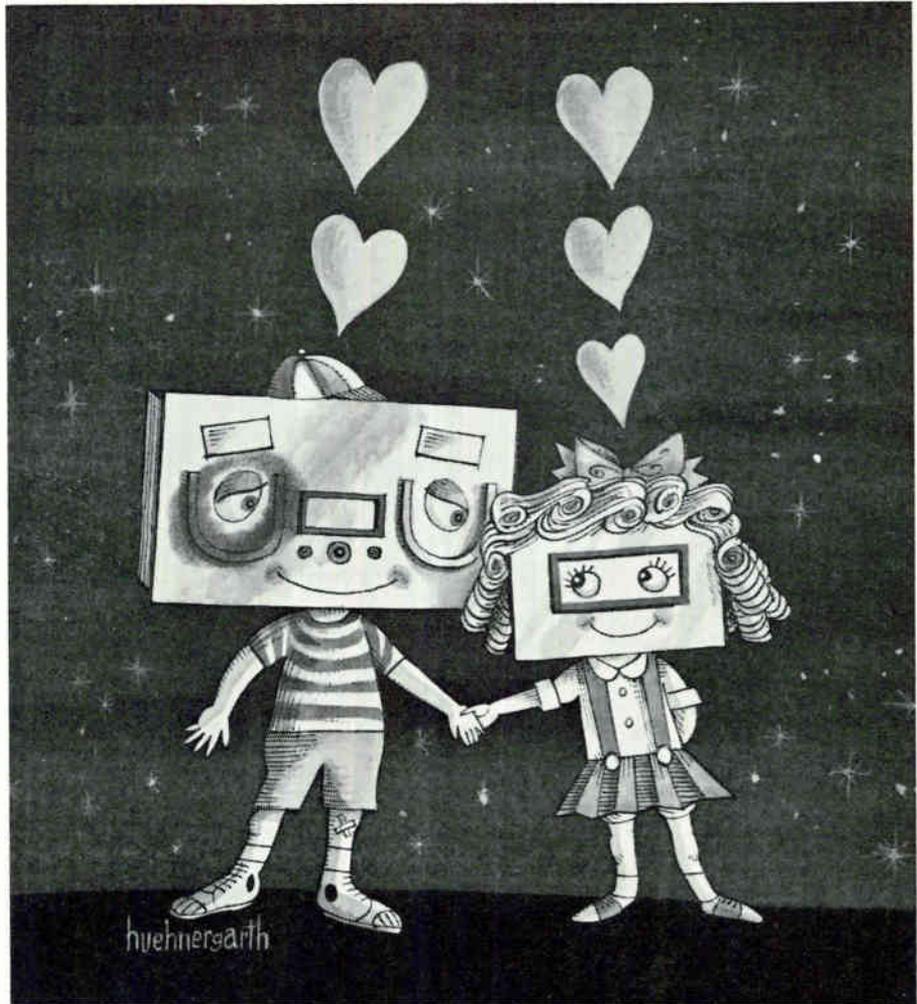
THREE LAYERS—Three photographic emulsions, having three different light sensitivity levels, are superimposed in layers on a conventional film base. The uppermost layer is most sensitive, with an ASA exposure index of 400, and registers the faintest light intensities. The bottom layer is the slowest, with an exposure index of 0.004, for photographing light of the greatest intensity. The middle layer has a sensitivity between the other two values. All three layers are exposed simultaneously.

Applying XR film to photographing a burst of light, such as an explosion, the researcher would obtain three images on the film. The faintest light resulting from the explosion would be recorded on the first, most sensitive emulsion layer. The light of medium intensity would be captured by the middle layer,

IR Scan Finds Forest Fire Through Smoke Cloud



HOT SPOTS of a forest fire are clearly visible in an airborne infrared scan, made through smoke cover by U. S. foresters during evaluation experiments of the technique of using infrared aerial mapping for control of forest fires (ELECTRONICS, p 8, Aug 23)



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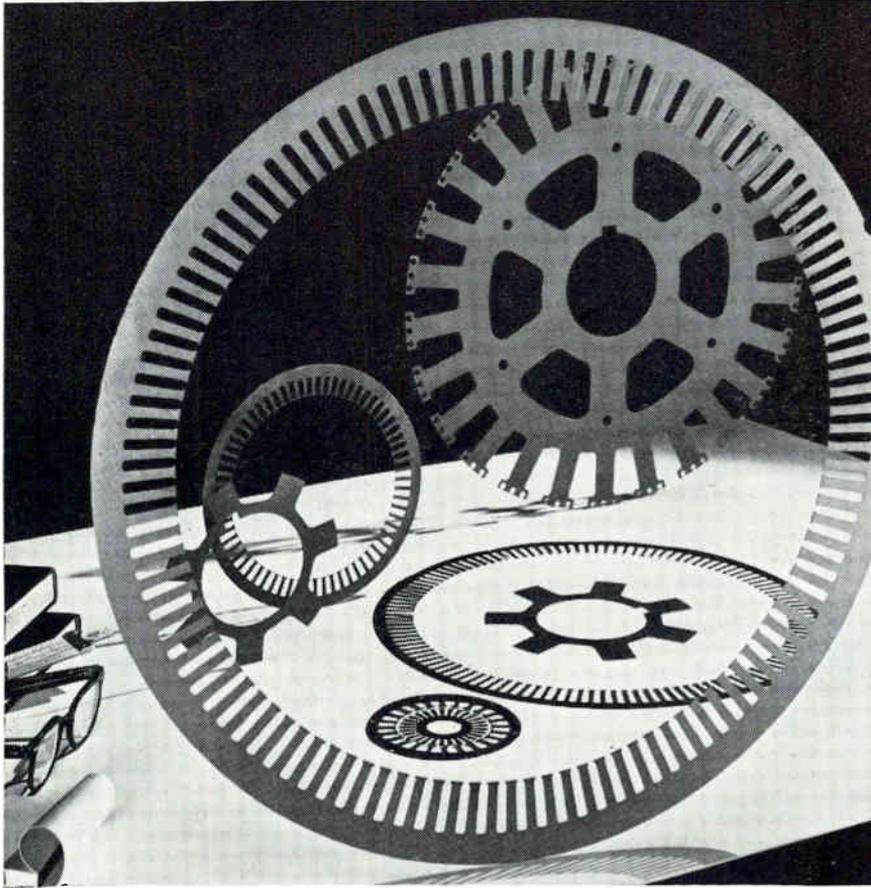


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and the most intense light occurring would register on the bottom layer. Thus the scientist would be able to look into the explosion, see the different light intensities that resulted, and find details that would normally be hidden by overexposure of ordinary film.

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Edgerton, Germeshausen and Grier, Inc., make available to qualified research users 35-mm test rolls, as well as cut-sheet and aerial film sizes. The company also provides a processing service for the film.

Air Force Gets Display Console for Radar Work

DISPLAY CONSOLE that translates computer output into words, numbers, graphics and symbols at a rate of up to 30,000 characters a second and displays them on a 19-inch special shaped-beam tube has been purchased by Air Force's Rome Air Development Center at Griffiss Air Force Base, Rome, N. Y., from General Dynamics/Electronics-San Diego.

Designed for use by the military as the vital man-machine link for presenting information from such sources as radar equipment to human operators, the new console makes use of a special tube with a small picture window in the rear. A projector placed at the window projects onto the tube face slides containing static information such as grids or maps, thus saving cathode-ray time. The electron beam is then used to superimpose the non-static information on the back-projected grid.

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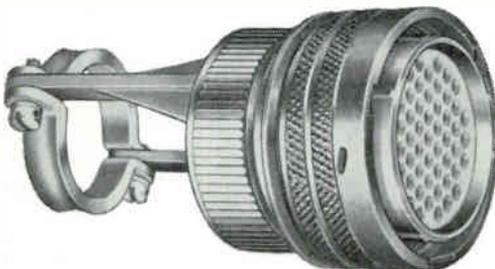
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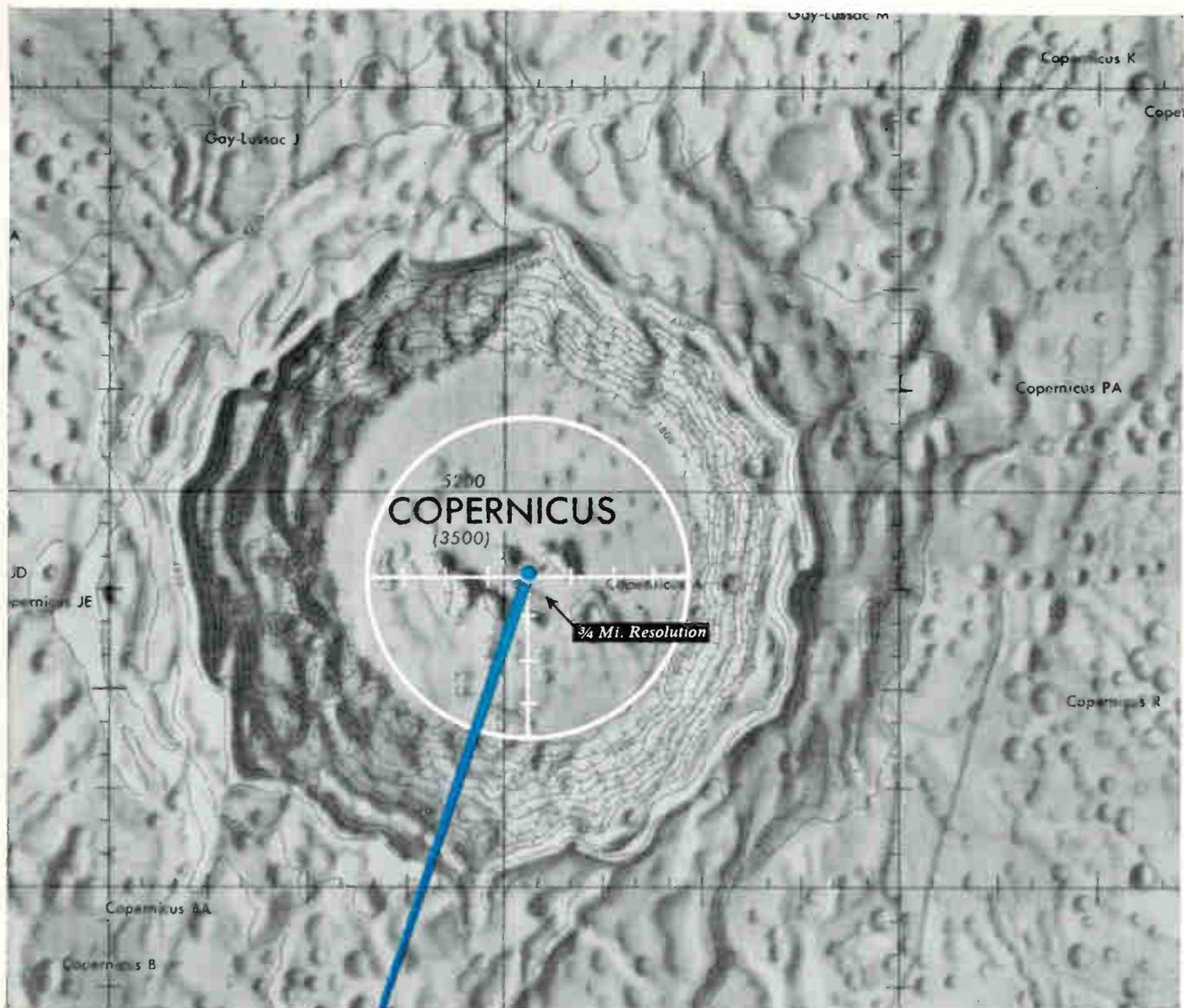
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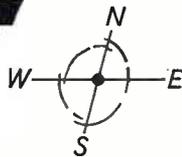
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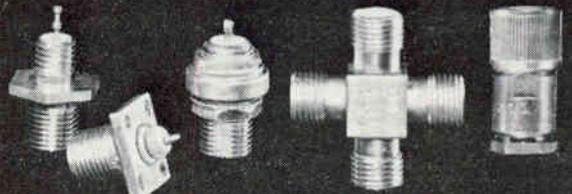
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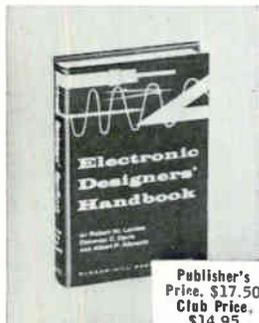
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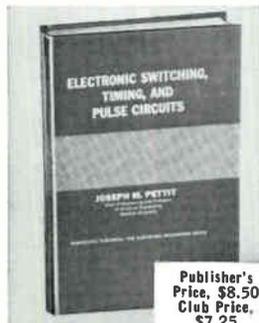
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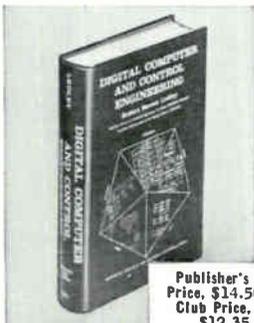
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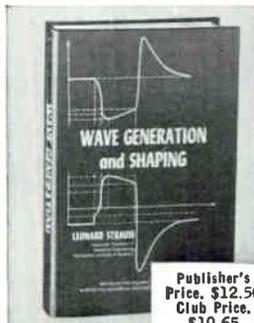
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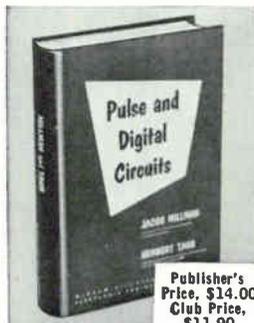
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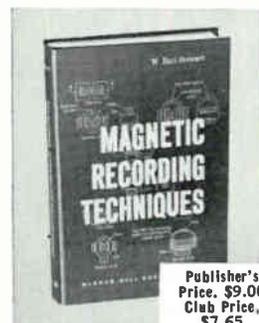
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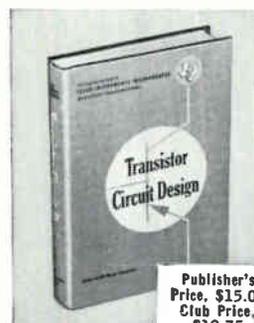
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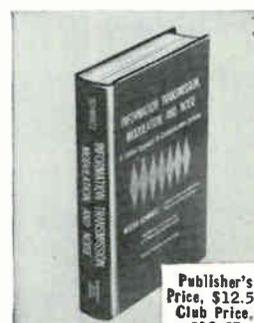
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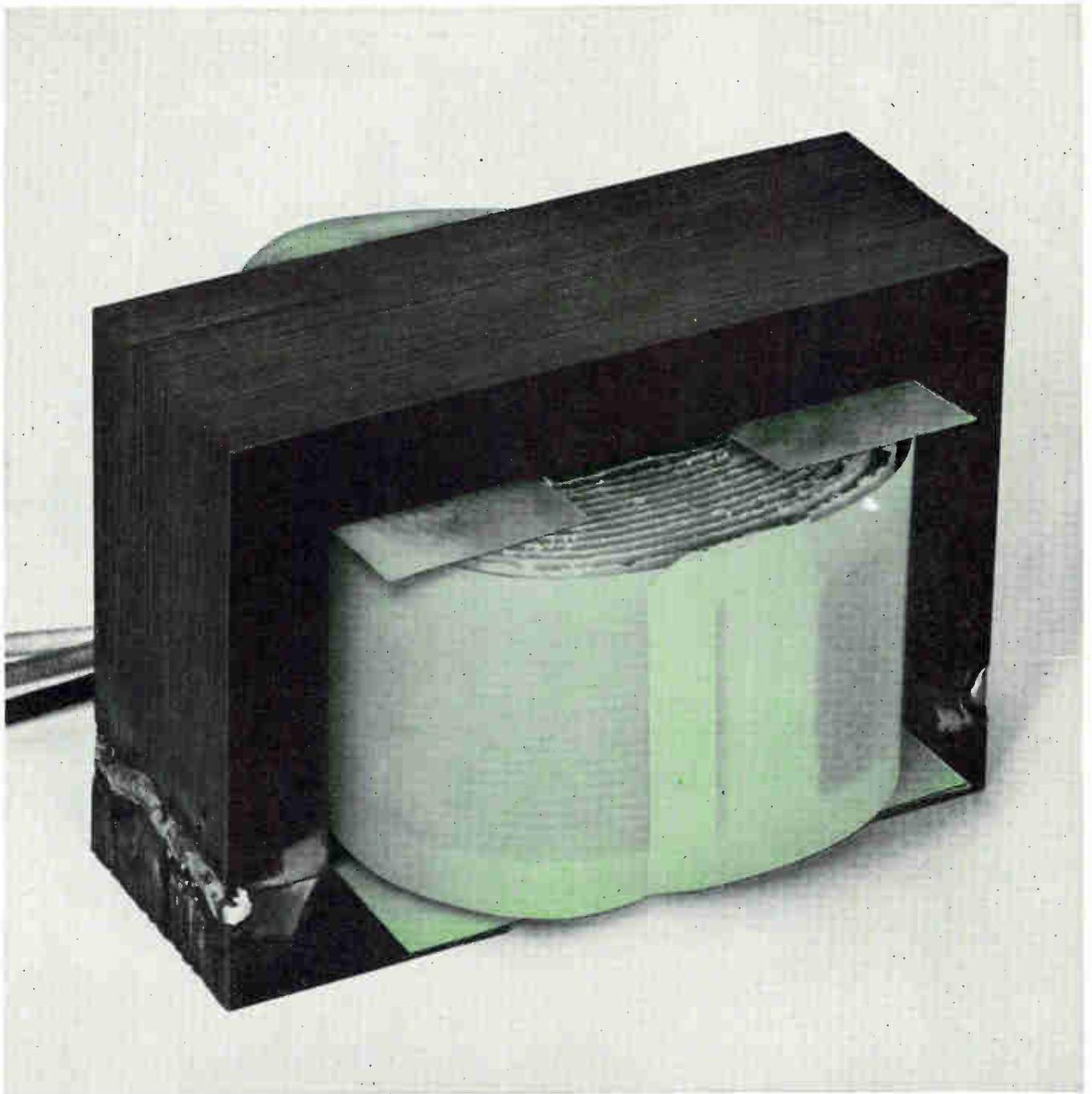
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It's Wide-Lite Corporation's new 1,000-watt ballast transformer. It offers an exclusive 3-year guarantee against failure, compared with the usual 1-year guarantee! Wide-Lite was able to do this by using insulation of "Mylar"* polyester film on the windings. "Mylar" is far more heat-resistant than conventional insulation, and it retains its extremely high dielectric strength even when damp. These properties also gave the ballast an official approval for Class B temperature conditions (130°C).

With longer guarantees and Class B approval possible, think what insulation of "Mylar"

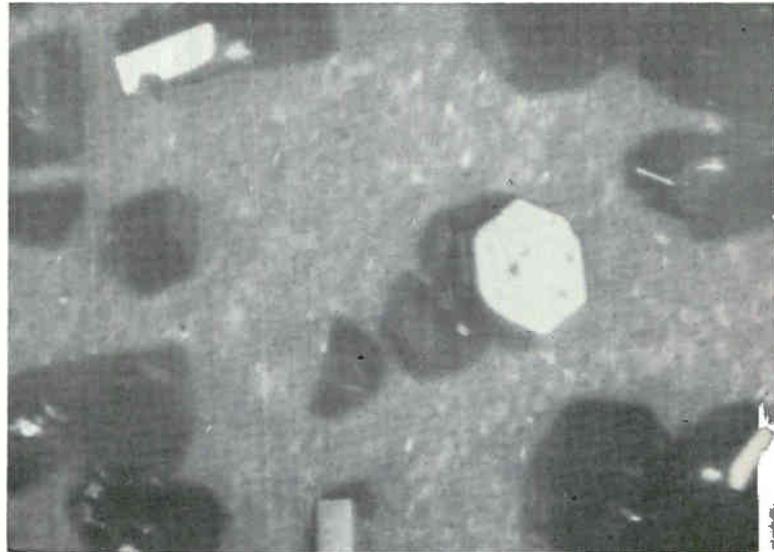
could do in your own designs! Besides its thermal, dielectric and moisture-resistant properties, insulation of "Mylar" is strong and durable. Also, "Mylar" is of high-volume resistivity, resistant to solvents and easy to work with, compared with other insulation materials.

Find out the full story by writing Du Pont Company, Film Dept., Box 22F — Rm. N10452, Wilmington 98, Delaware. *Du Pont's registered trademark.



Better Things for Better Living
...through Chemistry

HEXAGONAL structure of photoconductor material deposited on alumina. Cell contains cadmium, silicon carbide and sulphide compounds. Magnification is 1,800 times



Thin-Film

Photocells Get Brighter Faster

High density cells have
rise-decay under 50 μ sec.
Deposits are uniform



IMPROVED light characteristics are claimed for photoconductive thin films, developed for optical displays.

The material and techniques for deposition on substrates were developed by Photometics Corporation, Walker Valley, New York. Performance and applications were described by Roland C. B. Beeh, company president.

The material will open up new

avenues for optoelectronic devices and electroluminescent solid-state display panels, Beeh says.

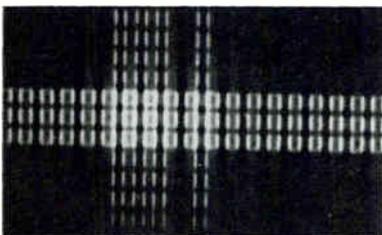
A mosaic of photoconductive cells is formed on a substrate by vacuum deposition. Cells are said to exhibit fast recurrent or nonrecurrent illumination. Rise and decay time of less than 50 μ sec is claimed. The photosensitive areas operate under light modulation up to 100 kc, according to reports.

Characteristics of the material can be applied to visual displays for command control centers, and large panel displays for air-traffic.

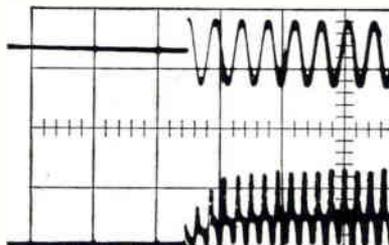
A high density of photoconductive regions can be attained. Performance is uniform and the material can be deposited over large areas with uniformity of deposition within 5 percent, Beeh added.

LATTICE—The photoconductor has a polycrystalline structure. Cadmium, silicon carbide and sulphide compounds are tightly bonded in a hexagonal lattice. Dimension of the lattice is given as less than 5 angstroms.

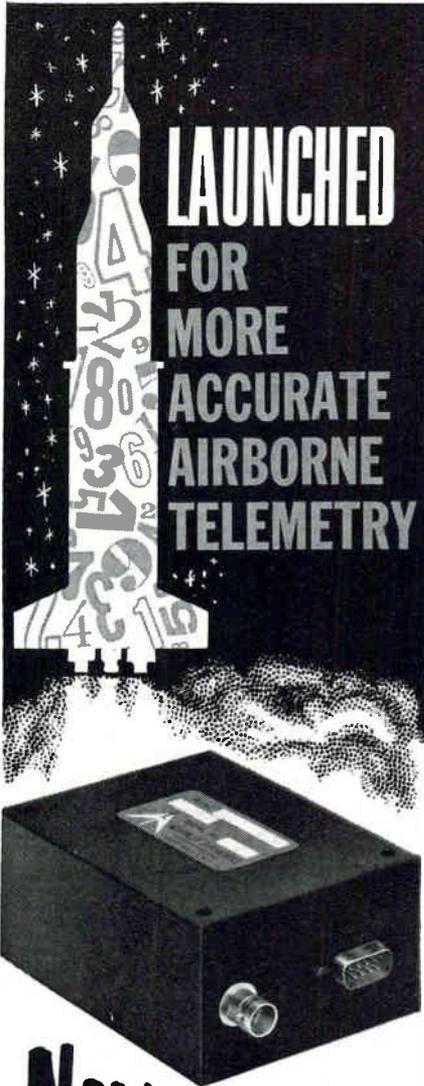
The materials are vacuum deposited, purified compounds are selected by molecular beam. Ion pumping is used, instead of oil diffusion, to avoid formation of hydrocarbons. Seven elements can be evaporated at the same time. Activators are introduced by ionization at high temperature, under high



GHOST effect is shown on 100 element/inch solid-state electroluminescent panel. Approaches are now being considered to circumvent cross illumination



SPEED of response of material is shown in lower trace. Upper trace shows 10,000 cycle input. Material obtains full brightness within 2 cycles



New solid state,
completely transistorized
airborne VHF/FM
telemetry transmitter

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DISPLAYS NOW, TELEVISION WILL FOLLOW

Emphasis is placed on improving solid-state electroluminescent panels. The government needs them for visual displays—panels for aircraft cockpits, for radar, and large display boards for military situations.

Ultimately this approach may be used for television sets with a flat, solid picture screen. But it may take five years to get needed megacycle range of speed response, an image that is bright enough, and a life that is long enough.

Photoconductive cells, deposited on substrates, now have speed of response in microsecond range. Mosaic of photocells can be deposited over large areas. Photoconductive regions can be isolated, high-density deposition is now possible.

New deposition techniques and improved materials promise longer life, higher brightness. Protective envelopes are no longer necessary. Storage is provided on the screen itself. Present work now attacks cross suppression of light between lines, eliminating cross talk, and uneven illumination.

vacuum. Quartz, aluminum or sapphire substrates may be used. Presently, the method does not apply to glass, because of contamination from the glass, and its low melting point.

Dr. Beeh told **ELECTRONICS** that the maximum spectral response of the photoconductor lies at 4100 angstroms. The wavelength may be shifted up to 6500 angstroms, depending on the activator used. Photoconductors operate with blue, yellow, and white phosphors.

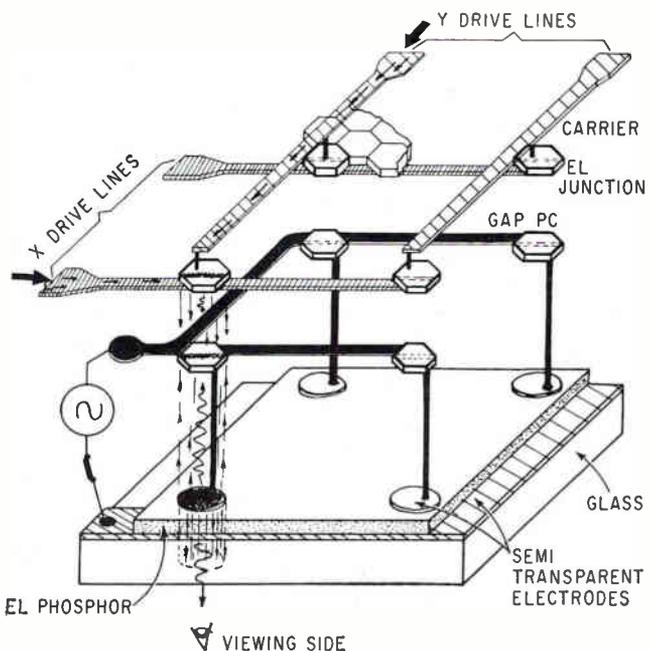
Voltage applied across the cells may range from a few microvolts up to 3,000 volts d-c, or from the 10 cycles up to 100 kc. The cells dissipate from a few milliwatts, up to 0.3 watts. Current may range from a few up to 200 milliamperes.

WRITE-IN—The high speed of response of the material is useful when photoconductors are combined with electroluminescent cells which are turned on and off according to a binary code generated by computers.

This feature, in a display panel, allows for write-in speeds of 200 microseconds or less, per picture element. Display panels, provided with these photoconductors, can operate at frame rates of less than one-half a second, Beeh said.

The number of photoconductors that can be incorporated per square inch depends upon the power dissipation per photoconductor.

Practical electroluminescent-photoconductor panels can be constructed that contain 4 million



FOUR element low drive voltage display panel



What you can do with General Electric's **RTV silicone compounds**

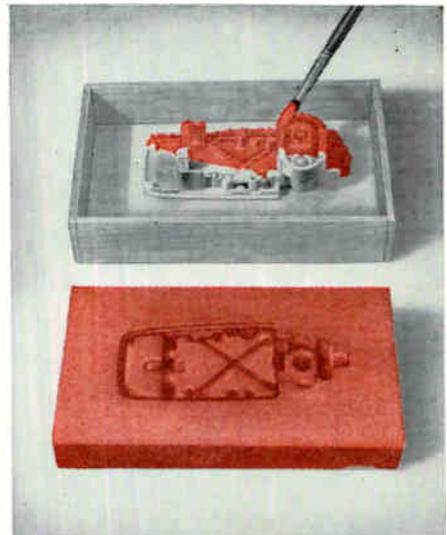
to insulate, seal and mold from -150°F to 500°F



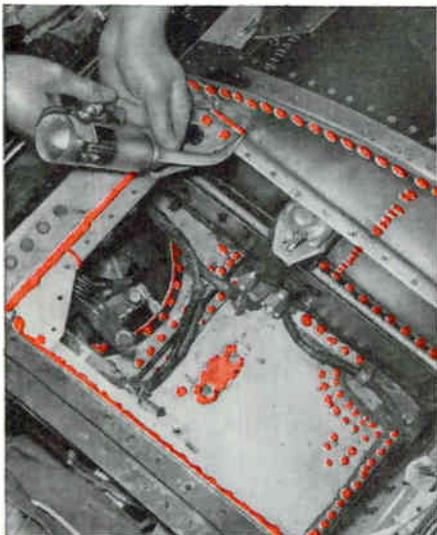
Encapsulate it. Fluid RTV silicone rubber penetrates deep into transformer coils. RTV has excellent dielectric strength and practically no shrinkage. Cure time at room temperature can be varied from minutes to hours.



Pot it. Transparent or opaque, G-E silicones provide a resilient protection against moisture, ozone, thermal and mechanical shock. Flows freely around complicated parts, can be cut away to replace internal components.



Duplicate it. Flexible RTV is often used to make molds for prototypes and short run production. This part requires deep undercutting, but duplicate parts flex free easily. RTV's tensile strength is as high as 850 psi.



Seal it. Bondable RTV (when surface is properly primed) seals against moisture and vibration, ozone and chemicals. Can be used for sheet metal fabrication, shock mounts, gasketing. Viscosities range from pourable to paste.



Insulate it. Adhesive/sealant RTV-102 requires no mixing of catalyst, can be used to insulate open wiring, for on-the-spot caulking, gluing and soldering. RTVs are virtually ageless, will not stress-crack or weather.



Manufacture it. RTV adhesive/sealants are fast working assembly tools, eliminate prefabricated parts or more costly, time consuming techniques. Here an RTV adhesive laminates flexible mica strips to form cylindrical ducts.

If you would like a free sample of one of the nine General Electric RTV silicones for evaluation, write on your letterhead, describing your application. For additional information, check reader service card. Section N995, Silicone Products Dept., General Electric Company, Waterford, New York.

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The new FLEXLEAD Fused Twisted Pair construction of Teflon insulated wire provides all the characteristics of a balanced twisted pair, with the added advantage that it will not unravel during installation or after repeated flexing.

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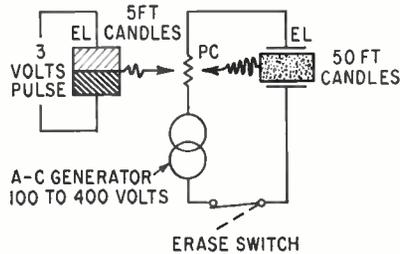
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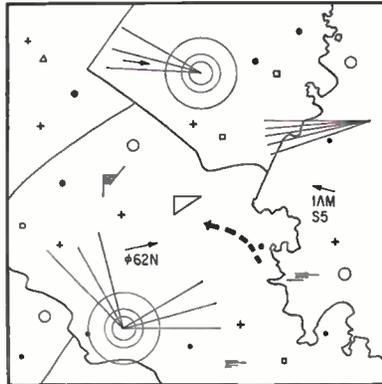
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SINGLE element display with storage



TYPICAL situation display shows coastline, radar stations, airfields, and armament centers. Vectors represent moving aircraft or missiles

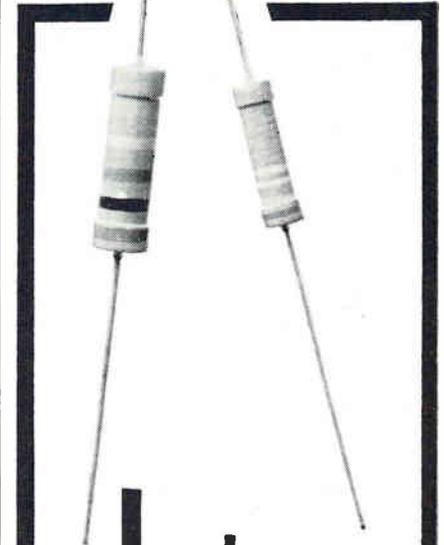
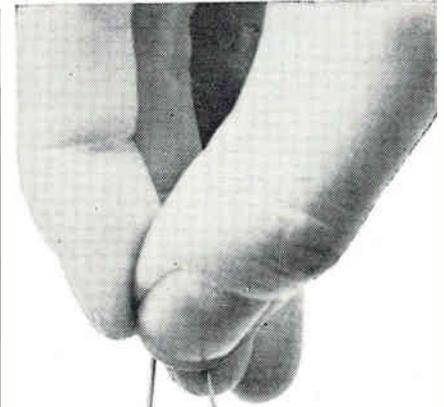
picture elements and 40,000 photoconductors per sq in.

The sensitivity of the photoconductors averages 6,000 microamperes per foot-candle. Polarizing voltage of 50 v d-c with an illumination of 1 foot-candle from a tungsten filament source, operates at 2,853 deg K.

The photoconductors may also be photoetched directly on the substrate to provide isolated junctions. Once deposited, the cells are not hygroscopic, and are said to have good surface hardness. Protective envelopes are not needed. This cuts the cost of fabricating a mosaic of cells. There is no need for hermetically sealing feedthrough for the lead wires.

One method looks promising for el displays. A storage would be provided on the display panel itself. A mosaic of photoconductors on the back of the panel would provide an el-pc latch. The photoconductor lowers its internal resistance when the picture element is excited by the x and y voltages. Current flows through the picture element, even though the selected electrical pulses have been removed.

The dark current characteristic



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I_b	70	mA

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of the cell is less than 0.0015 ma after removal, within 50 μ sec, of an illumination of 100 foot candles. Dark noise is less than 10^{-11} amperes. Beeh says that this is important in making decoding circuits using many cells.

The photoconductors operate within a range between -60 C and 150 C. Dark resistance is in the order of 800 megohms. Resistance under illumination can be as low as 4,000 ohms, depending upon application and intensity of illumination.

GHOST EFFECT — Suppression of illumination between the x and y drive lines has been a problem in el displays. Six x drive lines and eight y drive lines were selected in a 100-element-per-inch panel to show this effect, see photo. The ghost effect can be reduced using nonlinear resistive elements.

Layers of silicon carbide, cadmium sulphide, imbedded in epoxy, can be placed between the x and y electrodes. However, this approach increases voltage requirements. In higher-resolution panels, this can result in cross talk and uneven illumination.

Several other approaches are being considered at Photonetics to circumvent this problem.

The company is making available to industry, under development contracts, mosaics of photoconductors and electroluminescent panels. These are supplied with photoconductive wafers on isolated substrates to suit a variety of electrode geometrics.

Flexible Wire

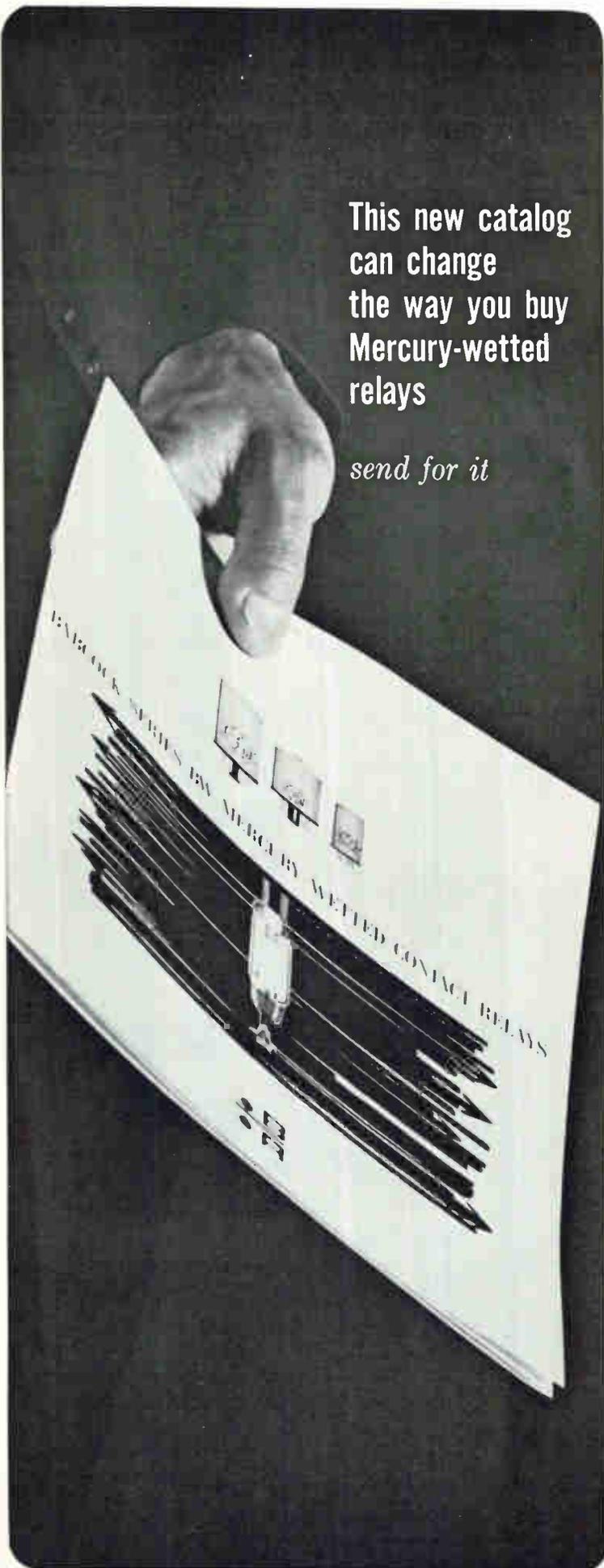
Takes 1,200 F

NUMBER 22 AWG wire, insulated with reconstituted muscovite mica, can take 1,200 F continuously. Exposed to 2,000 F for 15 minutes, wire withstands electrical tests at 600-v d-c.

Present demand is for miniaturized instrumentation and motor assemblies in space electronics. The wire is made by Rockbestos Wire and Cable Co., New Haven, Conn. Company says reinforced insulation gives complete flexibility, heat and radiation resistance, and no smoke during high current loads.

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Five models are available, each designed to meet specific applications.



Model BW-2: A single switch unit housed in a 1.234" steel container. Available in a wide range of single-side stable, bi-stable and chopper adjustments.



Model BW-3: Similar to the BW-2, but housed in a shorter steel container. Designed for use where mounting space is limited.



Model BW-4: A seven pin, miniature plug-in relay measuring only .625" (dia) x 1.891". Recommended for use in military and commercial applications where small size is a critical factor.



Model BW-5: Module form designed for printed circuit board applications. Plated steel enclosure can be grounded to provide both mechanical protection and magnetic shielding.



Model BW-6: Similar to the BW-5 but housed in an epoxy filled molded nylon enclosure for cooler operation. Recommended for applications where caustics and solvents are involved.

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Here's a completely solid state high-gain DC amplifier for only \$395. Exceptional reliability is achieved on low-level measurements with a specially designed photoconductive chopper and all-transistor circuitry.

The DY-2460A will supply an output of ± 10 v peak at 10 ma. Zero drift is less than $1 \mu\text{v}$ per week, noise less than $4 \mu\text{v}$ peak to peak. Fast settling time (as little as $25 \mu\text{s}$ to 0.01%) and rapid overload recovery (only $20 \mu\text{s}$, plus settling time) make the amplifier ideal for systems use.

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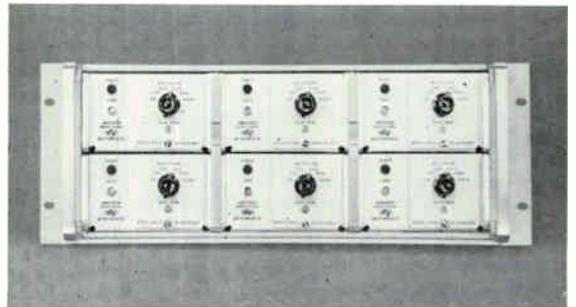
PRICE: DY-2460A Amplifier, \$395.00. DY-2461A-M1 Data Systems Plug-in, \$85.00. DY-2461A-M2 Bench-use Plug-in, \$125.00. DY-2461A-M3 Patch Unit Plug-in, \$75.00. DY-2461A-M4 Plus-one Gain Plug-in, \$35.00.

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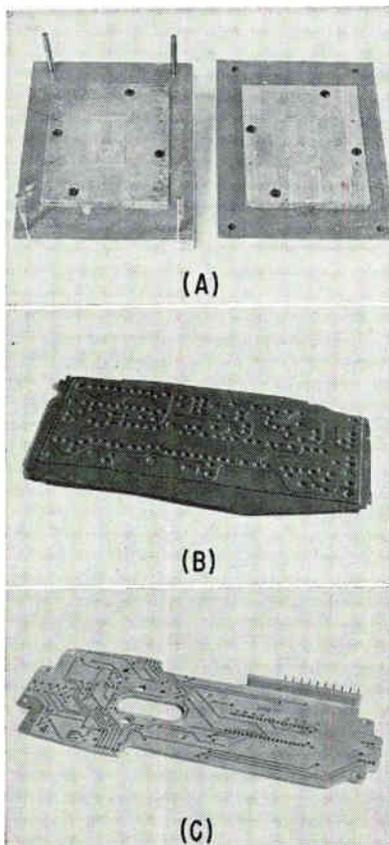


MOLDED BOARD is inspected by author Cichocki as it comes off molding press. Boards are made of glass-fiber-filled plastic

ETCHED MOLDS Form P-C Boards

By C. CICHOCKI and J. DILLON
Light Military Electronics Dept., G.E. Company, Utica, N.Y.

Cavities made by
photoengraving cut
costs and lead time



TYPICAL free flash mold commonly used for molded p-c boards (A). Molded board is shown before flash is removed (B). Note vertical riser produced by this process (C)

RELIABILITY and utility have spurred the use of molded printed-circuit boards. But a few years ago GE's Light Military Electronics Department had to face two major production drawbacks: potentially high tooling costs and long delivery cycles caused by the making of molds. Both of these were aggravated by the basic nature of the military market where small quantities and short delivery cycles prevail. Conventional mold-making techniques required a shop lead time of 2 or 3 months and a tool investment of \$3,000 to \$6,000 a mold.

LMED engineers have now developed a technique that quickly fabricates mold cavities by photo-printing and etching. This new mold-making process has reduced both mold cost and lead time enough to make molded circuit-board production economically feasible.

Compensation for board shrinkage

is easily made in setting up production. Reliability of connections through the board is improved because holes can be shaped by molding to improve the integrity and performance of electrical connections. The holes are electroplated.

MOLDS—Most often molds are of the free-flash design with a simple cavity configuration. Also used is the semi-positive mold, which restrains the flash by flow through a vertical channel before allowing it to flow horizontally. Multicavity molds 14 × 14 inches are now being used. Boards produced have thicknesses of 30 to 125 mils.

PROCEDURE—The DAIP (diallyl-iso-phthalate) molding material—a thermosetting alkyd resin plastic with a 40-percent filler of long glass fibers—is placed in the heated mold. After curing under pressure, the molded board is removed, de-flashed and oven-cured. This is followed by drilling to remove molding flash from holes, surface preparation and electroless deposition of thin copper. This deposition of electroless copper controls location of final

How Barden gained a 50% increase in cleaning capacity for precision bearings!



PROBLEM: Precision cleaning of assembled ball bearings for instruments used to be a time-consuming operation for the Barden Corporation, Danbury, Connecticut. Bearings up to 1" diameter went through a spray-cleaning machine at a relatively low production rate. Larger bearings were individually spray-cleaned.

SOLUTION: A new cleaning system based on an ultrasonic bath of FREON fluorocarbon solvent coupled with spray cleaning. FREON is a *selective* solvent in that it effectively removes dirt, yet has no effect on critical steel, bronze, plastic and fiber components of these bearings. Ultrasonic action combined with the extremely low surface tension of FREON digs contaminants out of the tiniest crevices. Result: Barden now cleans completely assembled bearings *in batches of hundreds*. Over-all cleaning capacity is up 50%!

And Barden reports that FREON solvents give them *better cleaning quality*. Particle count is 15% lower than before, which is a significant drop because the count was very low to start with.

Barden also points out that FREON dries quickly and leaves no residue, and that its very low toxicity and nonflammability let them operate without expensive ventilating equipment. They've found the new system economical to use, because FREON can be recovered in simple equipment—for reuse over and over again.

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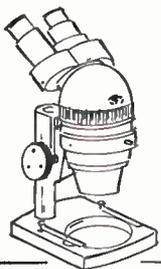
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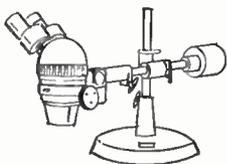
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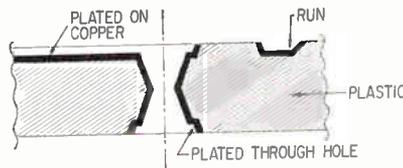
Elgeet OPTICAL COMPANY, INC.,
303 Child Street, Rochester 11, N.Y.

plating by electrolysis.

Rapid curing property of DAIP caused board-warping problems as variations above 0.015 inch per running inch are not tolerated. Chill blocks, heavy metal plates above and below molded boards, are used for cooling the hot board during the molding operation and is followed by post curing in ovens to stabilize board flatness. Cure completion is controlled by board surface hardness measurement after baking. However, this test is dependent on the constancy of molding plasticizer used in DAIP by vendors.

To counteract shrinkage, compensation is made in artwork used for the photoengraving process. This compensation is regulated so that after the board is removed from the mold, it shrinks to design dimensions.

A 50-percent overcharge of DAIP material in the mold is used to assure proper plastic flow to accommodate changes in circuit configurations and densities. This assures adequate quantity of DAIP for a given mold, despite normal process and material variations. Rec-



CROSS SECTION of the hour-glass shaped molded hole. Electroless deposition of thin layer of copper makes possible final electroplating of conductive surfaces

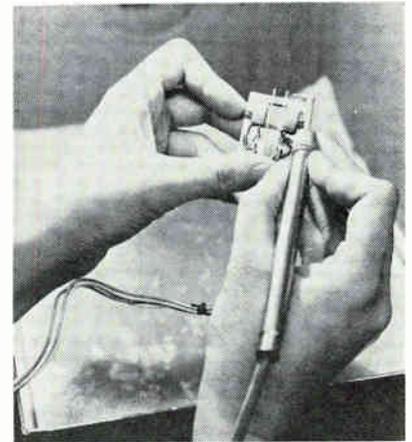
tangular bar preforms of DAIP have substantially reduced problems due to storage and lot-to-lot variability.

To eliminate small voids or porosities found occasionally in boards, minor adjustments are made in molding pressures and temperature.

KEY—DAIP material has been a key to process success. It is high-performance material with an impact strength of 9 ft lbs per inch notch, important in withstanding shocks. Heat distortion point of 490 F is good for limited dissipation available in process. It is resistant to organic solvents used during electroless copper deposition. Its arc resistance is 180 seconds.

Abrasive Powder Improves Tuning Fork Tuning

TUNING FORKS are now adjusted and balanced at Melpar's Special Products division by abrading the fork tines with gas-propelled alumina powder. The forks are tuned to accuracies of ± 10 parts per million while the operator monitors



NOZZLE directs fine abrasive at workpiece. Dust is removed from work area by custom-designed dust collector

fork performance with an oscilloscope and counter.

The tuning tool is an S.S. White Industrial Airabrasive unit. The nozzle projects the abrasive (S.S. White #1 aluminum-oxide powder at a flow of 10 gpm) from a distance of about 1 inch from the fork tines.

Among the reported advantages are: because of the fine cutting action of the powder, tines are rarely overcut (overcutting requires balancing of the other tine, which changes fork frequency and slows the process); the tool is not electrical, so cannot generate interference that would affect the monitoring instruments; since the tool does not contact the tine, stresses which could distort frequency are not set up in the fork's nickel-steel alloy; heat is removed by the gas stream.

Melpar had been using an electric grinder to trim the tines.

Cryopump Is Small But Evacuates Quickly

CRYOGENIC PUMP, capable of running 10,000 years at 10^{-8} torr before it would have to be purged of



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AC or DC Transducer outputs

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FOR AC-EXCITED TRANSDUCERS such as DT's, strain gage bridges and variable reluctance units, Sanborn offers single- to 8-channel Carrier Amplifiers for rack, cabinet or portable case mounting; Phase-Sensitive Demodulator Amplifiers, Accelerometer and Integrating Amplifiers; compact, low-cost 28 VDC or 115 VAC Transducer Converters for carrier excitation and signal demodulation of DT-type transducers; and 115 VAC or battery-operated portable Transducer Amplifier/Indicators providing transducer excitation, signal amplification and panel meter readout.

FOR DC-EXCITED TRANSDUCERS such as thermocouples, DC strain gages, DC tachometers, Sanborn "LVsyn" linear velocity and Series 7 DCDT linear displacement units, Sanborn makes 15 different signal-conditioning amplifiers. Straight DC, DC Coupling, Low Level and Stabilized DC types are each available in three *different* amplifier Series. For DC-10 KC and DC-100 cps differential amplification with floating input isolated from floating output, or DC-50 KC, 3-terminal floating amplification, the new solid-state, miniaturized "860" Series provides high performance in a compact highly reliable package. *Talk over your AC or DC transducer instrumentation problems now with your Sanborn Sales-Engineering Representative. He can supply valuable experience, complete information and the reliable equipment you need. Or write*

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CIRCLE 111 ON READER SERVICE CARD

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Measures 300 μ V to 3 V
from 0.1 Mc to 1,000 Mc

Measures True-RMS regardless of Waveform and Voltage

High, Uniform Accuracy and Resolution over entire 5-inch scale



Ballantine's new Model 340 is an extremely sensitive RF millivoltmeter designed for accurate True-RMS measurements with high resolution. Its 5-inch voltage scale spreads out the readings logarithmically so that you can make measurements to the same high resolution and accuracy at the bottom as at full scale. This advantage means that you can not only measure voltages accurately, regardless of waveform, but also calibrate the 340 using a signal source that may be far from sinusoidal. The new 340 is now available in both portable and rack versions.

SPECIFICATIONS

Voltage Range..... 300 μ V to 3 V	Crest Factor..... 100 to 3 depending on voltage range
Frequency Range..... 0.1 Mc to >1,000 Mc; calibrated to 700 Mc	Scales..... Two logarithmic voltage scales, 0.95 to 3.3 and 3.0 to 10.6. One decibel scale, 0 to 10
Indication..... True-RMS on all ranges, all voltages	Mean Square DC Output... 0.1 V to 1.0 V dc. Internal resistance 20 kilohms. (For connection to recorder.)
Accuracy...% of Reading	
0.1 Mc — 100 Mc, 4%;	
100 Mc — 700 Mc, 10%;	
above 700 Mc as sensitive indicator	

*Accessories include a probe tip for in-circuit measurements, an adapter for connection to N or BNC, a T adapter for connection to a 50 ohm line, and a 40 db attenuator

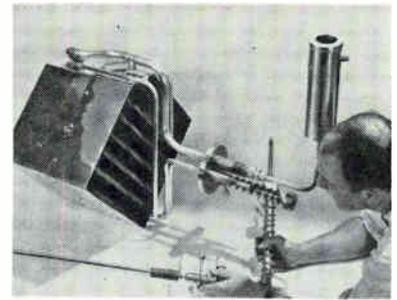
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CRYOGENIC PUMP removes gases by condensation on cryogenic surfaces

absorbed gases has been developed for space simulation, thin film applications and fundamental research according to the National Research Corporation, Newton, Massachusetts.

Pumping speed of this unit is 8,000 to 17,000 liters per second for nitrogen and oxygen, 6,000 to 15,000 liters per second for argon and 100,000 liters per second for water vapor.

Operating costs are approximately \$4 to \$5 per hour for use with a liquid helium dewar.

OPERATION—Basically this cryopump is a box measuring 12 × 15 × 15 inches with helium cooled surfaces. The pumping action is due to the fact that cryogenic surfaces remove gases by condensation. Operation is at temperatures below 25 degrees K. These helium-cooled surfaces are shrouded with liquid nitrogen-cooled chevrons that shield the main pumping area from the warmer surrounding atmosphere. Two flanges are provided so the pump may be used when helium is supplied from a storage dewar or to allow the pump to be coupled to a closed cycle refrigerator.

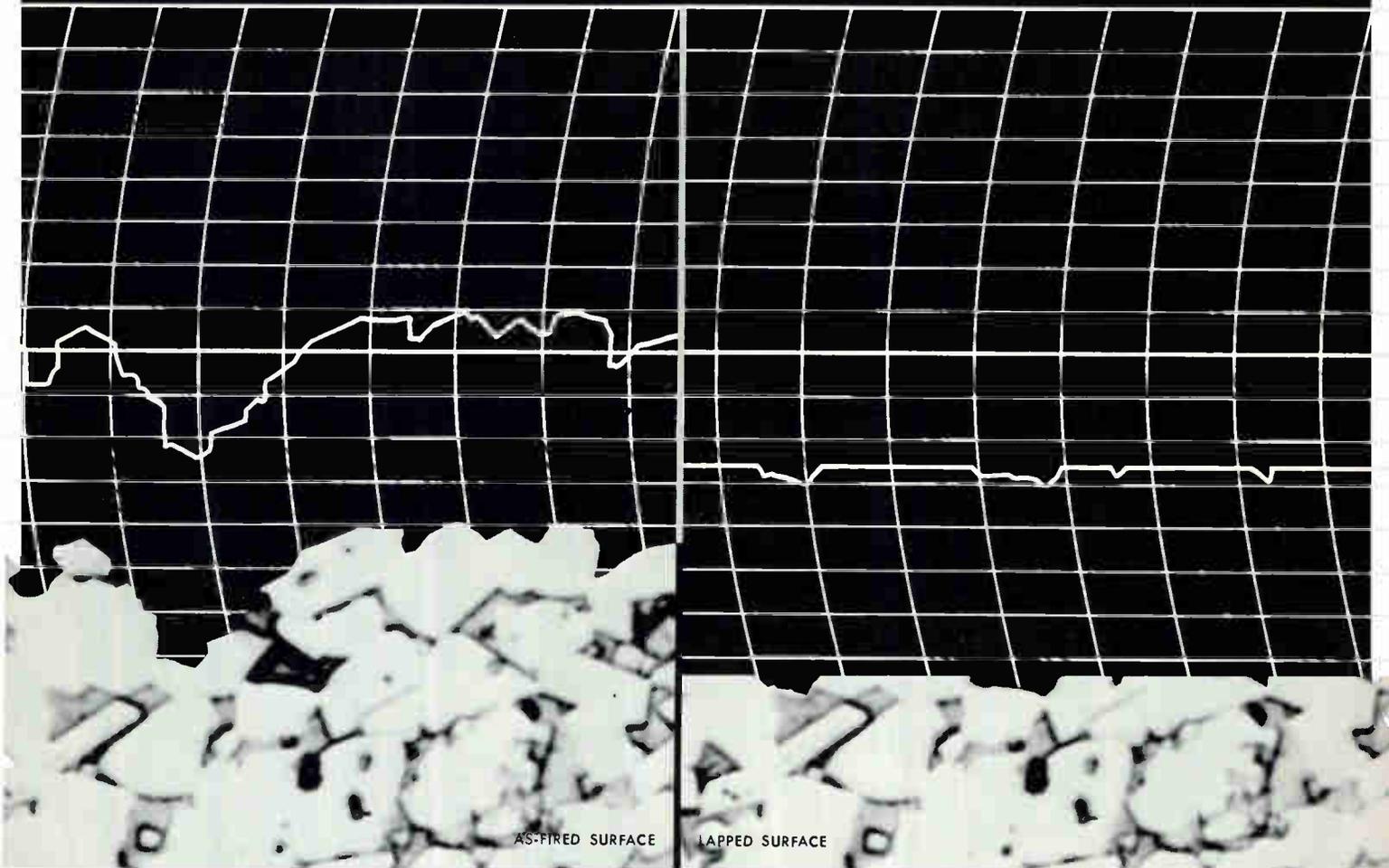
New Tool Solves

Cable Lacing Problems

UNIQUE hand held cable-lacer is being used at Seeburg Corporation, Chicago, to resolve production problems in lacing cable harnesses. This inexpensive device supplied by Gudebrod Brothers Silk Company is completely mechanical and requires no electrical power.

Functioning as a simple extension of the worker's hands, it performs all the intricate steps of the

Turning Mountains Into Molehills



AS-FIRED SURFACE

LAPPED SURFACE

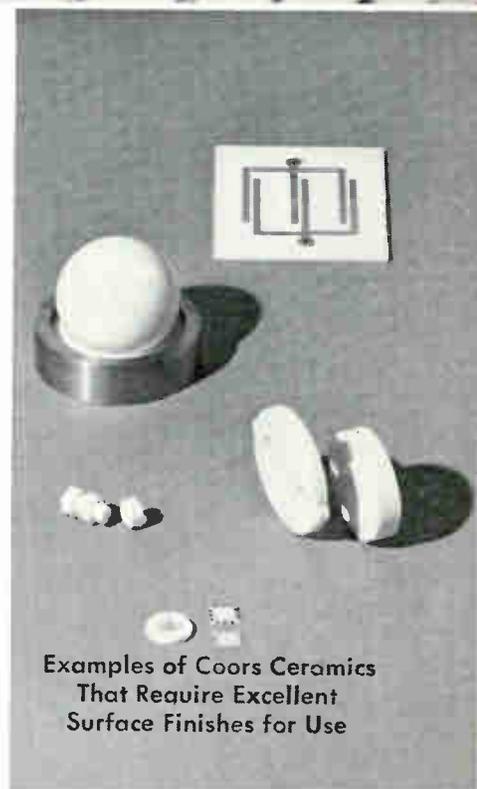
Photomicrographs: 3000x

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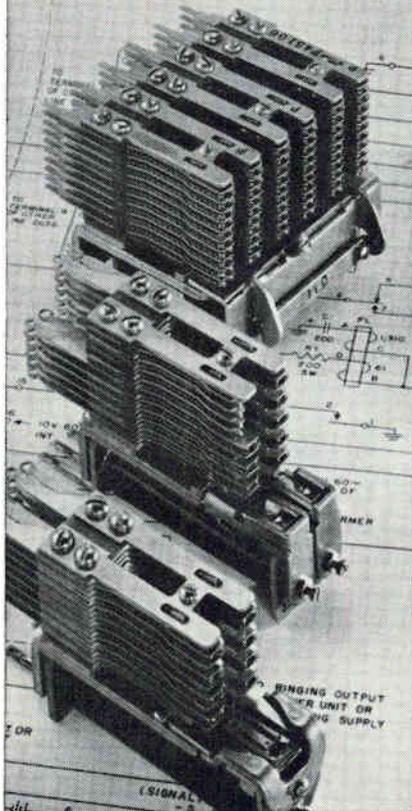
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Type A: general-purpose relay. Up to 20 Form "A" spring combinations.

Type B: multi-contact relay. Up to 60 Form "A" spring combinations.

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All standard spring combinations are available in these telephone-quality relays. For complete technical data and details on special features, write to Industrial Sales Department.

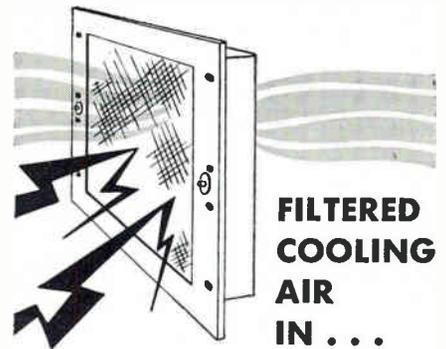
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knotting operation with consistent speed and efficiency. Physical abuse to the hands of the worker is absorbed by the lacer. Operators have exhibited measurably greater skill and higher morale, says Gudebrod.

DESCRIPTION—Lacer is of all-metal construction and has a torpedo-shaped body six inches in length. An extended lacing hook is from 2 to 4 inches long. This hook is formed to suit specialized harnessing needs. A guide shaft is provided within the cylindrical body for loading of a 60-ft. spool of nylon tape. The free end of the tape is fed up and out through a slot in the outer shell, then down through a guide hole provided in a cap in the base. Flow of the tape, as it unwinds from the spool, is regulated by a simple lever, parallel to and running the length of the lacer cylinder. This lever, called a cord grip handle, is easily compressed by light hand pressure and provides an instantaneous automatic stop for the tape whenever required.

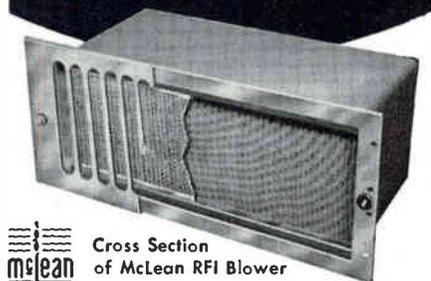
OPERATION—In the lacing operation the cord is first tied to the cable. The left hand is used to form a loop with the tape above the cable and is held there while the lower dangling part of the loop is engaged with the lacer's extended hook. With the tape being fed continuously from the bottom of the lacer, a second loop is formed on the side of the cable opposite the first, hand-held loop. Once this new loop has been made, the hook of the lacer is disengaged from it, and it is allowed to slide downward over the hook toward the lacer body. Then, with the handle compressed so no additional tape can be fed, the lacer is passed, completely through both loops to form the knot. Final position and tightness of the knot can be regulated to any desired degree through simple manipulation of the lacer. The tie cord handle is compressed in every case to insure tautness.

It is in the actual tying and tightening of the knot that the lacer has proven of most benefit, Gudebrod says. With the protection and control offered by the lacer body and its stop, knots of extreme firmness, and tightness can be tied.



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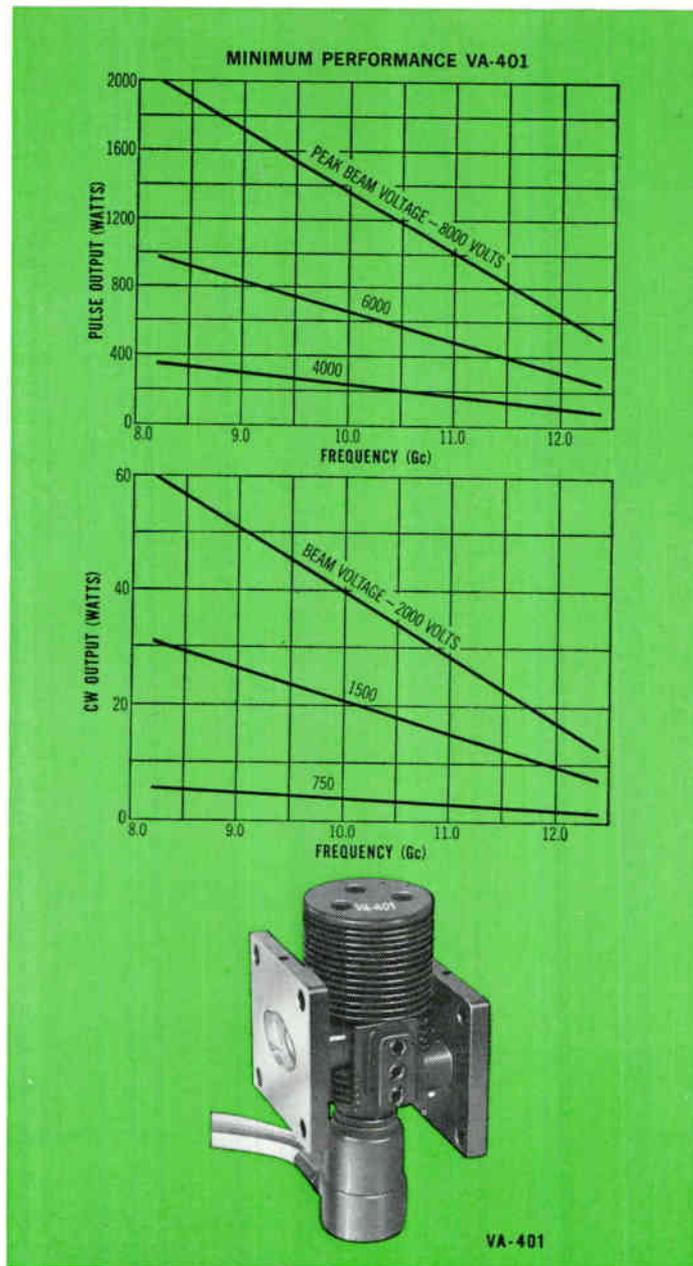
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Varian's new VA-401 klystron can operate either as a pulse or CW amplifier at any fixed frequency selected between 8.2 and 12.4 Gc. Exceptional design permits this tube to be operated at various power levels by using the appropriate beam voltage. ■ This electrostatically-focused three-cavity tube will deliver at least 500 watts in pulse service and 10 watts CW at the high-frequency end of the operating range. As shown in the graphs above, the output at the low-frequency end of the range is several times greater. This tube is an excellent choice for airborne CW radar, doppler navigation, multichannel parametric amplifier pumping, or synchrodyne systems. Typical gain, 30 db. Weight, 13 ozs. Write for more information.



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CIRCLE 211 ON READER SERVICE CARD



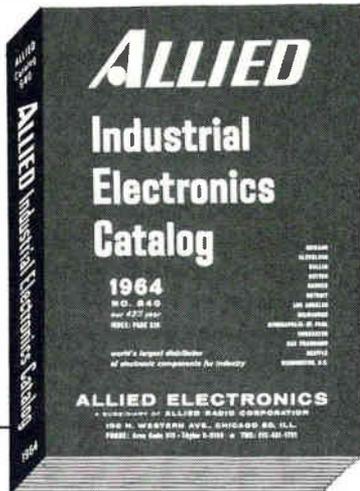
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Output	6.2 vdc ± 5% fixed at 10 ma constant load
Output ripple	1 mv p-p
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a Line stability	.01% over 105-130 vac input (less than .001% per volt of input change)
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b Shunt capacitance from dc output to ground	20 pf
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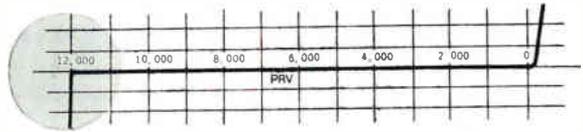
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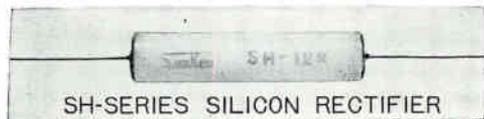
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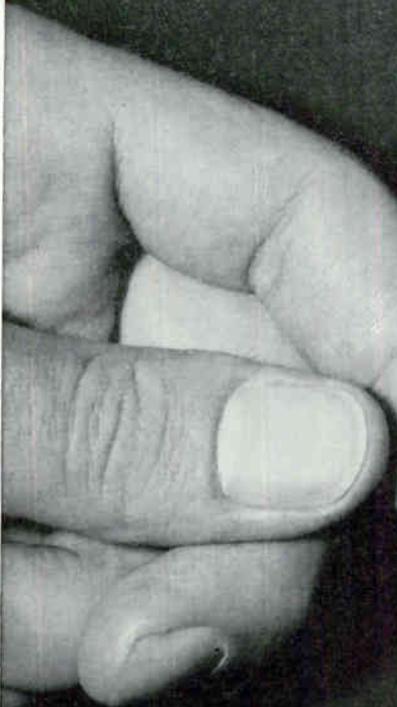
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SEPTEMBER 6, 1963 • electronics

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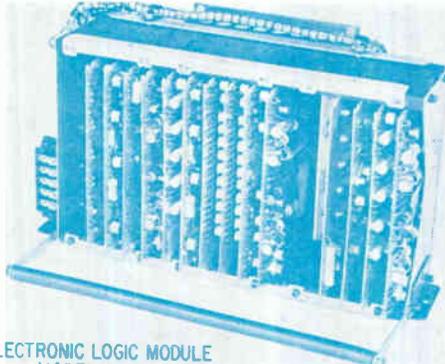
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High-Speed Solid-State Printer

Unit can provide
10,000 word-per-minute
line at a time printing

INTRODUCED by Kleinschmidt Div., Smith-Corona Marchant Inc., Deerfield, Illinois, Model 311 high-speed electronic data printer is designed for operation in communication or data processing systems and permits transmission and reception of 5, 6, 7 or 8 level codes. The printer operates at speeds of 40 character-per-second using sequential or parallel signaling and contains a type drum with 64 characters around its periphery. The unit's all-transistor electronic logic module provides for 14 plug-in boards, though most conventional applications require only 9. The additional 5 boards can provide operation or control features such as character selection and answer back. The en-



ELECTRONIC LOGIC MODULE
MODEL 311



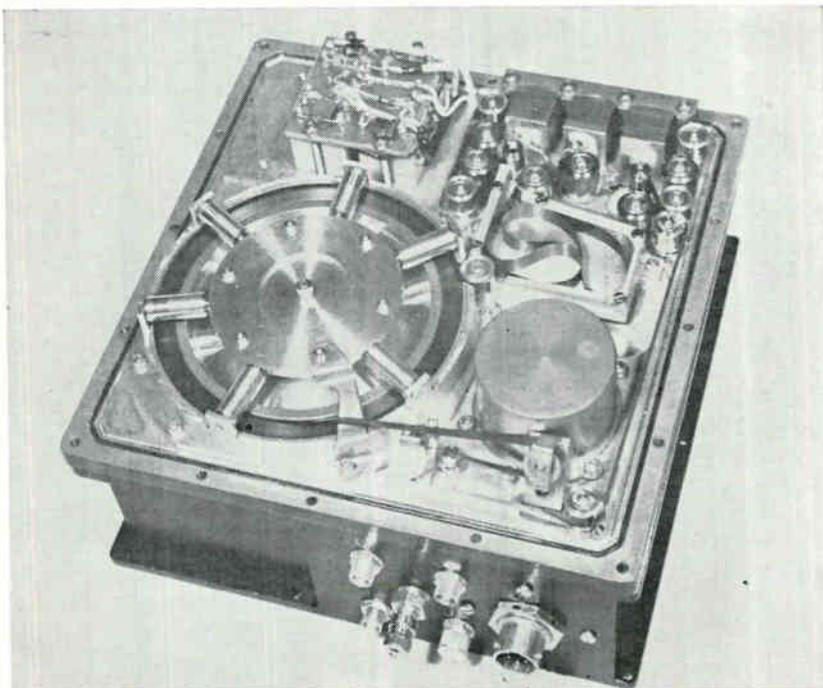
tire logic module, which normally mounts on the rear of the printer, may be positioned remotely to permit a variety of installations.

According to the manufacturer, the model 311 is the first teleprinter capable of handling both standard 60 to 100 word per minute direct-wire communications as well as input and output for computers requiring high-speed (10,000 wpm) line-at-a-time printing. Moreover,

the device requires only 25 percent of the moving parts found in conventional electromechanical printers without solid-state electronics and modular construction. Use of electronic rather than mechanical character selection permits receipt of incoming signals with as much as 45-percent distortion without error. Model 311 is self contained and weighs only 55 pounds.

CIRCLE 301, READER SERVICE CARD

Recorder Withstands 100-G Acceleration



DESIGNED specifically to obtain accurate data during missile re-entry, launch and other difficult environments, model R-304 recorder has proved capable of operation with low wow and flutter during tests at a sustained acceleration of 100 G. According to the manufacturer, Borg-Warner Controls, Santa Ana, Calif., the device is a continuous-loop unit with a capacity of 300 feet of ¼-inch magnetic tape. Moreover, the use of a Moebius loop permits a recording length of 600 feet with up to four data channels. Three magnetic heads provide record, reproduce and erase functions.

Model R-304 has tape speeds of 7.5 and 30 inches per second and can be provided with other speeds with minor modifications. Control of tape speed is within 0.1 percent.

Cornered by PW Assembly Problems?



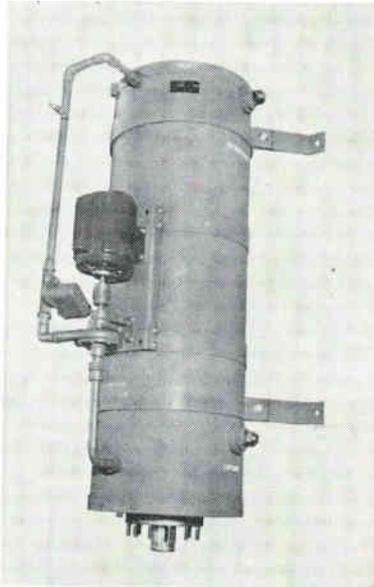
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Discover how automatic inserting equipment can open new ways to profit for you. This is modern, automated component insertion. Even if your production is as little as a few hundred insertions a week, Dynasert delivers a multitude of advantages. It's high-speed: up to ten times faster than costly hand methods. It delivers uniformly high product quality. It automatically feeds, cuts, and bends leads, inserts and clinches all types of axial lead components. Requires little operator training. Changes made from one board or component type in seconds. Money saved in direct labor costs and production time can pay for a Dynasert installation in less than a year. Get complete facts. Write for a free copy of: Dynasert — Production Equipment for Electronics. Dynasert Dept. 3, United Shoe Machinery Corp., Boston, Massachusetts.



United Shoe Machinery
BOSTON, MASSACHUSETTS

at any given temperature and within 0.5 percent over a wide temperature range. Speed control is achieved by means of an electronic servo system, while Mylar drive and pinch belts assure long transport life. The recorder has wow and flutter below 0.5 percent rms under severe operational conditions and consumes between 4 and 20 watts of power at an operating voltage of 28 volts d-c ± 4 volts. Furthermore, it meets RFI specs of MIL-I-26600 and weighs between 7 and 9 lb depending upon service requirements. CIRCLE 302, READER SERVICE CARD



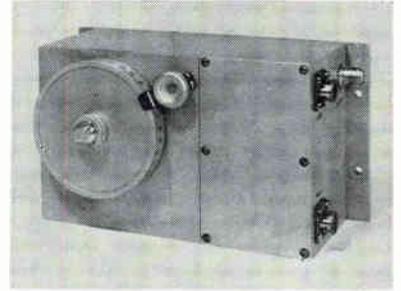
Dummy Load Dissipates 100 KW

ANNOUNCED by Electro Impulse Laboratory, 208 River Street, Red Bank, New Jersey, r-f termination will dissipate 100,000 watts between d-c and 1,000 Mc. Unit consists of an oil-filled resistor and an oil to water heat exchanger. Oil is circulated between the dummy load and the exchanger by a circulating pump and tap or sea water running through the exchanger carries away the heat. Since water is used only in the secondary cooling system, any type of water may be used in the load. Price is \$4,500. (303)

Phase-Shift Modules Are Lossless

MANUFACTURED by Nilsen Manufacturing Co., P. O. Box 127,

Haines City, Fla., new series of phase-shifting modules can be used for continuously shifting the phase angle of an r-f signal between 0 and 360 degrees without insertion loss. Called the Varigon series V-56A, units contain electrostatic phase



shifters with phase-splitting networks and transistor circuits that isolate and amplify phase-shifted signals. A special capacitor makes shifting possible without brushes and the units can be produced for any specified frequency and dialed manually or driven at speeds to 5,500 rpm. Moreover, they can be used to produce continuous time delays or phase variation directly proportional to dial rotation. Functional characteristics of a typical module at a frequency of 500 kc are: insertion loss of zero, 50-ohm input and output impedance, 1.1:1 typical vswr, infinite resolution and 0.5-volt rms input amplitude. Units have application in radar ranging, sine and cosine generators, frequency modulators, frequency changers, rotary-position indicators and phase-meter instruments. Series V-56A modules weigh about 4¾ pounds and are priced at \$822.90 each. (304)

Instrument Measures Leakage to 1 Nanoamp

MARKETED by Texas Instruments, Inc., 3609 Buffalo Speedway, Houston, Texas, low-current unit for use with the company's transistor and component tester (TACT) makes rapid, fully-automatic current measurements from 0.999 ma through 999 picoamperes. Device provides full-scale accuracy of 0.5 percent with picoampere resolution. Total ranging speed for 6 decades is less than 2 seconds. Low-current testing



Toughened to live with a nuclear neighbor

This is Leach's newest Satellite Tape Recorder. It is built to resist the radiation from SNAP-10A (System for Nuclear Auxiliary Power).

A two channel, miniature, hermetically sealed recorder, Model 2200 was tested this year during the development program at the Nuclear Aerospace Reactor Facility in Forth Worth. The final results tell the story—the complete recorder was successfully irradiated to the ultimate design goals—a radiation dose of 1×10^{13} neutrons/cm² and 1×10^8 carbon rads.

Capable of recording up to 136.2 minutes of DC to 128 cps square wave data, this nuclear-hardened satellite tape recorder weighs a mere 10.5 pounds and takes up only 304 cubic inches of space.

Other Leach Satellite Recorder/Reproducers, hardened for operation in the Van Allen Belt, are now in orbit.

They're storing quantities of data and playing that data back when and where it's needed. Soon this newest member of the Leach recorder family will also be in space...operating in a radiation environment near a nuclear reactor!

Leach is a leader in developing nuclear-resistant telemetry equipment and relays of all sorts. We'll be glad to share our findings with you. A collect call or letter to Leach is a good place to start.

LEACH
CORPORATION

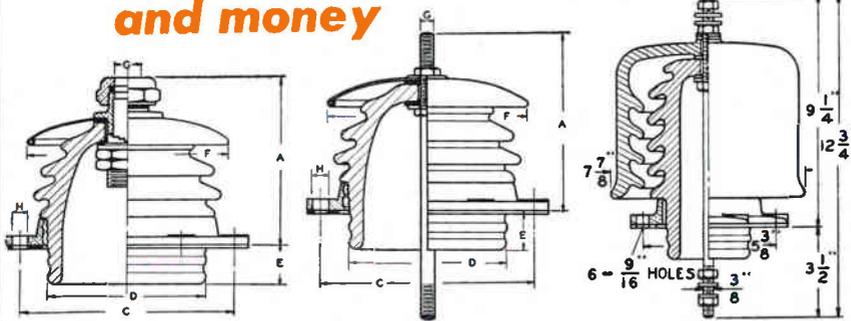
CONTROLS DIVISION

717 N. Coney Ave.
Azusa, California • Phone 334-8211
Export: Leach International S. A.

LAPP HEAVY-DUTY ENTRANCE INSULATORS



**...in all these standard sizes
to save you time
and money**



TYPE A
Permits use of continuous pipe conductor through the insulator.

TYPE B
Stud secured to porcelain bowl.

TYPE C—NO. 11896
Similar to Type B, but with porcelain hood added.

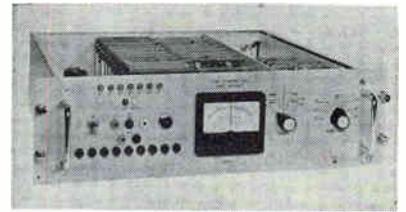
DIMENSIONS IN INCHES—FLASHOVER AND RADIO RATINGS

Catalog Number	Type	A	C	D*	E	F	G	H	DRY FO 60 ⁰⁰ kv eff.	Radio Rating kv eff.
10030	A	12 $\frac{3}{4}$	14 $\frac{5}{8}$	12 $\frac{1}{2}$	1	16	2 Max.**	$\frac{3}{8}$	80	16
9553	A	10 $\frac{1}{2}$	12	9 $\frac{3}{4}$	2 $\frac{1}{2}$	16	1 $\frac{1}{2}$ Max.**	$\frac{3}{8}$	70	12
9554	A	7 $\frac{1}{8}$	9	7 $\frac{1}{2}$	2	9 $\frac{3}{4}$	1 $\frac{1}{2}$ Max.**	$\frac{3}{8}$	55	8
22913	A	6 $\frac{3}{8}$	7 $\frac{3}{4}$	6 $\frac{1}{2}$	1 $\frac{1}{2}$	7 $\frac{1}{4}$	1 Max.**	$\frac{3}{8}$	45	9 $\frac{1}{2}$
7321	B	12 $\frac{1}{2}$	14 $\frac{5}{8}$	12 $\frac{1}{2}$	1 $\frac{1}{2}$	13 $\frac{3}{8}$	$\frac{3}{4}$	$\frac{1}{8}$	80	16
5363	B	10 $\frac{3}{8}$	12	9 $\frac{3}{4}$	2 $\frac{1}{2}$	16	$\frac{3}{4}$	$\frac{3}{8}$	70	12
8141	B	6 $\frac{1}{2}$	7 $\frac{3}{4}$	6 $\frac{1}{2}$	1 $\frac{1}{2}$	7 $\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	45	9 $\frac{1}{2}$
22611	B	8 $\frac{3}{4}$	5 $\frac{3}{8}$	4 $\frac{1}{4}$	1 $\frac{1}{2}$	8 $\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$	55	9 $\frac{1}{2}$
10300	B	6 $\frac{1}{2}$	5 $\frac{3}{8}$	4 $\frac{1}{4}$	1 $\frac{1}{2}$	5 $\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	45	8

*D is mounting hole diameter.
**Always specify outside diameter of conductor.



WRITE for Bulletin 301-R.
Lapp Insulator Co., Inc.,
208 Sumner Street, LeRoy, N. Y.



is automatically performed when called for by prepunched card programming used to assure absolute repeatability. Readout for all tests is either by an in-line visual unit and one of several printers or card-punch devices.

The low-current unit has seven full-scale ranges from 10^{-3} amps to 10^{-9} amps, accuracy of ± 1 percent or ± 0.5 percent of full scale depending upon which is greater, speed for automatic ranging and stabilization to the most sensitive range of 1.5 seconds, fixed range stabilization speed of 380 millisecc and output of ± 1 volt d-c for full-scale reading, or panel-meter indication. The device is basically a capacitance - modulated summing amplifier with ranges selected by connecting feedback resistors between 1,000 ohms and 1,000 megohms between the amplifier output and the summing point. Resistors are switched by means of low-leakage reed relays that can be operated manually, remotely or automatically.

CIRCLE 305, READER SERVICE CARD



Decimal Computer Displays 8-Place Data

MODEL 123 decimal display computer provides decimal format conversion of 10 to 24 bit serial or parallel binary data. Eight-place decimal data is visually displayed and BCD and decimal outputs are provided for external recording. Unit accepts either positive or negative logic, variable-amplitude inputs and is capable of being programmed to permit automatic scaling of fractional, integer, or linear scale fac-

WORKHORSE

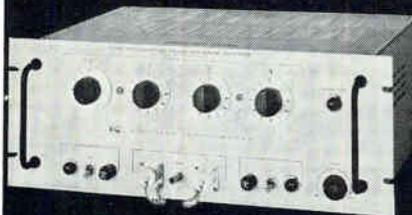


Downtime's nemesis, rugged and reliable as a purebred workhorse—that's Mincom. Common denominator of dependability in all four basic Mincom Recorder/Reproducers is the exclusive Mincom DC Top Plate. Here's a tape transport built with beautiful simplicity: Only 12 moving parts with four easy adjustments, full dynamic braking, instant six-speed pushbutton control, seven or fourteen tracks—plus tape speed accuracy within $\pm 0.005\%$ using Mincom's Cyclelock®. Whether your specifications call for wideband predetection at 1.5 mc, or a comfortable 120 kc at 60 ips, there's a reliable Mincom workhorse to meet your facility's needs. Write today for details.

Mincom Division **3M**
COMPANY

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425 13th Street N.W., Washington 4, D.C.

Stable to 0.01%
... Indefinitely



**NEW KEITHLEY
 3500V D. C. SUPPLY**

The extreme stability of the Model 242 is not specified in hours. Now—over several months—you can perform extended duration measurements. Cumulative drift of this regulated supply is prevented by a self-correcting feedback loop featuring a temperature compensated zener diode reference, photo-chopper comparator and wire wound sampling resistors. 300 V to 3500 V are delivered at 25 ma, with less than 1 mv combined ripple and noise—ideal for photo tube, photo multiplier and electron multiplier applications. Other specifications contributing to the outstanding value of the Keithley 242 are shown below.

- **output:** 300 to 3,500 V at 25 ma in 1 volt steps—plus, minus, or floating to 4500 V
- **stability:** 0.01% indefinitely, after 30 minute warm-up
- **accuracy:** $\pm 0.1\%$
- **ripple and noise:** Less than 1.0 millivolt rms
- **line regulation:** 0.005% for 10% change in line voltage
- **load regulation:** 0.005% from zero to full load
- **overload protection:** Automatic disconnect if current exceeds 27 ma
- **price:** \$850

Other Regulated DC Supplies

Model 241, 0-1000 V, 0.05% accuracy \$800
 Model 240, 0-1000 V, 1.0% accuracy \$345

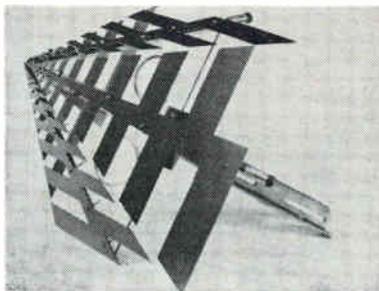
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**KEITHLEY
 INSTRUMENTS**

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tors. Missouri Research Laboratories, Inc., 2109 Locust Street, St. Louis 3, Missouri.
 CIRCLE 306, READER SERVICE CARD



**Log Periodic Feeds
 Have Dual Polarization**

DUAL polarized log periodic feeds have vswr of 2:1 maximum and minimum crosstalk of 20 db. The units employ broadband, trapezoidal-tooth, log periodic elements and can be used with a variety of paraboloidal reflectors to achieve excellent gain, beamwidth and side-lobe performance. Model 95690 operates in the 800 Mc to 2.2 Gc range while model 96410 operates between 400 Mc and 2.0 Gc. Other models are available for operation down to 80 Mc and up to 4.0 Gc. Kennedy Antenna Division, 155 King Street, Cohasset, Massachusetts. (307)

**Wirewound Potentiometer
 Is Radiation Resistant**

MINIATURE wirewound potentiometer, which operates efficiently at extremely high temperatures and in radiation environments, has been developed. Bourns model 3040 is encased in the established TRIMPOT® Rectangular configuration and operates to 350 C with a power rating of 5 watts at 70 C. Unit will function satisfactorily in radiation environments of high flux dosage—150 megarad total gamma radiation and fast neutron radiation of $5 \times 10^{15}n/cm^2$. Model 3040 will successfully withstand bombardments of high-energy particles from nuclear explosions or from outer-space environments such as the Van Allen belt. Specifications include: resistance range of 500 to 20K ohms; resistance tolerance of $\pm 10\%$; operating temperature range from -65 to $+350$ C; shock

**With Hart Series W:
 More Relay**



... 25 amps!

CONTACT RATINGS

- | | |
|-----------------|------------------------------|
| 25 A resistive | 120 V a-c or 240 V a-c |
| 25 A inductive | (75% power factor) 120 V a-c |
| 12½ A inductive | (75% power factor) 240 V a-c |
| 1 HP | 120 V a-c (96A locked rotor) |
| 2 HP | 240 V a-c (72A locked rotor) |
| 25 A resistive | 24 V d-c |

Low Cost, Easy to Mount



For more information on these compact, dependable, general-purpose relays, write for Bulletin WU-09 which gives complete data, specifications, applications and illustrations.



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 MANUFACTURING CO.

202 BARTHOLOMEW AVENUE
 HARTFORD 1, CONNECTICUT
 Telephone: Area Code 203: 525-3491
 A SUBSIDIARY OF OAK MANUFACTURING CO.

Model
7 DCDT-050
transducer



**MEASURE
DISPLACEMENTS**
of $\pm 0.050''$ to $\pm 3''$ with
**6 VDC EXCITATION,
DC OUTPUT**

Now you can have all differential transformer transducer advantages in linear displacement measurements — without external carrier systems or phase shift and balancing problems. Sanborn 7 DCDT Series are miniature, hermetically sealed units with carrier systems built-in. Features include unlimited resolution, high accuracy and high sensitivity. Delivery from stock. Modifications available on special order.

MODEL	FULL SCALE STROKE (inches)	FULL SCALE OUTPUT (VDC)	OUTPUT IMPED. (K ohms)	FREQ. RESP. (3 db down at cps)	PRICE (FOB Waltham, Mass.)
7 DCDT-050	± 0.050	± 1.5	2.2	350	\$ 99
-100	± 0.100	± 2.8	3.0	170	104
-250	± 0.250	± 1.5	5.0	120	119
-500	± 0.500	± 3.3	5.3	135	132
-1000	± 1.000	± 4.8	5.5	114	141
-2000	± 2.000	± 4.6	5.2	128	155
-3000	± 3.000	± 5.0	5.0	100	162

TRANSducer DIVISION
SANBORN COMPANY
175 Wyman St., Waltham 54, Mass.

CIRCLE 214 ON READER SERVICE CARD

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The Worry Out Of Being Close**

Here is a sure way to eliminate waste space in electronic packaging... LEL-LINE Strip Type components are compatible, lightweight and compact... just right for reliable performance in close quarters. Hybrids, dividers, comparators, modulators, mixers, switches, attenuators or matched assemblies.

Need 'em fast? Quick Reaction Capability delivers one or all in jig time to do the job... they're LEL designed and manufactured too.



LEL-LINE Strip Type Low Pass Filters
FREQUENCY RANGE: 1000 to 5000 Mc

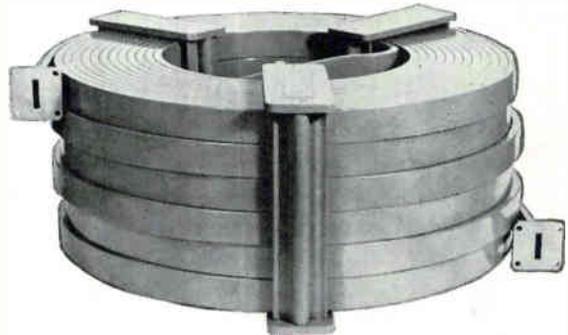
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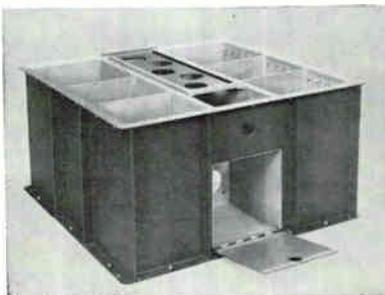
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CIRCLE 125 ON READER SERVICE CARD 125

ELECTRONICS ENGINEERS...EVALUATE THIS COIL... DELEVAN'S MOLDING TECHNIQUES OPEN NEW HORIZONS FOR **VARIABLE COILS**

Discover new reliability in molded variable coils. Eliminate the "weak link" in your system. Most variable coils (and transformers) are designed and built today exactly as they were 10 years ago. With the Delevan Molded "Variable," the state-of-the-art for variables is advanced to equality with all other reliable components. Available with either powdered iron or ferrite cores, each coil is designed for minimum capacity and optimum Q. Delevan is proud of this achievement in high-reliability programming.

SPECIFICATIONS: **SERIES 4000 MOLDED VARIABLE COILS**

- Size: 0.40" Diameter; 0.93" Molded Length
- Mounting: Chassis or Printed Circuit
- Inductance: .18 uh to 70,000 uh
- Environment: Grade 1, Class B, MIL-C-15305



Delevan Electronics Corporation

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Write for further information on these engineering kits today.

CIRCLE 126 ON READER SERVICE CARD

WANT TO DO BUSINESS WITH THE GOVERNMENT ????????

Then check the Military and Government Procurement Guide in the orange section of your **ELECTRONICS BUYERS' GUIDE**.

of 50 G and vibration of 20 G between 30-2000 cps. The unit weighs 0.25 ounce. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif. CIRCLE 308, READER SERVICE CARD



Pulse Energy Source Yields 10,000 Joules

SERIES 520 Joule Pac stores 1250 or 2500 joules of electrical energy and is continuously variable from 0 to 4 kv. Series 522 power supply can be used with any combination of up to four series 523 energy banks to produce a full 10,000 joules of stored energy. Originally designed as a pulsed energy source for the company's extensive range of high-power laser flash tubes, series 520 Joule Pac is a modular system that can be used in virtually any application where large pulses of energy are required. Safety interlocks are provided and the unit is also protected by a circuit breaker. The power supply module includes a jack for synchronous output and provision is made for manual or remote firing. Edgerton, Germeshausen and Grier, Inc., 170 Brookline Ave., Boston, Mass. (309)



Precision Drive Stresses Accuracy

SUBMINIATURE precision dual-speed drive occupies less than a 2-inch square of panel space and weighs 4 ounces complete with mounting hardware and servo component

WHAT MAKES AN INSTRUMENTATION CABLE FAIL?

It can pass inspection perfectly one minute and fail miserably the next. Simply manufacturing it to spec isn't good enough. Insurance against failure must be built into the cable at every step from diagram to installation.

Where can it go wrong? At almost any point not adequately safeguarded. Here are four of the most common trouble spots:

- (1) Incompatible Plasticizers
- (2) Filler Material
- (3) Component lay-factors
- (4) Shielding

INCOMPATIBLE PLASTICIZERS A unique form of chemical warfare within cable materials has fouled more than one missile program. Plasticizer materials have to be added to compounds to obtain the required flexibility. These additives are seldom compatible with each other. Incompatible plasticizers used in systems in contact with each other without control may attack each other with disastrous effects. (As a prime example, additives in low temperature neoprene jackets are not always compatible with the insulating materials.)

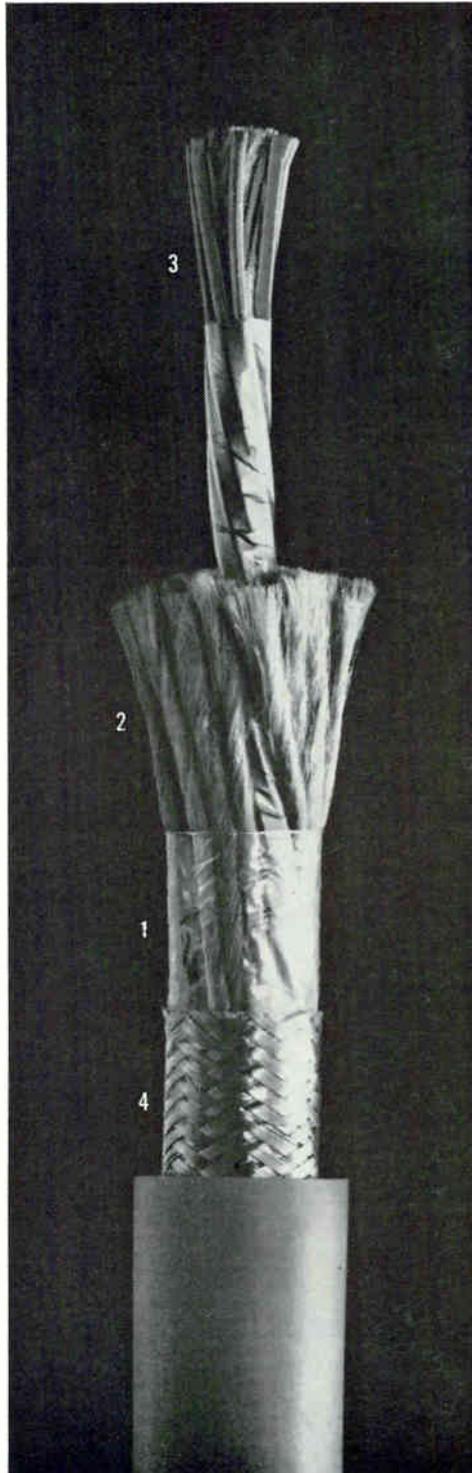
Manufacturers can control plasticizer migration problems by selecting proper materials and by using suitable barriers between components. Many specifications make the use of barrier material optional and a manufacturer whose only concern is price will leave it out.

Rome-Alcoa, as a result of its wide experience with materials, always uses barriers where migration could be a problem.

FILLER MATERIALS When spurious signals arrive at your display, recording or control panel, the fault could be in the improper selection of filler material. Compatibility between insulations and filler materials is of prime importance.

In the case of some plastics or rubbers, the material's "memory" can cause it to shrink disproportionately, creating undue stresses internally in the cable. This can cause kinking of the insulated conductors; electrical failures follow.

Only experience can tell a cable manufacturer how to compensate for "memory" and how to control compatibility in filler materials. Experience in areas such as this has given Rome-Alcoa its remarkable record of instrumentation cable reliability.



COMPONENT LAY-FACTORS Conductor kinking can also be a result of mistakes in the twisting of component conductors. Inconsistent tensions and improper sequence of lay-up can create uneven tensions in the assembled conductors.

In such cases, individual conductors may actually push through their insulations, causing electrical failures.

Obviously, these mistakes should be avoided during cabling. At this stage in cable construction careful, experienced workmanship can provide safeguards against possible trouble later on. Such careful craftsmanship sometimes costs a little more, but it can make the difference between success and failure.

SHIELDING Constructed of many ends of fine strands, shielding braids are prone to having broken and loose ends. These can break through insulations and short out component conductors. Improperly treated, they are the most common cause of shielding failures.

It's cheaper to let such loose ends remain in the braid—but it can also be disastrous. Experience on thousands of such shieldings has taught Rome-Alcoa the exact tensions which must be maintained, as well as methods of protecting and treating loose ends.

HOW TO AVOID FAILURES No manufacturer can promise you 100% reliability at every development stage. But it's only logical that the one way to be sure of maximum reliability is to have your cable planned and manufactured by a company with depth of experience and a record of reliability in the field.

Rome-Alcoa is, frankly, one of the few companies that qualify. We've been designing and constructing these cables since their first conception—long enough to know what can cause a cable failure, and how to avoid it. If you're planning to design or install instrumentation cable soon, call us.

As a starter, send for our 24-page booklet titled "Instrumentation Cables, Cable Assemblies and Hook-up Wires." In it, we describe instrumentation cable constructions, production, military specifications and our qualifications. For your copy, write Rome Cable Division of Alcoa, Dept. 27-93, Rome, N.Y.





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- guaranteed 6 months stability
- all solid-state reliability
- completely automatic and programmable
- complete system flexibility

Companion instruments to the 5001 also feature 6 months stability, all solid-state reliability and complete system flexibility. They include:

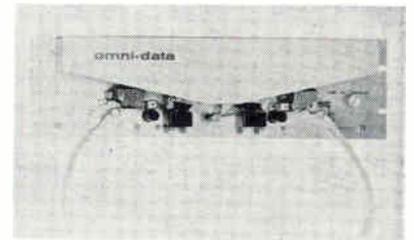
- AC/DC and AC/DC/OHMS digital multimeters
- Digital volt-ohmmeters
- AC-DC Converters
- Input Scanners
- Output printers and serializers
- Remote display units

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EAI ELECTRONIC ASSOCIATES, INC. Long Branch, New Jersey

ADVANCED SYSTEMS ANALYSIS AND COMPUTATION SERVICES/ANALOG COMPUTERS/HYBRID ANALOG-DIGITAL COMPUTATION EQUIPMENT/SIMULATION SYSTEMS/SCIENTIFIC AND LABORATORY INSTRUMENTS/INDUSTRIAL PROCESS CONTROL SYSTEMS/PHOTOGRAMMETRIC EQUIPMENT/RANGE INSTRUMENTATION SYSTEMS/TEST AND CHECK-OUT SYSTEMS/MILITARY AND INDUSTRIAL RESEARCH AND DEVELOPMENT SERVICES/FIELD ENGINEERING AND EQUIPMENT MAINTENANCE SERVICES.

adapter. Called the DSD-6, the unit is a plug-in module designed for assembly and checking with Size 5 through 11 servo mounting components before installation, as a complete precision positioning assembly. Unit has zero backlash at torques up to 3 ounce inches and provides readings of angular setting to 0.1 degree for resolvers, synchros, tuning devices, potentiometers and other servo components. A coarse inner scale provides readings from 0 to 360 degrees in 10 degree increments. It is precision gear coupled in a ratio of 36:1 to an outer fine scale providing readings from 0 to 10 degrees in 0.1 degree increments. Both scales read out on a single vertical hairline. Rigidity and loading of all bearings and internal operating components is said to facilitate accurate 3-minute positional estimates. Scales finer than the 0.1-degree divisions can be supplied. The drive can be installed or removed as a unit for access to other system components without disturbing the dials or necessitating revisions to precision logging charts. Acton Laboratories, Inc., subsidiary of Bowmar Instrument Corp., 533 Main Street, Acton, Massachusetts. CIRCLE 310, READER SERVICE CARD



Tape Readers Operate At 1,000 Characters Per Sec

VERY-high-speed photoelectric tape readers, designated models PTR-90 and PTR-91, are designed for reading all types and colors of paper and plastic tape at speeds up to 1,000 characters per second. An exclusive principle of reflected light is employed to enable interchangeable reading of opaque or transparent, punched or printed, light or dark-colored tapes without need for amplifier adjustment. No variable electrical components are used. Model PTR-90 is a unidirectional reader, priced at \$1745, or at \$3430 in combination with a model

FOUR NEW *Preformed*
TRADE MARK
GRID WIRE CONNECTORS... AND... TWO HANDS

1

T-CONNECTORS*— Designed for terminating a wire at a cross-wire or catenary, they prevent premature fatigue damage often caused by high-stress fittings... Available in both standard and reducing configurations.

CROSS-TIES*— Interlock design holds grid wires securely yet permits adjustment to various angles. Available in standard or reducing configurations, as well as spacer types, which join intersecting but noncontacting wires.

2

3

L-CONNECTORS*— An excellent electrical and mechanical connector; made of compatible materials... available in standard or reducing types, for wires of equal or different diameters.

4

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No parts can loosen to create noise. High mechanical strength and electrical conductivity are assured

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 600 Hansen Way • Palo Alto, California • 327-0170 (DDD 415)

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*Made in accordance with U. S. Patent No. 2,691,865.

**Made in accordance with or for use under U. S. Patents 2,691,865 and 2,761,273.

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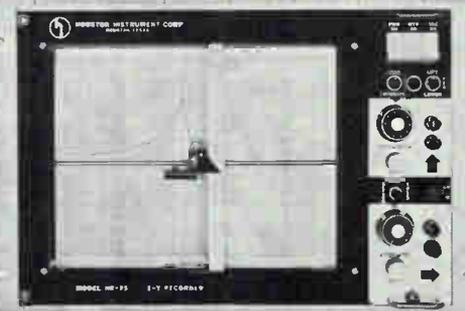
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GUIDANCE STUDIES

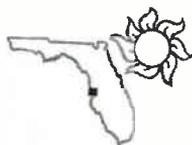
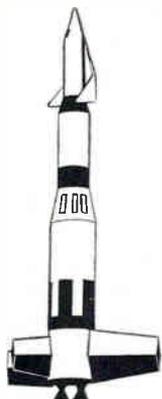
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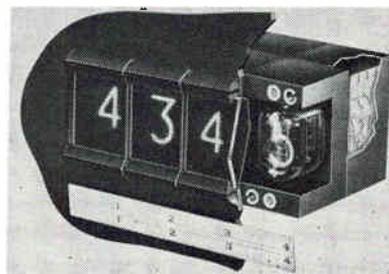
To investigate professional openings in other Honeywell facilities, send resume to F. F. Laing, Honeywell, Minneapolis 8, Minnesota.

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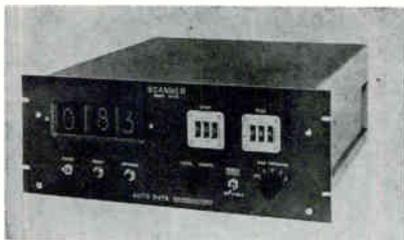
RS-500 reeler operating at speeds up to 100 inches per second. The bidirectional model, PTR-91 is priced at \$1,995, or at \$3,780 in combination with a model RS-600 bidirectional reeler, also 100 inches per second. Omnitronics, Inc., 511 N. Broad St., Philadelphia 23, Pa. CIRCLE 311, READER SERVICE CARD

Digital Readouts Handle Many Codes

COMPLETELY self-contained transistorized digital readout mounts on one-inch centers. Called the TEC-LITE TNR-30 series, it is available in eight models to handle 8-wire or 4-wire BCD input in 1, 2, 4, 8 code. Other input codes as well as a wide variety of signal voltages, can be accommodated on special order. Supply voltage of 180 v d-c ± 10 v d-c at 2 to 6 ma is confined to the panel area, and elements of the rectangular neon readout tube are controlled by internal all-tran-

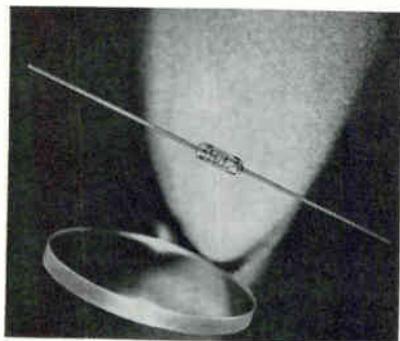


sistor decoder-driven circuitry that eliminates diode decoders and reduces the number of semiconductor components by 60 percent. All tube elements may be turned off when no indication is required. Readout utilizes rectangular, ultra-long-life NIXIE tube with a flat face which brings numerals closer to front for excellent wide-angle viewing. Numerals are 0.610-inch high. Life expectancy is 100,000 to 200,000 hours. TNR-30 series meets all applicable MIL or Federal Specifications and can be custom designed to meet unusual mechanical requirements and special electrical functions such as coded input to octal readout, counters and memories. Transistor Electronics, Box 6191, Minneapolis 24, Minnesota. (312)



Scanner Gives 4,200-Point Skips

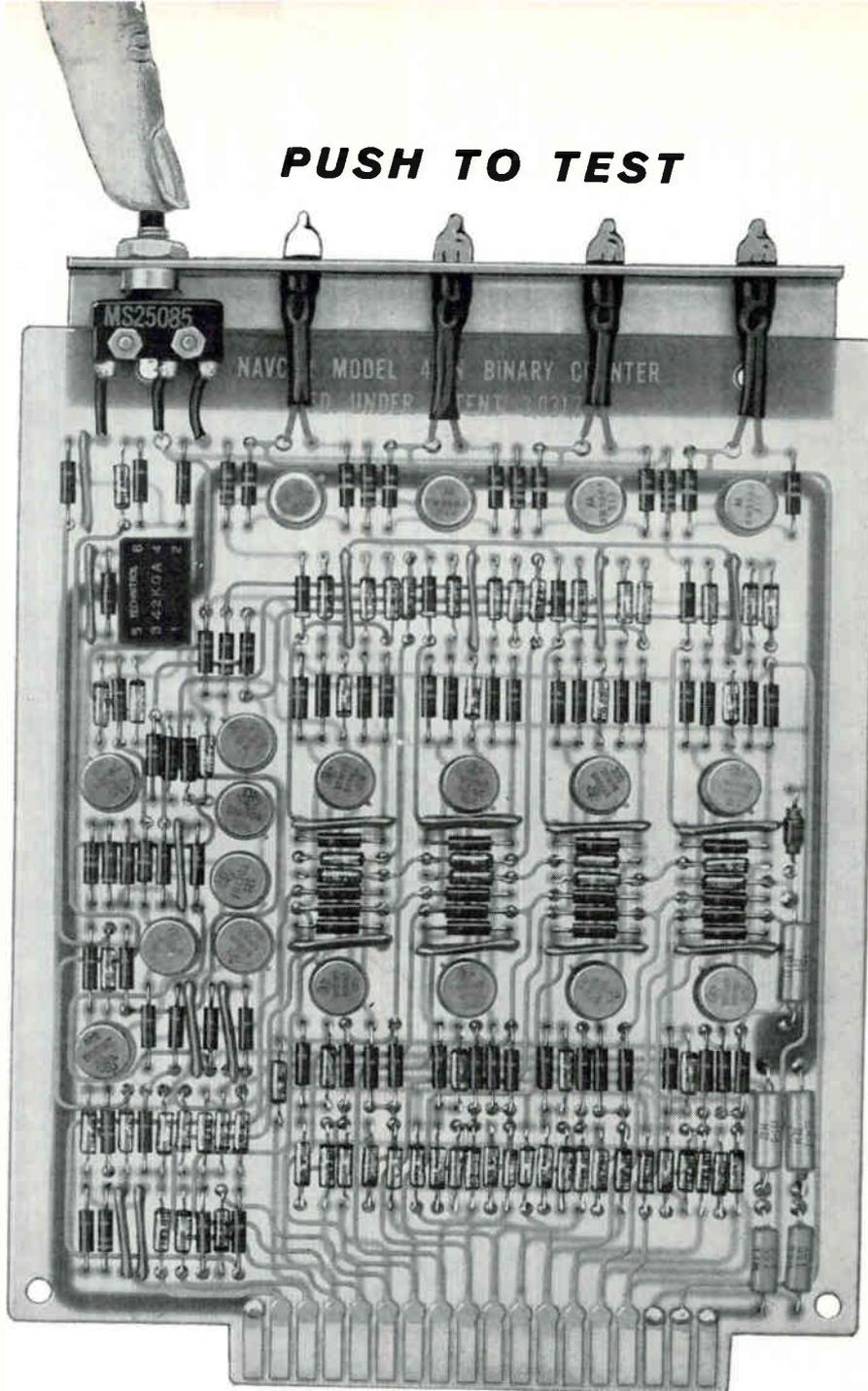
MODEL 3205, 200 Position Scanner can scan sequentially, be internally programmed for 4 separate 200 point skip programs, or remotely randomly programmed by tape or card readers. The internal skip programming facility consists of 4 plug-in cards, each providing a 200 point skip program. The active points in a program are determined by inserting ordinary carbon resistors into the corresponding matrix positions on the card. The four programs are selected by a front panel switch. The start and stop scan positions are determined by front-panel, thumb-wheel switches. Isolated decimal contact closures are provided by reed relays for printout. The device uses tamper-proof dry reeds for switching, and all reed contacts are isolated by epoxy glass blocks for minimum leakage and are direct wired to external connectors for minimum series resistance. Contact resistance of each reed switch is less than 40 milliohms. Price: \$3,475. Houston Instrument Corp., 4950 Terminal Ave., Bellaire, Texas. (313)



4-Layer Switches Extend Sensitivity

TWO-terminal subminiature light activated silicon switches extend light sensitivity to fire range to 3,000 footcandles. Designated types FL3S1 through FL3S25, the silicon

PUSH TO TEST



Push a button . . . follow the operation of a Navcor 400 Series system function module one logical step at a time on the neon indicator lights. Each module is a complete system function, grouping many logic elements. Push button and lights permit positive checkout in a fraction of the time required with less sophisticated flip-flops. Write for data on complete MIL Standard line of

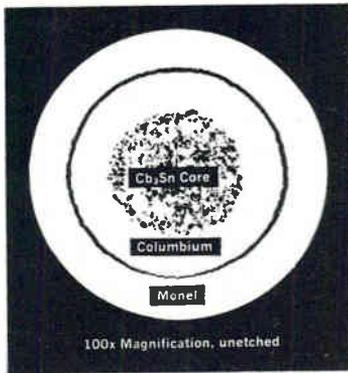
Transistorized Digital System Function Modules

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Straits Tin Report

New superconductive wire is formed with a columbium-tin core. According to its developer, Superior Tube Co., Norristown, Pa., it offers designers significant advantages in the development and fabrication of supercooled magnetic coils.



Only 1/20 the diameter of 200-amp solid wire, yet it offers up to 2½ times greater field strength, 3-4 times greater critical temperature, and the same current-carrying capacity.

The superconductive powder core is 75% columbium, 25% tin. The core is encased in a barrier tube of high-purity columbium and an outer insulating sheath of Monel metal.

This new tin-containing wire affords field strengths of 80-200 kilogauss compared with 50-80 for solid zirconium-columbium alloy wire (15-30% zirconium). Maximum operating temperature is 18.5°K compared with a maximum temperature between 4 and 6°K. Current-carrying capacity is the same as 200 amp rubber-covered copper wire, although the diameter is only .015 in. compared with .325 in. Field experience indicates that supercooled magnets of 100 kilogauss can be made for a fraction of the cost of the old style.

This is one more example of the ever-new uses for tin in today's technology. Consider Straits Tin from Malaya—world standard for quality, purity, reliability.

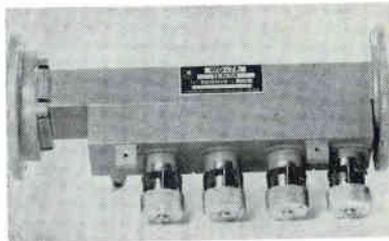
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The Malayan Tin Bureau
Dept. B-25-J, 2000 K St., N.W., Washington, D.C. 20006

switch series offers maximum forward and reverse blocking voltages from 12 to 250 volts at 75 C, and maximum transient peak reverse voltages from 20 to 350 volts at 75 C. The pnpn light switches have particular application in data processing readout systems, direct switching of controlled rectifiers, relays and solenoids, and light logic. Units are priced between \$2.20 and \$12.50 in quantities between 1 and 99. International Rectifier Corp., 233 Kansas St., El Segundo, California.

CIRCLE 314, READER SERVICE CARD



C-Band Filter Handles 6 kw

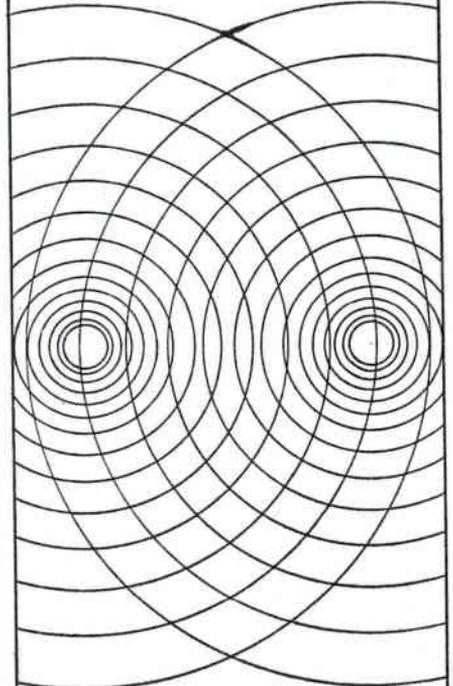
FILTER WQ7A is a tunable high-power unit designed for c-w operation in the 4.4 to 5.0 Gc band. It is designed to provide greater than 40 db rejection to frequencies spaced 200 Mc from the tuned center frequency. Tuning is achieved by means of calibrated micrometers for maximally-flat response. Insertion loss varies between 0.3 and 0.5 db from the high to the low end of the band and maximum vswr for a 25-Mc bandwidth is 1.2 when terminated in a 1.02 load. The WQ7A handles 6 kw of c-w power over the entire frequency band when water cooled; rating with air cooling varies from 2 kw at the low end of the band to 5 kw at the high end. Electronics Division, Canadian Westinghouse Company, Ltd., Hamilton, Ontario, Canada. (315)

Silicone Resins Cure at Room Temperature

Two flexible silicone resins, one transparent and one opaque, cure at room temperature. The transparent product, Sylgard 184, is the first flexible, room-temperature-curing, transparent silicone potting material ever developed. Its com-

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At 20°C, response: 50 to 10,000 c/s with a separation of 16.5 db. 0.6 V output at 50 mm/sec. Tracking force: 6 ± 1 gm. Compliance: 1.5 × 10⁻⁶ cm/dyne. Termination: 1MΩ + 150 pF.

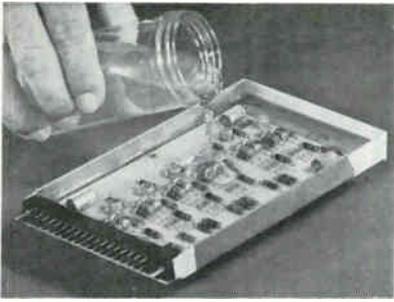
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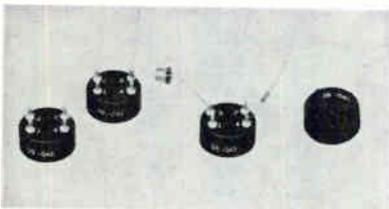
**JAPAN PIEZO
ELECTRIC CO., LTD.**

Kami-renjaku, Mitaka, Tokyo, Japan

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SEPTEMBER 6, 1963 • electronics



panion product, Sylgard 185 is a black, opaque material with identical handling characteristics. Each of the materials cures in 24 hours without exotherm, after a curing agent is mixed with the resin. Curing time can be shortened by heating the mixture. Conventional flexible packaging resins and encapsulants require heat to cure. Both products provide protection for electronic circuitry against moisture, mechanical shock and vibration, thermal shock, heat, ozone, chemicals and voltage stress. Moreover, both retain good physical and electrical properties from -65 to 200 C and show little change in electrical characteristics over a wide range of frequencies. Dow Corning Corp., Midland, Mich. (316)



Toroidal Transformers for A-M Detectors

TRANSFORMERS S5-046 through S5-049 are toroidal units designed specifically for use with diode a-m detectors. Units have a 1:12.5 turns ratio which permits operation of the detector diode in its linear region, when driven from a low-voltage transistor. The four units are similar except for the carrier frequency bands that vary between 20 to 90 kc for model S5-046 to 400 kc to 1 Mc for model S5-049. Upper frequencies are limited by winding resonance. The low limits correspond to a 1000-ohm resonant primary impedance which is adequate for the 2N2217 or other transistors with similar saturation con-

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VERSATILITY IN LIGHT MEASUREMENT

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measures:

MEASUREMENT	MONOCHROMATIC SPECTRUM		CHROMATIC SPECTRUM
	LASER	GALLIUM ARSENIDE	
WAVESHAPE Rise time Fall Time Duration Amplitude	Yes	Yes	Yes
Average Power (watts)	Yes	Yes	*
Energy (joules)	Yes	Yes	*

*Can be calculated within spectral response capabilities.

		RESPONSE RANGE									
		1.13 μ ————— 0.35 μ									
ANGSTROMS		9,000	8,000	7,000	6,000	5,000	4,000	3,000			
	NEAR IR					VISIBLE					NEAR UV
	10 ⁴										
MICRONS	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3			



Compact (10" high) and lightweight, the EG&G LITE-MIKE has built-in controls for sensitivity and balancing of ambient light. Head is swivel-mounted for ease of alignment with source.

NEW

SD-100 SILICON PHOTO-DIODE offers this unique combination of advantages

- (1) **FAST RESPONSE** / Rise time: 4×10^{-9} sec. @ 90v
Fall time: 15×10^{-9} sec. @ 90v
- (2) **WIDE SPECTRUM** 0.35 to 1.13 microns (10% points)
- (3) **HIGH SENSITIVITY** 0.25 microamps per microwatt
- (4) **LDW NOISE** 1×10^{-12} watts \cdot (cps) $^{-1/2}$
- (5) **WIDE DYNAMIC RANGE** 0.1 amp to approx. 10^{-8} amp

Applications: receiving equipment for lasers and injection laser systems; measurements on modulator and pulsed light sources; measurements of light intensity and wave forms, detection of color changes.

For full information on LITE-MIKES and SD-100 photo-diodes, contact: Marketing Dept., EG&G, 176 Brookline Ave., Boston 15, Mass.



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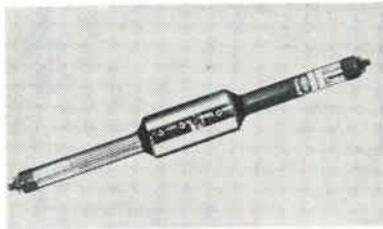
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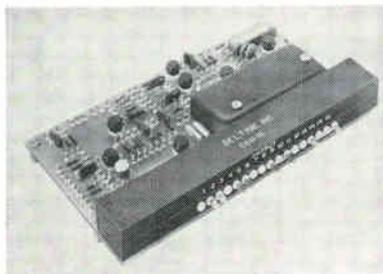
ductance. Units are priced at \$21 in quantities between 1 and 9. Spectran Electronics, 146 Main St., Maynard, Mass.

CIRCLE 317, READER SERVICE CARD



Storage Tube Uses Dual-Gun Scan

DUAL-GUN scan-converting storage tube has been developed for use in all transistor bright-display systems of the FAA. Called the CK1383, storage tube features electronic input and output for use in equipments requiring simultaneous reading and writing. Resolution exceeds 1200 TV lines-per-diameter. This, a high output signal, and ability to gradually erase previously-recorded information, qualify the device as an efficient scan converter of circularly-scanned radar data into horizontally-scanned television form for multiple display and transmission. Automatic and gradual erasure of old information is adjustable and provides a method for generating target trails indicating course and speed of aircraft or vessels detected by the radar. The tube employs magnetic deflection and focusing on both electron guns. Raytheon Co., 58 Chapel St., Newton, Mass. (318)



Unity Gain Line Provides Delays to 18.5 μ Sec

VARIABLE, unity-gain delay line, designated the CGM-16 provides delays from approximately 2.5 to 18.5 μ sec. Device has no switches, knobs, or buttons. Delays are se-

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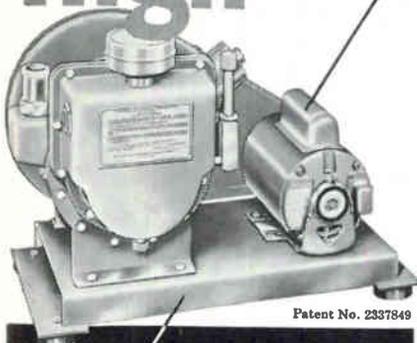
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High CAPACITY VACUUM



Patent No. 2337849

WELCH DUO-SEAL VACUUM PUMP WITH VENTED EXHAUST

Welch "Duo-Seal" No. 1397 is a two-stage, oil sealed, rotary vacuum pump with a free air capacity of 425 liters per minute and a guaranteed vacuum performance of 0.1 micron or better with the vented exhaust closed . . . 1.0 micron with vent open. The performance is uniformly high over a range to 1×10^{-4} mm Hg (Torr). It is especially suited for application to large systems involving substantial vapor removal.

The 1397's are equipped with vented exhausts to eliminate condensation of vapors which raise the vapor pressure of the sealing oil, contaminate and break down the oil, and corrode the metal parts.

IMPORTANT FEATURES:

- High pumping speed—425 liters per minute
- Low ultimate pressure— 1×10^{-4} mm Hg (Torr)
- Quiet, vibration-free operation
- Compact, rugged design
- Air-cooled
- Vented Exhaust—eliminates condensed vapors, oil filters and separators
- Belt guard
- Trouble-free, low maintenance

Over the years, Welch "Duo-Seal" Vacuum Pumps have gained a world-wide reputation for best performance, greatest reliability and quietest operation. They are available in a wide selection of capacities and ultimate vacuum characteristics, ranging in capacities from 21 to 1400 liters/minute and ultimates from 2×10^{-2} mm Hg (Torr) down to 1×10^{-4} mm Hg (Torr).

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electronics • SEPTEMBER 6, 1963

lected from the front panel in 1.0 μ sec steps by inserting miniature jumpers into Teflon-insulated jacks. The only inputs required are d-c power and an input trigger. The unit contains 10 transistors, a multi-tapped magnetostrictive delay line and associated circuitry. Weighing only 8 ounces, the CGM-16 requires a panel access slot of $9/32 \times 4$ -inches. Module operates in a return-to-zero mode and provides up to 16 output pulses with an amplitude of -6.60 volts, a width of 0.5 μ sec and having rise and fall times of less than 0.1 μ sec. Nominal input trigger requirements are: -6 volts amplitude, 0.3 μ sec width, and rise and fall times of less than 0.08 μ sec. Power requirements are ± 6 v d-c. DelTime, Inc., 608 Fayette Ave., Mamaroneck, N. Y. (319)

Pencil Triode Operates to 3 Gc

MEDIUM- μ (20) triode capable of operating at full input ratings at frequencies up to 1.7Gc and at reduced input rating up to 3.0Gc is announced. Called type 5675, the tube is intended primarily for service as a local oscillator and will provide a useful power output of approximately 475 mw and 50 mw at 1.7 Gc and 3.0 Gc respectively, when used in a suitable cavity in a cathode-driven circuit. For use in a typical cathode-driven oscillator at 1.7 Gc, the 5675 requires plate voltage of 128, plate current of 25 ma, grid current of 4 ma and delivers useful power output of about 475 mw. Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York. (320)

Microwave Power Supply Is Universal

MODEL Z817B universal microwave power supply drives all microwave triodes, tetrodes, klystrons, twts, bwos, voltage tunable magnetrons, or any of their variants. Six individual floating power supplies may be interconnected in various combinations to extend flexibility of the instrument for laboratory and pro-

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SERIES 14000—FOR SOLID STATE LOGIC

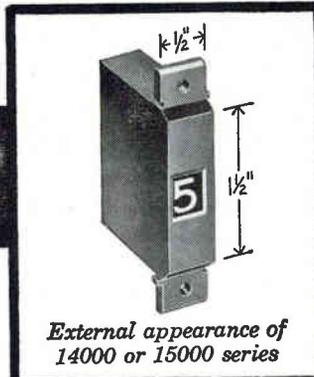
Character Size..... $\frac{9}{32}$ " x $\frac{1}{4}$ "
No. of Characters.....Up to 11
Leads.....11 plus a common
Watts.....2.4

SERIES 15000—FOR RELAY LOGIC

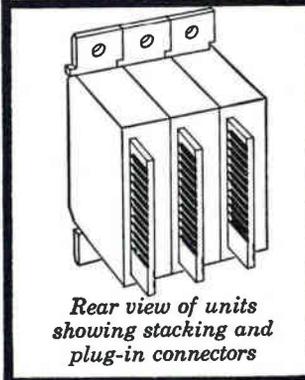
Character Size..... $\frac{5}{16}$ " x $\frac{1}{4}$ "
No. of Characters.....Up to 10
Leads.....5 plus a common*
Watts.....1.3—1.7

*Requires switching of lead in combination with reversal of polarity to change indicator.

Units hold last reading without power. Totally enclosed, self-stacking housing for front or rear mounting. Jewel bearings, only one moving part. Standard voltages 6, 12, 24, or 28 V.D.C. Readability 12 feet at normal room lighting. Options include special voltage, special characters, and internal lighting for dark room applications.



External appearance of
14000 or 15000 series



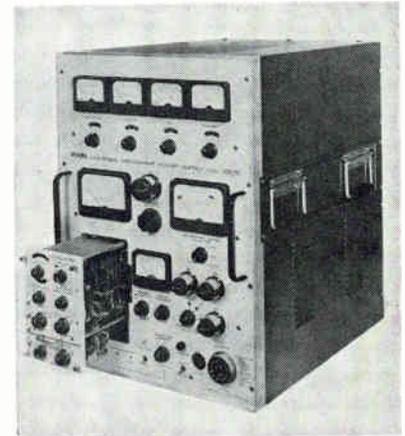
Rear view of units
showing stacking and
plug-in connectors

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duction applications. All voltages can be pre-set, and both voltage and current can be checked on front panel meters. Provisions are made for both automatic frequency control and automatic gain control. Beam voltage (0-4000 v d-c) may be pre-set to $\pm 0.1\%$ using a 4-digit counter with a least division of 1 volt. All other major power supplies have dial readouts accurate to 0.5% or digital readouts to 0.25%. Seven panel meters register voltage and current of the various supplies to a full-scale accuracy of $\pm 2.0\%$. Beam current meter has a non-



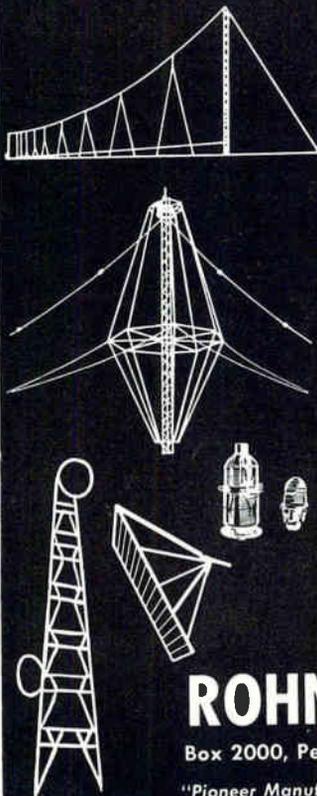
linear movement that expands the low-current region of the scale. A calibrating meter for all major supplies is accurate to $\pm 0.25\%$ at the zero and full-scale points. Four types of modulation are provided: sine wave, square wave, pulse wave and sawtooth wave. Modulation can be applied to the four grid supplies and the anode supply. Other features include overload relays on d-c supplies and cabinet, and output-connector personnel safety interlocks. The Z817B has been completely modularized for convenient maintenance, and the unit is available in both rack mount and cabinet styles. Price of cabinet model is \$2,950. FXR, 25-26 50th Street, Woodside 77, N. Y.

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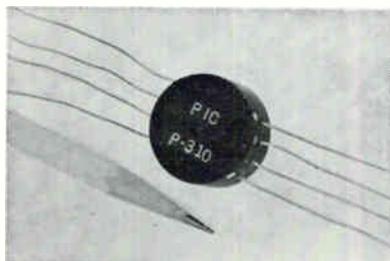
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from 20 cps to 50 kc. Full-scale voltage range is $30 \mu\text{v}$ to 300 v, with 1-megohm input impedance on all ranges. Several outputs are provided: 100-kc and 1 ma d-c outputs for recording, a restored-signal output at the frequency of the input signal, and a tracking-analyzer sine-wave output at the indicated center frequency. Availability of these outputs makes the unit a complete system for response measurements on a wide variety of networks and devices. Other features include a built-in voltage-calibrating system, a precise, linear frequency scale, and afc. Type 1900-A wave analyzer is priced at \$2150.00 and is available in both rack and bench versions. General Radio Co., West Concord, Mass. (322)



Transformer Gives Square Pulses to 250 Watts

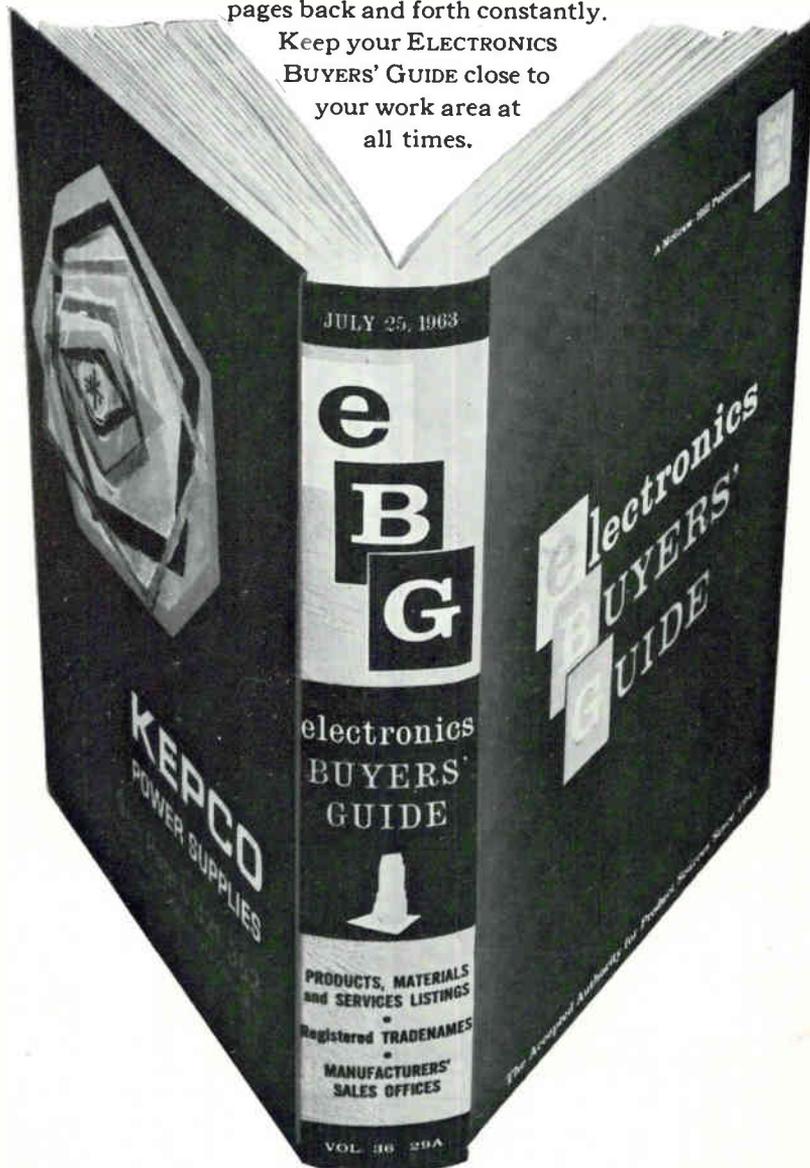
FLAT-top pulses for pulse powers up to 250 watts are now attainable from a transistorized blocking-oscillator circuit. Designed for use in a two-transistor BO circuit, P-300 series BO transformers deliver pulse outputs from 50 to 600 volts and $\frac{1}{2}$ to 5 amp. Output pulses are unaffected by changes in load impedance. Nominal pulse widths of 1, 2, 3, 5, 10 and 20 microseconds are provided by separate units in the P-300 series. The size of the 10 microsecond-pulse width unit is 1-inch dia. \times 0.6-inch high. Rise times down to 0.1 microsecond may

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Advertising Product Sections

Advertisements in the ELECTRONICS BUYERS' GUIDE are grouped together according to the kind of product advertised. All Power Supply advertisements, for example, will be found in the same section of the book. Thus it is made convenient for you to "shop" through the specifications presented to you by advertisers, without having to flip pages back and forth constantly.

Keep your ELECTRONICS BUYERS' GUIDE close to your work area at all times.



FIRST TIME

A VHF-UHF RECEIVING SYSTEM THAT PROVIDES AM-FM-CW RECEPTION OVER 30 - 1000 mc FREQUENCY RANGE IN ONE RECEIVER

A visual display of signals in a band around the received signal is provided. This complete frequency coverage and visual display is packaged into a 5 1/4 inch high unit designed for rack mounting. Audio and video outputs are provided from a 2mc IF strip and a selectable 20kc/75kc/300kc IF strip simultaneously. Nuvistors and transistors are used throughout to reduce weight and power consumption.



CEI TYPE RS-111-1

Frequency range.....30-1000mc.	Type of reception.....AM, FM, CW
Band A: 30-60mc Band B: 60-300mc.	Power input.....115.230vac, 50-60/cps
Band C: 235-500mc Band D: 490-1000mc.	Power consumption.....50 watts, approx.
Noise figure	Weight.....35 lbs. approx.
Band A: 4db max. Band B: 6.5 max.	Size.....5 1/4" H x 19" W x 15 1/2" D
Band C: 10db max. Band D: 12db max.	
If Bandwidths (4).....2 operate simultaneously: 2mc and either 20kc 75kc or 300 kc selectable from front panel	
Frequency display sweep width.....Continuously adjustable 0 to 3mc.	

Communication Electronics Incorporated

4908 HAMPDEN LANE BETHESDA 14, MARYLAND

CIRCLE 220 ON READER SERVICE CARD

be obtained. Units have applications in trigger circuits for thyratrons and microwave diodes, modulators for r-f tubes, and test circuits for pulse transformers. Polyphase Instrument Co., Bridgeport, Pa.

CIRCLE 323, READER SERVICE CARD



Bandpass Filters Are Adjustable

DEVELOPMENT of four new models of adjustable bandpass filters for general lab and breadboard testing is announced. The four models cover the frequency ranges: 50 Mc to 125 Mc; 125 Mc to 250 Mc; 250 Mc to 500 Mc; and 500 Mc to 1.0 Gc. Filters are manually adjustable, and bandwidth range is 2.5% to 25%. Insertion loss is 2 db at 2 1/2 % bandwidth; 1db at 4% bandwidth; and is reduced to only 1/2 db at maximum bandwidth. Units feature full-octave tunability and low vswr of 1.5:1. Input and output impedance is 50 ohms with power levels up to 5 watts. The standard unit has BNC connectors, other connectors are optional. Resdel Engineering Co., 990 S. Fair Oaks Ave., Pasadena, Calif. (324)



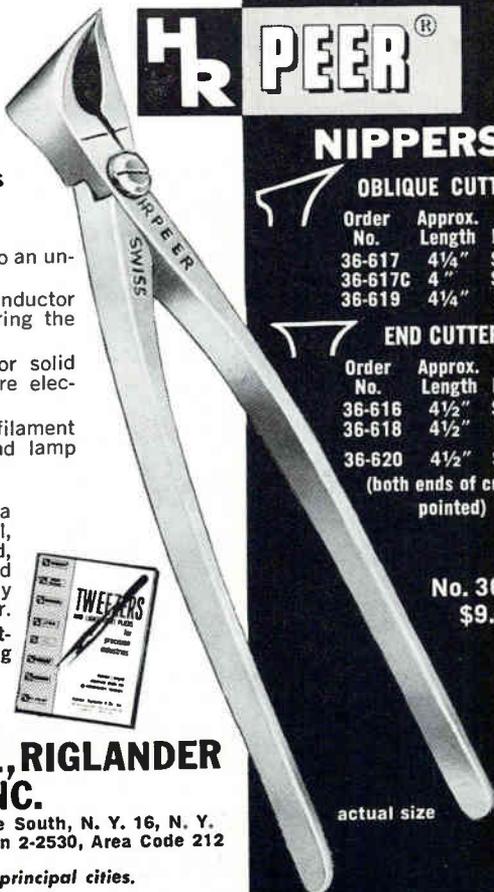
Proportional Controller Has Many Applications

THE NIATROL, rated at 10 amperes a-c output, but usable to 15 amperes at a 120 volt reference, is designed chiefly for precise temperature control (-60 to +280 C) with thermistors. It is also useful

FOR CLOSE TOLERANCE FLUSH CUTS of Electronic Wires

1. Cut extruding leads flush to an unencapsulated module.
2. Snip off excess semi-conductor whisker wire without jarring the delicate solder bond.
3. Cut and strip stranded or solid Hook-Up wire in miniature electronic equipment.
4. Remove excess hard filament wire in electron tube and lamp assembly.

The HR PEER Nipper is a light-weight precision tool, hand made in Switerland, with long-wearing, honed cutting edges, that easily outlasts the ordinary nipper. Send for catalog on light-weight nippers and cutting tweezers today!



NIPPERS

OBLIQUE CUTTERS

Order No.	Approx. Length	Handles
36-617	4 1/4"	Straight
36-617C	4"	Straight
36-619	4 1/4"	Curved

END CUTTERS

Order No.	Approx. Length	Handles
36-616	4 1/2"	Straight
36-618	4 1/2"	Curved
36-620	4 1/2"	Straight (both ends of cutter pointed)

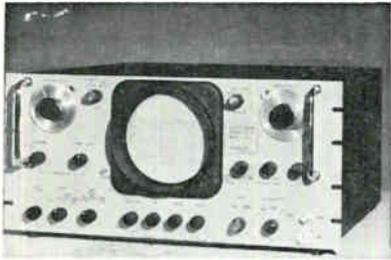
No. 36-617
\$9.00

actual size

HR HAMMEL, RIGLANDER & CO., INC.
401 Park Avenue South, N. Y. 16, N. Y.
Phone: LExington 2-2530, Area Code 212

Distributors in most principal cities.

with other transducers controlling from light, humidity, etc. Unit produces proportional outputs from other instruments and is also useful as a finely-adjustable power source. with or without self-regulation. A semiconductor device, the Niatrol has no moving parts, requires no maintenance and is quiet in operation. Niagara Electron Laboratories, Andover, New York. (325)



Spectrum Analyzer Features Log-Lin Display

SPECTRUM analyzer model LCA-1 is an extremely sensitive scanning-heterodyne receiver that automatically displays the frequency and amplitude of signals from 50 cps to 600 kc. Its output can be linearly or logarithmically displayed on a calibrated cathode ray tube. Unit features 60 db displayed log range, independent or automatic optimum resolution, balanced or single-ended input, variable sweep rate of 30 sec/sweep to 60 sweeps/sec, calibrated frequency and sweep width dials and 10 kc and 100 kc markers good to 600 kc. Applications include check-out of Loran C and communications transmitters, harmonic-medical-ultrasonic spectrum-frequency band and cross-modulation studies, ultrasonic vibration measurements, filter and transmission line checks and telemetering. Probescope Co., Inc., 211 Robbins La., Syosset, N. Y. (326)



Stereo Recorder Has 14 Moving Parts

SIMPLIFIED and ruggedized mechanical construction features tooled

"CLAIREXCOR NYC — TELEGRAM

"AT 1201 PST TODAY DEC 14 1962 THE MARINER 11 SPACECRAFT MADE ITS CLOSEST APPROACH TO THE PLANET VENUS WITHIN THE PLANNED MISS CORRIDOR THIS INTERPLANETARY FLIGHT HAS SET MANY WORLD RECORDS INCLUDING COMMUNICATIONS DISTANCE QUANTITY AND SIGNIFICANCE OF DATA RECEIVED THREE AXIS ATTITUDE CONTROL AND INTERPLANETARY SPACE MANEUVER.

"WE ARE PLEASED TO REPORT THAT YOUR CADMIUM SULFIDE PHOTOCONDUCTOR DETECTORS USED IN THE MARINER 11 SUN SENSORS AND SUN ATE HAVE OPERATED SUCCESSFULLY THROUGHOUT THE COMPLETE 109 DAY FLIGHT YOUR DETECTORS HAVE PLAYED A KEY PART IN THE SUCCESS OF THIS HIGHLY SUCCESSFUL MISSION.
JET PROP LAB G W MEISENHOLDER R SCHMIDT R G FONEY J M WHALEN"

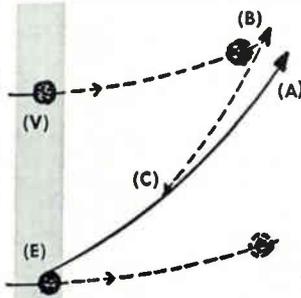
THE EYES OF A MODERN MARINER



CLAIREX PHOTOCONDUCTIVE CELLS recently served as the detectors in the sun-sensing "eyes" of Mariner II, our Venus space vehicle, controlling reference attitude prior to the critical mid-course correction maneuver which reduced the "miss" from 233,000 to 21,000 miles! The sun sensors also served as panel-orientors throughout the flight for maximum power output of the solar cell panels, signalling position errors to the pitch and yaw stabilization jets.

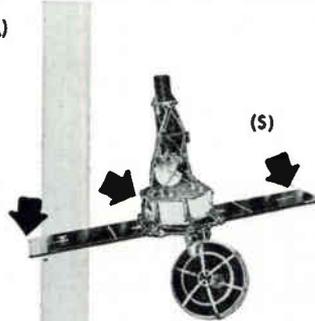
The Clairex cells in Mariner II were the standard CL-605 type now in use in hundreds of other more earth-bound applications. Special single-crystal Clairex components, however, have been utilized in Ranger and other space probe projects as radiation detectors.

MID-COURSE CORRECTION AFFECTS FLIGHT PATH



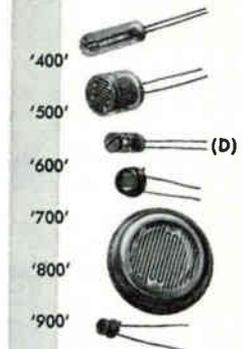
Redirecting vehicle from destination (A) to (B) in vicinity of Venus required flight correction at point (C) by applied jet propulsion of short duration. The vehicle's maneuvers prior to corrective propulsion were based on initial proper sun reference via the photoconductive sun sensors.

SUN SENSING ARRAY ON MARINER VEHICLE



Throughout the life of the craft, prior and subsequent to mid-course correction, the sun sensors (S) signalled error-correcting commands to the stabilization jets for pitch and yaw control, thus keeping the solar cell banks properly oriented for maximum power output.

PHOTOCONDUCTIVE CELL COMPONENTS



Six Standard Series of photoconductive cells, including the Mariner II type, (D), are manufactured by Clairex Corporation. Illustrated are units of both Cadmium Sulfide and Cadmium Selenide, in glass or metal containers, offering a wide range of response characteristics.

Technical design data available on request.

"The light touch in automation and control"

CLAIREX CORPORATION

8 West 30th Street, New York 1, New York

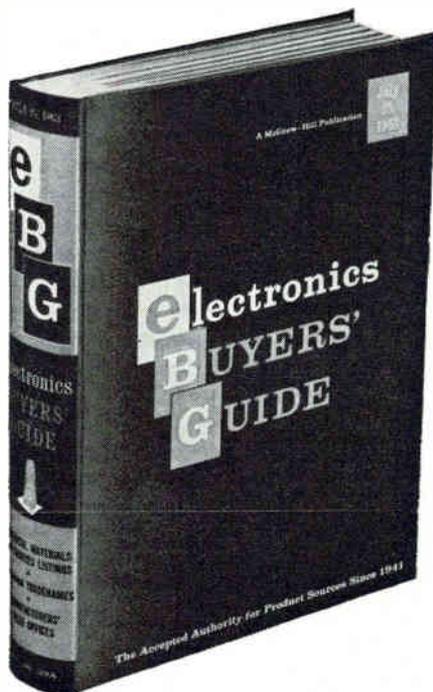
THE OLDEST MANUFACTURER OF CADMIUM SULPHIDE AND CADMIUM SELENIDE PHOTOCONDUCTIVE CELLS

NEW 16 PAGE PHOTOCONDUCTIVE CELL DESIGN MANUAL FREE ON REQUEST

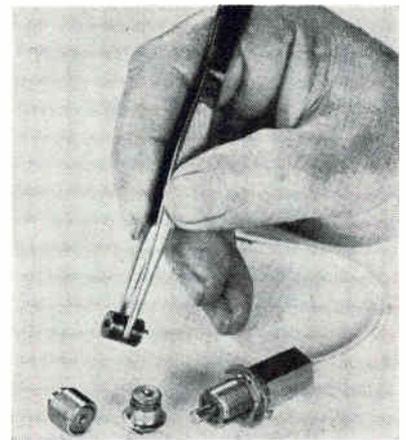
HOW TO USE YOUR ELECTRONICS BUYERS' GUIDE *

Advertising Product Sections

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parts, heavy-gage materials, automotive-type brake shoes and unitized staking of parts in this professional type stereo tape recorder. The model 70 unit provides four-track monaural recording that enables two separate programs to be combined on a third track. Illuminated recording level meters, 20-watt output per channel, detachable wing speakers and external connections for public address use are available. Locking devices on wind-rewind and recording controls prevent tape breakage and accidental erasure. When desired, up to eight recordings can be placed on a single monaural track. Estey Electronics, Inc., 201 West John St., Hicksville, N. Y.
CIRCLE 327, READER SERVICE CARD



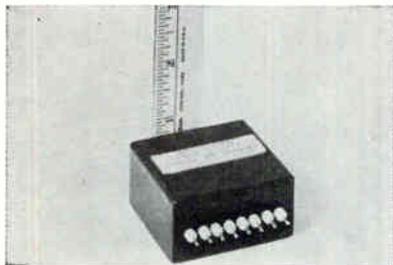
Snap-Acting Switch Is All-Welded

SUBMINIATURE (0.045 cu in.), snap-acting, all-welded, Class A hermetically-sealed sensitive switch operates in ambient temperature from -65 F to 650 F, weighs less than 1 gram and features vibration resistance over 75 g. Ratings of the Klixon 3AT are 2 amp resistive at 28 v d-c for 10,000 cycles minimum, or 1 amp resistive at 28 v d-c for 15,000 cycles minimum. Metals & Controls Inc., a corporate division of Texas Instruments Incorporated, Attleboro, Mass. (328)

Switching Diode For Logic Circuits

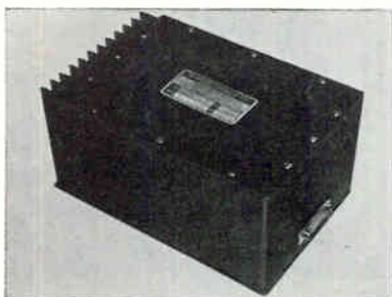
DIFFUSED silicon switching diode for logic circuits and h-f modulation circuits has been developed. Maximum ratings of type 1S306 are: peak inverse current, 35 v; d-c inverse voltage, 30 v; peak forward

current, 180 ma; average rectified current, 60 ma. Nippon Electric Co., Ltd., Box 1, Takanawa, Tokyo, Japan. (329)



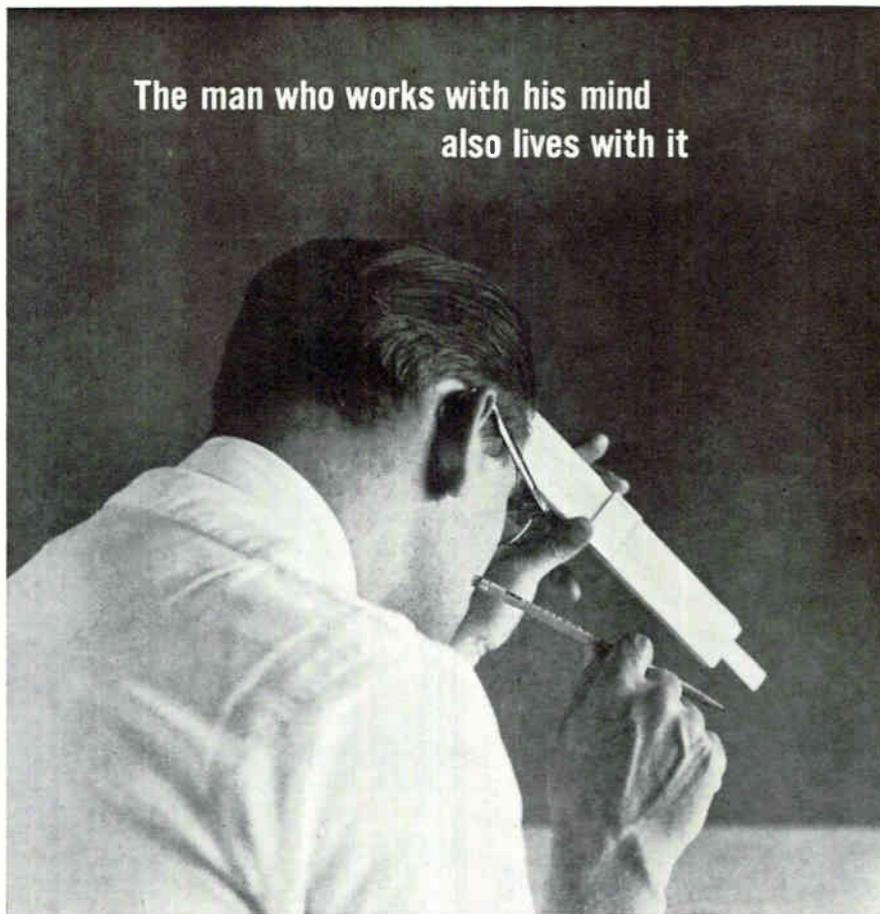
Dual Power Supply Has High Regulation

ALL-SILICON-TRANSISTOR, highly regulated dual power supply is announced. A 400-cps a-c input with fixed d-c outputs from 5 to 50 v at 50 ma each, are available in a package size $\frac{3}{4}$ in. by 2 in. by 2 in. Line regulation is 1.5 mv for 10-percent line change, load regulation is less than 2 mv from no-load to full-load. Ripple is less than 800 μ v rms. Compact size and stability of the power supply make it an ideal substitute for mercury cells, or any situation where the power unit can be placed at the load to eliminate a sensing loop. Universal Electronics Co., 1720 Twenty-Second St., Santa Monica, Calif. (330)



Core Memory Contains 4,096 Words

MILITARIZED, high-density, random access core memory, SEMS-1R has a 4.0 μ sec read/write time and will operate over a range of -55 C to $+100$ C without current compensation. The memory contains 4,096 words, up to 32 bits in length. It is available in two package configurations—the larger has removable circuits to allow maximum field maintenance and repairs; the smaller has all subassemblies packaged in



...that is why hard-to-get technical help prefers to live in Washington state, where the recreational, cultural and educational advantages are outstanding!



Washington's many facilities for culture, education and research all appeal to highly skilled or technical personnel.

IF YOUR BUSINESS utilizes highly technical or skilled personnel, you know they're often hard to find, and sometimes harder to hold. But in Washington State, there is an abundance of skilled and technical workers. Why? For one thing, this is a center of space-age technology, such as atomic energy, aerospace and electronics.

Too, year around recreational facilities in Washington State are fabulous. The mild, easy-going climate, summer and winter, appeals to everyone. Educational and cultural centers are at every hand. Highly skilled workers live here by choice, are reluctant to leave.

If you're planning a business expansion or move, consider Washington State, where space-age technology has come into its own, along with a better life.

For more information on *The Surprising State*, Washington, write on your letterhead today, to Washington State Department of Commerce and Economic Development—Industrial Division, General Administration Building, Olympia, Washington.

Rob't. E. Rose, Director

Albert D. Rosellini, Governor

THE
Surprising
STATE



WASHINGTON

Assure High Reliability and Effective Display

with DIALCO Twin Lamp

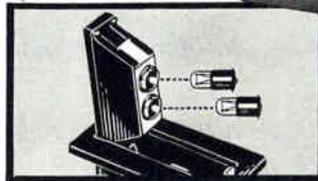
PLACARD LIGHTS

Maximum reliability and safety are achieved by DIALCO'S twin lamp and Press-to-Test construction: Burnout of one lamp will not result in failure of the indication. The Press-to-Test feature enables instant checking of both lamps without removing them from the Placard Light assembly.

Flexibility in application is provided by: Choice of single units or stacks of 2 to 10 indicators; maximum area for legend display and wide variety of legend colors and styles; 4 mounting methods—with an escutcheon plate, or flush-to-panel with end-mounting, side-mounting, or "L" angle brackets...DIALCO Placard Lights conform to applicable Military Standards.

THE LIGHT SOURCE: ▷

Two T-1¾ Incandescent Bulbs (with midget flanged base); available in voltages from 1.3 to 28 V. Lamps are easily replaced from the front—without removing the assembly.



A typical stack of 10 Placard Light assemblies with an escutcheon plate. (approx. 3/5 size)

For complete data, request Catalog L-170

Foremost Manufacturer of Pilot Lights
DIALIGHT
CORPORATION

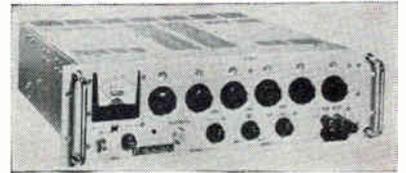


60 STEWART AVENUE
BROOKLYN 37, N.Y.
(212) HYacinth 7-7600

CIRCLE 221 ON READER SERVICE CARD

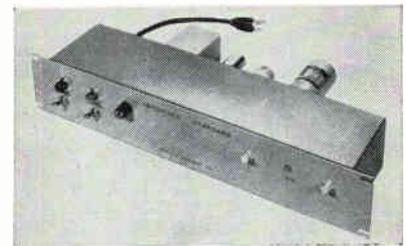
welded modules for maximum reliability. Both utilize standard components in special, high-density welded circuit designs. Electronic Memories, Inc., 12621 Chadron Ave., Hawthorne, Calif.

CIRCLE 331, READER SERVICE CARD



Solid-State Supply Has High Stability

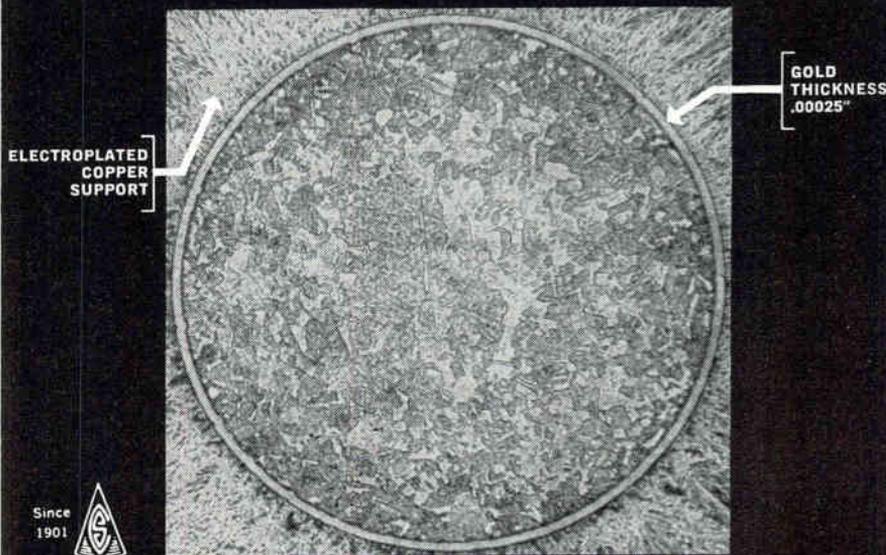
SOLID-STATE d-c power supply, model 313A, is capable of supplying up to 2 amp from 0 to 50 v with a calibration accuracy of 0.01 percent of its six-digit in-line read-out. It has a resolution of 10 μ v (5 v range) and 100 μ v (50 v range) with a stability of 0.002 percent per hour and 0.005 percent per month. Line and load regulation are 0.0005 percent with less than 100 μ v rms ripple. Remote programming, remote sensing, and continuously adjustable current limiting are provided. John Fluke Mfg. Co., Inc., P. O. Box 7428, Seattle 33, Wash. (332)



Frequency Standards Are Solid-State Units

FREQUENCY standards, models 67100 (fixed frequency) and 67200 (voltage controlled), are available at any output frequency between 60 cps and 100 Mc. with 0.001-percent to 0.000001-percent stability. Input: 120 v a-c, 60 cps \pm 10 percent. Output: 1 v rms minimum. Load impedance: any load from 100 ohms to 1 megohm. Output wave form: sine, 2 percent max harmonic distortion. Output regulation: \pm 2 percent. Greenray Industries, Inc., East Simpson Road, Mechanicsburg, Pa. (333)

Gold Plated Copper Wire .020" diam.



Gold Plated per MIL-G-45204 Type 1, Class 3

Photomicrograph 133x

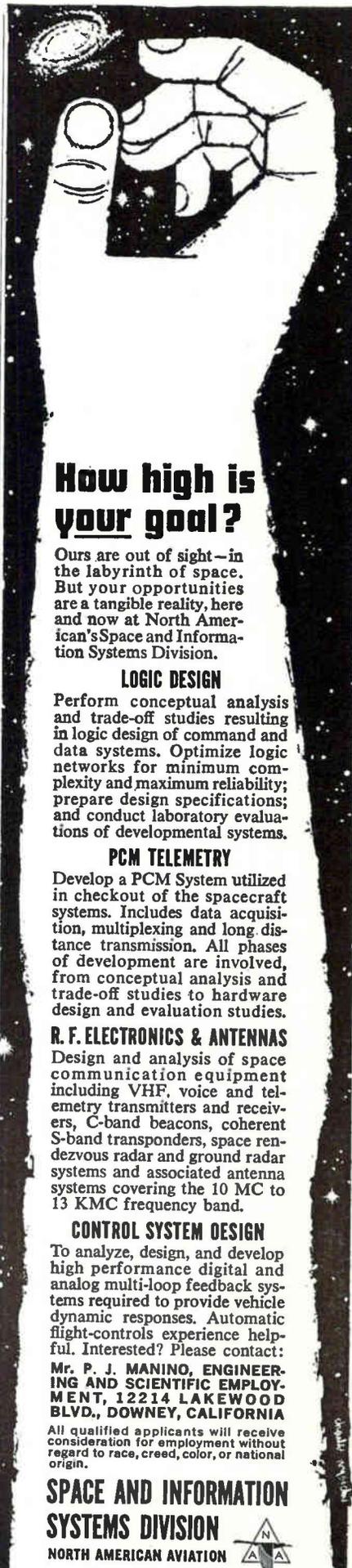
Uniform . . . Well-bonded . . . Quality with Economy . . .

SIGMUND COHN CORP. 121 So. Columbus Ave., Mount Vernon, New York

SIGMUND COHN CORP. OF CALIFORNIA, 151 C. NORTH MAPLE STR., BURBANK, CAL.

LITERATURE OF THE WEEK

- EPOXY RESIN HARDENER** Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City 4, N. J. Properties of Sonite No. 41 hardener for epoxy resins and its use in making castings and laminates are described in three technical bulletins. (334)
- SWEEEPING OSCILLATOR** Kay Electric Co., Maple Ave., Pine Brook, N. J. Mailing piece illustrates and describes Multi-Sweep 159-A, a 1- to 300-Mc sweeping oscillator. (335)
- SOLDER STRIPPER** MacDermid Inc., Waterbury, Conn. Technical data sheet contains complete information on a new solder stripper for p-c boards and other electronic components and hardware. (336)
- VHF VOLTMETER** Ballantine Laboratories, Boonton, N. J. Looseleaf-perforated bulletin illustrates and describes model 340 true-rms r-f millivoltmeter. (337)
- D-C RECORDERS** Amprobe Instrument Corp., 630 Merrick Road, Lynbrook, N. Y. Catalog/specification sheet covers a line of d-c 50-mv recorders. (338)
- CIRCUIT-BUILDING TECHNIQUE** AeroCircuits Co., Box 209, Fairfield, Conn. Four-page folder describes CirPlan circuit boards, which are designed to provide a quality and effective method of packaging a complete high- or low-frequency circuit. (339)
- TUBE SHIELDING** Cool-Fin Electronics Corp., 1717 No. Potrero, South El Monte, Calif. Folder of catalog sheets covers high-efficiency fin-type heat dissipating and r-f shielding for electronic tubes. (340)
- SCR FIRING CIRCUIT** Lectrologic Corp., P. O. Box 4857, Fort Lauderdale, Fla. Four-page folder describes model 101 firing circuit. (341)
- UHF TRIODE POWER AMPLIFIER** Amtron Corp., 17 Felton St., Waltham, Mass. Catalog sheet describes model 125 uhf scr firing circuit. (341)
- P-C BOARD ASSEMBLY MACHINES** Universal Instruments Corp., Binghamton, N. Y. Four-page brochure describes new automatic high-speed inserting and clinching machines for printed-circuit board assembly. (343)
- SLIDE RULE** Electra Scientific Corp., Electra Way, Fullerton, Calif., offers at no charge a slide rule intended primarily for engineers involved in piezoelectric transducer design and similar applications. (344)
- TAPE TRANSPORT** S-I Electronics, Inc., 103 Park Ave., Nutley 10, N. J. Data sheet describes a precision digital magnetic tape transport designed for airborne, shipboard and vehicular system applications. (345)
- MYLAR DIELECTRIC CAPACITORS** The Gudeman Co., 340 W. Huron St., Chicago 10, Ill., has available a bulletin describing a new line of miniature flat and tubular Mylar dielectric capacitors. (346)
- CLUSTERED MAGNETIC SHIELDS** Magnetic Shield Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. Data sheet 163 deals with space-saving clustered Netic and Co-Netic magnetic shields for multiple photomultiplier tube applications. (347)
- AUTOMATIC CIRCUIT CHECKOUT** Digital Equipment Corp., 146 Main St., Maynard, Mass. Brochure covers a system for automatic production-line checkout of electronic circuits, controlled by the Programmed Data Processor-4 computer. (348)
- POWER SUPPLY MODULES** Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif. Bulletin PS663 covers MilliPak miniature d-c power supply modules. (349)
- METALIZED TEFLON CAPACITORS** Dearborn Electronic Laboratories, Inc., P. O. Box 3431, Orlando, Fla. Engineering data 4-TB-63 contains complete information on a line of metalized Teflon capacitors that offer volumetric reduction to as much as four-to-one. (350)
- NPN TRANSISTORS** Bendix Semiconductor Division, Holmdel, N. J. An engineering data sheet discusses silicon Leaf planar epitaxial npn transistors. (351)
- BIPOLAR ANALOG COMPUTATION** Applied Dynamics, Inc., 2275 Platt Rd., Ann Arbor, Mich. A 16-page pamphlet describes a significant improvement in analog-computer programming through the use of bipolar operational amplifiers. (352)
- ELECTROLYTIC CAPACITORS** Aerovox Corp., New Bedford, Mass. Catalog 203B1 describes type QE aluminum electrolytic capacitors designed for high reliability and long life. (353)
- INTERCHANGEABLE WAFER THERMISTORS** Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. Bulletin describes interchangeable wafer thermistors for temperature measurement, control and compensation. (345)
- DIGITAL OPERATIONS SYSTEM** Electronic Associates, Inc., Long Branch, N. J. Bulletin AC-6297 describes the series 350 hybrid computer digital operations system. (355)
- MULTI-APPLICATION CAPACITOR** CTS Corp., Elkhart, Ind. Advance data sheet 8500 covers a multi-application thin-film screened capacitor which features high reliability due to the inherent stability of its inorganic construction. (356)
- DUAL TRANSISTORS** Hughes Semiconductor Division, 500 Superior Ave., Newport Beach, Calif. Bulletin DX52 describes the 2N2871 and 2N2872 pnp silicon alloy dual transistors. (357)
- RECORDING SYSTEMS** Brush Instruments, division of Cleveite Corp., 37th and Perkins, Cleveland, O. A 20-page condensed catalog describes a line of recording systems for industrial, military and scientific applications. (358)



How high is your goal?

Ours are out of sight—in the labyrinth of space. But your opportunities are a tangible reality, here and now at North American's Space and Information Systems Division.

LOGIC DESIGN

Perform conceptual analysis and trade-off studies resulting in logic design of command and data systems. Optimize logic networks for minimum complexity and maximum reliability; prepare design specifications; and conduct laboratory evaluations of developmental systems.

PCM TELEMETRY

Develop a PCM System utilized in checkout of the spacecraft systems. Includes data acquisition, multiplexing and long distance transmission. All phases of development are involved, from conceptual analysis and trade-off studies to hardware design and evaluation studies.

R. F. ELECTRONICS & ANTENNAS

Design and analysis of space communication equipment including VHF, voice and telemetry transmitters and receivers, C-band beacons, coherent S-band transponders, space rendezvous radar and ground radar systems and associated antenna systems covering the 10 MC to 13 KMC frequency band.

CONTROL SYSTEM DESIGN

To analyze, design, and develop high performance digital and analog multi-loop feedback systems required to provide vehicle dynamic responses. Automatic flight-controls experience helpful. Interested? Please contact:

Mr. P. J. MANINO, ENGINEERING AND SCIENTIFIC EMPLOYMENT, 12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

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

**SPACE AND INFORMATION
SYSTEMS DIVISION**

NORTH AMERICAN AVIATION





Sanders Enters New Facility

SANDERS ASSOCIATES, INC. has occupied a new 50,000-square foot facility on "electronics row" in Bedford, Mass. The new Bedford division will house the Corporate Advanced Program Development Group and the Advanced Systems Laboratories previously located in a leased building in Burlington, Mass.

The versatile, two-story Bedford facility is a self-sustained division of Sanders Associates, Inc., with both a capacity and capability to support company research, development and production programs.

A flexible plant layout allows for fast economical expansion by adding modular sections of up to 150,000 square feet to the new facility.

The Corporate Advanced Program Development Group is directed by corporate vice president Martin R. Richmond. It is responsible for the coordination and expansion of total company capabilities in all facilities for new programs of major potential in several fields of advanced weapon systems.

The Advanced Systems Laboratories is directed by vice president David D. Coffin, and is engaged in the development of advanced radar pulse doppler systems, space communications, missile systems analysis, product design and computer synthesis.

The Bedford division is the third new plant constructed by the company in the past three years in a program of rapid expansion. During the three-year period the sales volume has climbed from about \$17 million in 1960 to a present annual rate of about \$55 million.

Sanders Associates, Inc. has its headquarters in Nashua, N.H., with other facilities in Plainview, L.I., N.Y., and Manchester, N.H.



Univac Elevates Retterer

RAY W. RETTERER has been appointed senior vice president, marketing, of the Univac division of Sperry Rand Corporation, New York City. In this newly established position, he will be responsible for all commercial, Federal Government, and defense marketing activities for the division in the continental United States.

Retterer joined Univac in 1961 as executive assistant to the vice president and general manager. Since December, 1961, he has been director of marketing.



Radiation at Stanford Appoints Leifer

RADIATION AT STANFORD, Palo Alto, Calif., has appointed Meyer Leifer as vice president-operations. In this position he will be in charge of the company's operating divisions, which include the R-F Systems division, Optical Systems division, Products division, Magnetic Components division, and the Production division.

Prior to joining Radiation at Stanford, Leifer was director of Sylvania's Systems Engineering and Management Organization (SEMO) in Waltham, Mass.



Culver Takes Over Top Company Post

EUGENE S. CULVER has been elected president of Washington Technological Associates, Rockville, Md. He succeeds Harold M. Briggs who has resigned.

Culver has been serving as executive vice president and director of technical operations of WTA since 1960.

Washington Technological Associates, Inc. is an engineering research/development and manufacturing firm specializing in missile handling equipment, prototype fabrication, satellites and electrome-



Print top and side together at 3200/hour



Identify products with inks that meet government specs



Print 1500 hard-to-hold items per hour with complete uniformity — change to new imprint in seconds

cut your identification costs with modern methods like these



Color-band and/or print economically by machine — in sample lots or up to 6000/hour



Save purchase, inventory and obsolescence costs by making your own labels exactly as needed



Get sharp, durable imprints on extremely irregular shapes or rough surfaces

Looking for faster identification . . . imprints that meet government specs . . . flexibility to meet changing requirements . . . a practical way to mark prototype or sample lots? Would direct printing or making your own labels cut costs, give higher print quality? Ask Markem to analyze your identifica-

tion needs now — without obligation — and show you *how* and *where* you can save money. Frequently, a Markem in-plant identification system pays for itself in a few months. Contact the Markem Technical Representative near you, or write Markem Machine Co., Keene 5, New Hampshire.

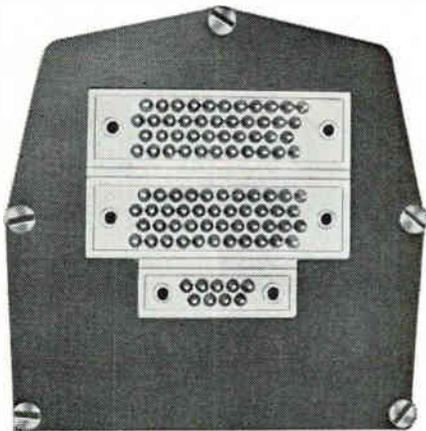
New 12-page Catalog describes Electrical/Electronic Identification Methods and Equipment. Copy on request.



MARKEM

TECHNICAL ASSISTANCE AND INDUSTRY-PROVEN EQUIPMENT
WORLDWIDE . . . TO HELP YOUR PRODUCT SPEAK FOR ITSELF,

CODE/SCAN[®]

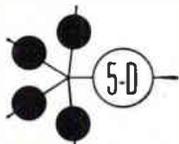


You are looking into the business end of today's most reliable multiple low level signal conditioner.

It time shares one amplifier with up to 128 different data points in perfect pulse-lock with your channel and frame program. It is agreeable to signal levels as low as 10 mv full scale. Its scanning format can be cross strapped or rearranged in the field for flexible application.

It gives you better than 1/2% accuracy whether you heat it, freeze it or bang it around. It completely ignores common mode voltages and with automatic drift correction quietly changes your 10 mv signal into a husky 5 volt output for direct insertion into your data system. You provide only raw power and a place to sit (the other interfaces have already been attended to).

It doesn't use matched components, doesn't require special personnel and you don't have to fiddle with it or tweak it. Over its extended life-time it requires no adjustments or calibrations and in fact has no provision to do so. If you need data you can trust, you can get **CODE/SCAN**, mated to your particular requirement in less than 60 days and with kind attention to your budget. Order the same kind NASA uses and save yourself the qualification effort.



FIFTH DIMENSION INC.
P.O. BOX 483 • PRINCETON, N. J.
WALNUT 4-5990

*Your company letterhead is enough to get a live demonstration of **CODE/SCAN** in your laboratory, or see it at the London ITC.*

mechanical-electronic instrumentation and development.



Augenblick Assumes Bogart Presidency

HARRY A. AUGENBLICK has assumed the presidency of Bogart Manufacturing Corp. of Brooklyn, N.Y. Bogart, recently acquired by Microlab, manufactures waveguides and high power microwave components.

Augenblick, who will continue in his capacity as president of Microlab, will actively coordinate and direct the various activities of Bogart.



Howard Accepts New Position

APPOINTMENT of George F. Howard as manager of Blackstone Ultrasonics, Inc., Sheffield, Pa., is announced. Blackstone Ultrasonics, which was formed early this year, is a wholly-owned subsidiary of Blackstone Corp., Jamestown, N.Y.

In his new position, Howard will be responsible for complete management of the company, including production and sales.

Most recently, Howard served as sales manager for General Instrument Corp., Harris A.S.W. division.

EOS Appoints Two Senior Scientists

EDMUND M. DIGIULIO and Ivan E. Walenta have joined Electro-Optical Systems, Inc., Pasadena, Calif., as senior scientists engaged in advanced systems development operations and advanced systems engineering, respectively.

Digiulio was previously vice president of engineering and manufacturing at Craig Research, Inc., Los Angeles.

Walenta was formerly with Caltech's Jet Propulsion Laboratory, Pasadena, as chief of the space instrument systems section of the Space Sciences division.



Bridge Incorporated Elects Leas

J. WESLEY LEAS, formerly general manager for the data communications and custom projects department of the EDP division at RCA, has been elected vice president of Bridge Inc., Philadelphia, Pa.

Bridge designs and manufactures high-speed card readers and punches, as well as specialized peripheral equipment for the electronic data processing industry.

Orr Joins Tracerlab As Division Manager

JAMES F. ORR has been named manager, Industrial division, for Tracerlab, a division of Laboratory For Electronics, Inc., Waltham, Mass. His responsibilities in this new post include engineering, manufacturing and marketing of Tracerlab's industrial beta gage process

LAST CALL!!

for Electronic Engineers
to manage the
Installation, Maintenance
& Reliability Programs
for Naval
Shipboard Systems

Because the many electronic devices and systems on board the Navy's new surface and sub-surface vessels must operate with near-perfect reliability—despite rugged environmental conditions and inherent complexity—installation and maintenance engineering are more important than ever before. Specifically to meet this challenge, the Bureau of Ships has established the ELECTRONICS MAINTENANCE CENTER in Norfolk, Virginia . . . to take over the management of, and the responsibility for, shipboard INSTALLATION, RELIABILITY, MAINTENANCE and PRODUCT IMPROVEMENT requirements for

- ECM and RADAR • COMMUNICATIONS
- SONAR • COMPUTERS
- SUPPORT SYSTEMS

If you are a graduate EE with 3 to 5 years' experience—or a top-grade graduate without experience—you may qualify for one of the few remaining key positions in which you can gain an insight and influence in military electronics matters far beyond your years and experience. And, since you will be responsible for liaison with design and development people at Bureau headquarters, with industrial contractors, with operating units and support activities, and with your counterparts in other Navy Bureaus, you will have ample opportunity to *know and become known*.

As a Project Engineer at the Center you will start as high as \$9,475 (\$9,980 after January 1st), with the many benefits of Career Civil Service. For those without sufficient experience, there are Junior Engineering positions open from \$6,650 to \$7,125 (also subject to automatic increase on January 1st), plus Civil Service benefits. Advancement to Senior Project Engineering positions—to \$13,615 and beyond—is well within reach for both engineering categories.

Get in on the ground floor of this new forward-looking organization by contacting the Director—Industrial Relations and Manpower, Code 722A.

bureau of ships

Department of the Navy
Washington 25, D.C.

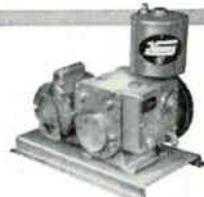
An Equal Opportunity Employer

KINNEY PUMPS AND COMPONENTS REDUCE HIGH VACUUM PROBLEMS TO A MINIMUM



VACUUM GAUGES

A variety of Kinney vacuum gauges includes the KTG Thermocouple Gauge (3000 to 1 micron range), the KDG Discharge Gauge (10 microns to 2×10^{-7} torr range), and the TD-1 McLeod Gauge (150 torr to 1 micron range).



CAM AND PISTON MECHANICAL PUMPS

Kinney produces the highest quality in mechanical pumps ranging in size from 2 to 850 cfm. Series KS and KD Single Stage Pumps attain pressures below 10 microns; Series KC Compound Pumps deliver pressures below 0.2 micron.



DIFFUSION PUMPS

Kinney Series KDP Diffusion Pumps provide maximum pumping speeds in 2", 4", and 6" sizes. They obtain pressures of 4×10^{-7} torr un-baffled, and 1×10^{-8} torr when combined with the Model KDB baffle using liquid nitrogen.



HIGH VACUUM VALVES

Kinney's complete line of vacuum valves includes series DC Diaphragm Valves, Series BB and OB Bellows sealed Valves, Series KRV Right Angle Valves, and Series G Gate Valves. They are provided for soldered, threaded, or flanged connection and for manual or air operation.



VANE-TYPE MECHANICAL PUMPS

The Series KCV Vane Pumps are provided in 2, 3, 5, and 7 cfm sizes and are manufactured to the same high quality standards as Kinney cam-and-piston pumps. Quiet, vibrationless, and smoke-free, they are ideal for laboratory use.



BAFFLES AND COLD TRAPS

A unique design gives Kinney Baffles high conductance and maximum effectiveness. The Series KDB is intended for water or liquid nitrogen cooling; the Series KWB is used with water or freon. Supplied in 2", 4", 6" and 10" sizes.



KINNEY VACUUM DIVISION

THE NEW YORK AIR BRAKE COMPANY
3529 WASHINGTON STREET • BOSTON 30, MASS.

KINNEY . . . EVERYTHING IN VACUUM

**FREQUENCY
STANDARD
PERFORMANCE**
in
**Packaged
Oscillator
Size**



For additional technical data, WRITE:



PRODUCTS

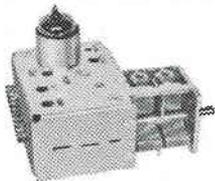
**THE
JAMES
KNIGHTS
COMPANY**

SANDWICH, ILLINOIS

JKTS-1000: A completely packaged oscillator-oven unit. Performance equal-to or better than many laboratory frequency standards designed for system and equipment use. SPECIFICATIONS: large diameter, 1 mc, glass-enclosed crystal, together with oscillator-buffer circuitry, voltage regulation and temperature control completely housed in a double proportionally-controlled oven. External and remote trimming. Stability and calibration 1×10^{-9} per day at time of shipment.

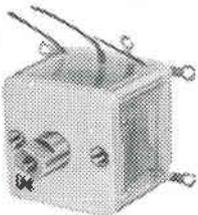
CIRCLE 222 ON READER SERVICE CARD

AM-FM Tuner Unit



AM SEC. CAPACITY: MAX. 377PF
MIN. 12PF
TUBE: 6AQ8, 12DT8, 17EW8

**PLASTIC
VARIABLE CONDENSER**



Square Size :
15mm., 17mm.,
20mm., 21mm.,
Single band :
2 band, 3 band
and for FM only.



SANKAISHA CO., LTD.

Cable address: SANESVARICON TOKYO
1425, 4-chome, Higashinakanobu,
Shinagawa-ku, Tokyo, Japan.

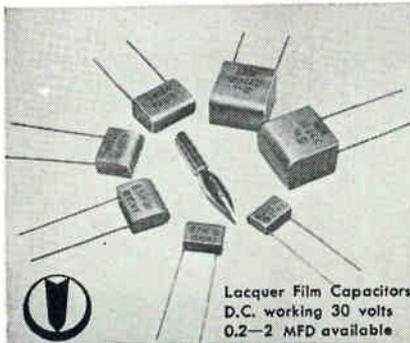
CIRCLE 223 ON READER SERVICE CARD

**DON'T CUT CORNER
ON VITAL PARTS!**

**SHIZUKI
CAPACITORS**

Using metallized paper and metallized mylar film produced by itself.

- * Lacquer Film Capacitors
- * Polystyrene Capacitors
- * Mylar Capacitors
- * Metallized Paper Capacitors for motor running, fluorescent ballasts
- * Noise Suppression Capacitors
- * Ignition Capacitors



Lacquer Film Capacitors
D.C. working 30 volts
0.2-2 MFD available

SHIZUKI ELECTRIC WORKS CO., LTD.

HEAD OFFICE: 1, TAISHA-CHO, NISHINOMIYA, JAPAN
CABLE ADDRESS: "CAPACITOR" NISHINGOMIYA
TOKYO FACTORY: 10-7, ARAJIYUKU, OTA-KU, TOKYO

control systems. Orr joins Tracerlab from the servo Corporation of America, Hicksville, N.Y.

PEOPLE IN BRIEF

Stanley J. Kukawka moves up to quality control director of Bourns Trimpot div. **William E. Williams**, formerly with Missimers, Inc., named chief engineer of the Western div. of Tenney Engineering, Inc. **Robert R. Sparacino** promoted to R&D director for General Motors AC Spark Plug div.'s missile and space activities. **Frederick W. Treue** advances to mfg. mgr. for Frequency Engineering Laboratories. **William H. Christoffers** and **John T. Mendel** are raised to mgr. and associate mgr., respectively, of the microwave tube div. of Hughes Aircraft Co. **Charles J. Koch**, with Martin Co. since 1941, appointed exec director of space programs. **Peter F. LeFort** leaves Microwave Associates to join Amperex Electronic Corp. as product mgr., microwave tubes and components. **Stanley E. Rauch**, ex-U. of Calif. professor, named head of the Electronics Research dept. of the Research div. of Melpar, Inc. **Tak Yamashita**, from Bendix Computer div. to TRW Computer div. as mgr., Programming Sciences dept. **Wendell D. Trudgen** promoted to mgr. of application engineering for GE's Process Computer Section. Litton Industries elevates **Bernard Rider** to director of the Advanced Technology operation of the RADCOM div. **Harry F. Albert**, formerly with the Teledynamics div. of American Bosch Arma Corp., appointed g-m of Sonex, Inc. **Thomas R. McGinley, Jr.**, previously with Kollsman Instruments Corp., now mgr. of operations for the Physics Research div. of Geophysics Corp. of America. **Fred E. Stote**, ex-Texas Instruments, named g-m of the new Semiconductor div. of Clevite Corp. **M. Donald Blue**, ex-Westinghouse and Bell Labs, appointed section head of solid-state physics research at Honeywell Research Center. **Oscar Valdez**, previously with Arnoux Corp., named operations engineering mgr. for Telemetry, Inc.

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. Please print clearly.
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York, N. Y. 10036. (No charge, of course).

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PAN AMERICAN WORLD AIRWAYS, INC. Guided Missiles Range Division Patrick Air Force Base, Fla.	55*	7
SPACE—GENERAL CORP. A Subsidiary of Aerojet-General Corp. El Monte, Calif.	52*	8
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UNIVAC Div. of Sperry Rand Corp. St. Paul, Minn.	150	10

* These advertisements appeared in the August 30th issue.

(cut here)

electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

(cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME

HOME ADDRESS

CITYZONESTATE.....

HOME TELEPHONE

Education

PROFESSIONAL DEGREE(S)

MAJOR(S)

UNIVERSITY

DATE(S)

FIELDS OF EXPERIENCE (Please Check)

9663

- | | | |
|--|--|---------------------------------------|
| <input type="checkbox"/> Aerospace | <input type="checkbox"/> Fire Control | <input type="checkbox"/> Radar |
| <input type="checkbox"/> Antennas | <input type="checkbox"/> Human Factors | <input type="checkbox"/> Radio—TV |
| <input type="checkbox"/> ASW | <input type="checkbox"/> Infrared | <input type="checkbox"/> Simulators |
| <input type="checkbox"/> Circuits | <input type="checkbox"/> Instrumentation | <input type="checkbox"/> Solid State |
| <input type="checkbox"/> Communications | <input type="checkbox"/> Medicine | <input type="checkbox"/> Telemetry |
| <input type="checkbox"/> Components | <input type="checkbox"/> Microwave | <input type="checkbox"/> Transformers |
| <input type="checkbox"/> Computers | <input type="checkbox"/> Navigation | <input type="checkbox"/> Other |
| <input type="checkbox"/> ECM | <input type="checkbox"/> Operations Research | <input type="checkbox"/> |
| <input type="checkbox"/> Electron Tubes | <input type="checkbox"/> Optics | <input type="checkbox"/> |
| <input type="checkbox"/> Engineering Writing | <input type="checkbox"/> Packaging | <input type="checkbox"/> |

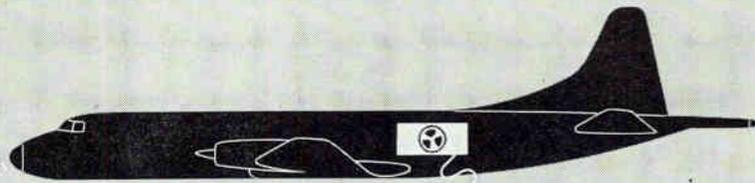
CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



A-NEW

■ One of the U.S. Navy's most pressing problems is anti-submarine warfare. An important step toward the solution to this problem is the A-NEW concept to provide the fleet with an integrated airborne ASW system able to cope with potential submarine threats.

A basic airborne ASW problem centers around the necessity for rapid and precise information processing. Therefore, the A-NEW system is integrated by the application of digital and analogue techniques designed by an Industry/U.S. Navy team. A most important element of the A-NEW system is ADD (Aerospace Digital Development), a UNIVAC airborne computer.

The UNIVAC computer will assist in the determination and display of such things as optimum tactical employment of sensors, sonobuoy and armament, thereby providing a tracking and attack capability against multiple targets.

The A-NEW program is just one of the challenges available at UNIVAC to qualified scientific personnel.

Immediate Openings. Engineering or Scientific Degree plus experience in one of the following disciplines is required.

Aero Space Systems Engineers • System Design Engineers • Production Research Printed Circuit Engineers • Micro-Module Design Engineers • Scientific Programmers • Military Operations Analysts

Address inquiries with a resume of your education and experience to:

R. K. PATTERSON
UNIVAC
Univac Park
St. Paul 16, Minnesota

OR

W. K. LOWE
UNIVAC
P.O. Box 6248
San Diego 6, California

UNIVAC

DIVISION OF SPERRY RAND CORPORATION

Sperry Rand Building, New York 19, N. Y.
(An Equal Opportunity Employer)

FOR INFORMATION

about Classified Advertising
contact the McGraw-Hill
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4 Gateway Center
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PArkview 5-7285 (Area Code 314)
- SAN FRANCISCO, 94111
J. A. HARTLEY
255 California Street
DOuglas 2-4600 (Area Code 415)

Modulating the laser light beam is a key to using the vast data-transmission capability of lasers.

IBM scientists achieved a significant advance when they created the injection laser. With other types of lasers, it is necessary to modulate the output light beam itself. This is relatively inefficient. In contrast, since the injection laser is stimulated by electrical energy, it can be modulated simply by varying the stimulating current. Six months after IBM announced the first injection laser—made of gallium arsenide—engineers were able to demonstrate the first successful transmission of voice signals over an injection laser beam. In addition, IBM scientists have pursued the exploitation of new materials for injection lasers and recently fabricated an indium phosphide device.

The injection laser is excited by passing a current above

a certain threshold through a p-n junction. Electrons produce photons by falling from the conduction band to the valence band and stimulate regenerative oscillations between sharply cleaved ends of the crystal in the region adjacent to the junction. The reinforced oscillations emerge from a 0.01 square millimeter cross-sectional face as an infrared beam having a spectral width of less than 0.5 Angstrom and an angle of spread of 2.5 degrees. Modulation of the output light can be accomplished by varying the current across the junction.

If you are interested in making contributions in lasers or other areas in which IBM scientists and engineers look for answers to basic questions, write: Mgr. of Employment, IBM Corp., Dept. 554J1, 590 Madison Ave., N. Y. 22, N. Y. IBM is an Equal Opportunity Employer.

IBM asks basic questions in lasers

How can we modulate light?

ADVANCED COMMAND & CONTROL SYSTEMS DESIGN ENGINEER

A high level position is now available with Bell Aerosystems Co., a company holding a variety of advanced contracts including a lunar landing research vehicle, exotic instruments, battlefield air traffic controls, mapping systems and learning machines.

The man selected will be responsible for analytical and preliminary design studies of command and control systems for terrestrial and orbital vehicles, accurately defining system requirements and limitations. Specific areas of investigation include position determination, vehicle control, data processing and transmission, and information display.

The demands of the job to be done require an advanced degree in Physics or EE with minimum 8 years related experience, plus knowledge of military system design requirements. Salary to \$18,000.



Please send resumes, in confidence, to
Mr. Thomas Fritschi, Dept. G-32

BELL AEROSYSTEMS CO.

DIVISION OF BELL AEROSPACE CORPORATION - A **Textron** COMPANY
P.O. BOX # 1, BUFFALO 5, NEW YORK
An Equal Opportunity Employer

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is \$27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured 1/8 inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

\$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, \$2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

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

GEORGE:

D.A.T.A. Tabulations keep you current on all Transistors • Semicon. Diodes • Microwave Tubes in the world. Characteristics, type numbers, manufacturers. Far free literature write: D.A.T.A., INC., 43-15 S. Day St., Orange, N. J. 07050

CIRCLE 951 ON READER SERVICE CARD

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
3 & 10 CM. SCR. 584 AUTOTRACK RADARS.
AN/TPS-1D SEARCH. AN/TPS-10 HT. FINDERS.
AN/FPN-32CAL AN/APS-10 RADIC. & WEATHER.
AN/APS-15B PRECISION. AN/APQ-35B. PRECISION.
AN/APS-31A SEARCH. DOZENS MORE.
S-12 MEGAWATT HIGH POWER PULSERS.

RADIO RESEARCH INSTRUMENT CO.
550 Fifth Ave., New York Judson 6-4691

RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 952 ON READER SERVICE CARD

SEARCHLIGHT EQUIPMENT LOCATING SERVICE

No Cost or Obligation

This service is designed to help you, the reader of SEARCHLIGHT SECTION, to locate used or rebuilt equipment not currently advertised. HOW TO USE: Check the ads in this SEARCHLIGHT SECTION to see if what you want is advertised. If not, print clearly the specifications of the equipment and/or components wanted on the coupon below, or on your own letterhead.

THIS IS A SERVICE TO OUR READERS. THIS PUBLICATION DOES NOT BUY, SELL OR STOCK EQUIPMENT OR MATERIALS OF ANY TYPE. Your requirements will be brought promptly to the attention of the used equipment dealers advertising in this section. You will receive replies directly from them.

Obviously, the list of such advertisers is limited by comparison with the over 57,000 subscribers to ELECTRONICS, all directly engaged in the electronics industry. A small EQUIPMENT WANTED advertisement in the SEARCHLIGHT SECTION will bring your needs to the attention of ALL who read ELECTRONICS. The cost is low—3/8" x 2-3/16". Just \$27.25 per advertising inch—3/8" x 2-3/16".

Searchlight Equipment Locating Service CLASSIFIED ADVERTISING

c/o Electronics P. O. Box 12, New York, N. Y. 10036

Please help us to locate the following used equipment:

.....
NAME

TITLE

COMPANY

STREET

CITY

STATE

9/6/63

SELLING OPPORTUNITY AVAILABLE

"ALFA" Radio Testers (VOM)—Made in Belgium. We should like to appoint Distributors in USA for the famous ALFA Radio Testers (VOM), competitive in the International Market—beautiful and precise instruments. For conditions and quotations please write to: Societe Industrielle Alfa, S.A., 80, rue de la Senne, Brussels-Belgium. Tel.: 12-67-30 (5 lines). Telex: 2-21844.

POSITION WANTED

Swiss Engineer (Diploma Technician), age 25, presently working on electronic microscopes, seeks position with American firm, preferably research or laboratory work. Available Spring 1964. Apply Box OFA 4761 CH, Orell Fussli-Annonces, Zurich 22/Switzerland.

"Put Yourself in the Other
Fellow's Place"

TO EMPLOYERS

TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section. We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division
McGraw-Hill Publishing Co., Inc.
330 West 42nd St., New York, N. Y. 10036



E. E.'s for FEE-PAID Positions WRITE US FIRST!

Use our confidential application for professional, individualized service . . . a complete national technical employment agency. ATOMIC PERSONNEL, INC. Suite 1207L, 1518 Walnut St., Phila. 2, Pa.

EMPLOYMENT OPPORTUNITIES



The advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Look in the forward section of the magazine for additional Employment Opportunities advertising.

— RATES —

DISPLAYED: The advertising rate is \$40.17 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured 1/8" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED: \$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions. Not subject to Agency Commission.

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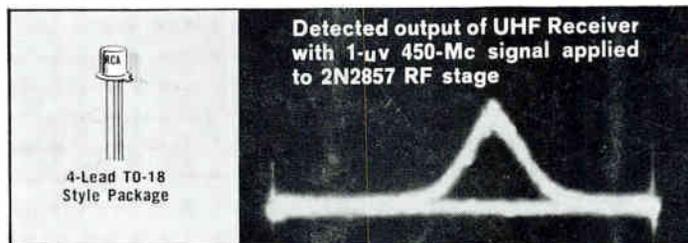
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