A McGraw-Hill Publication 75 Cents December 21, 1962

electronics

CHARACTER READER

Optical system handles many kinds of type, p 58
(*photo below*)

FERRITE LIMITERS

New microwave components, p 40

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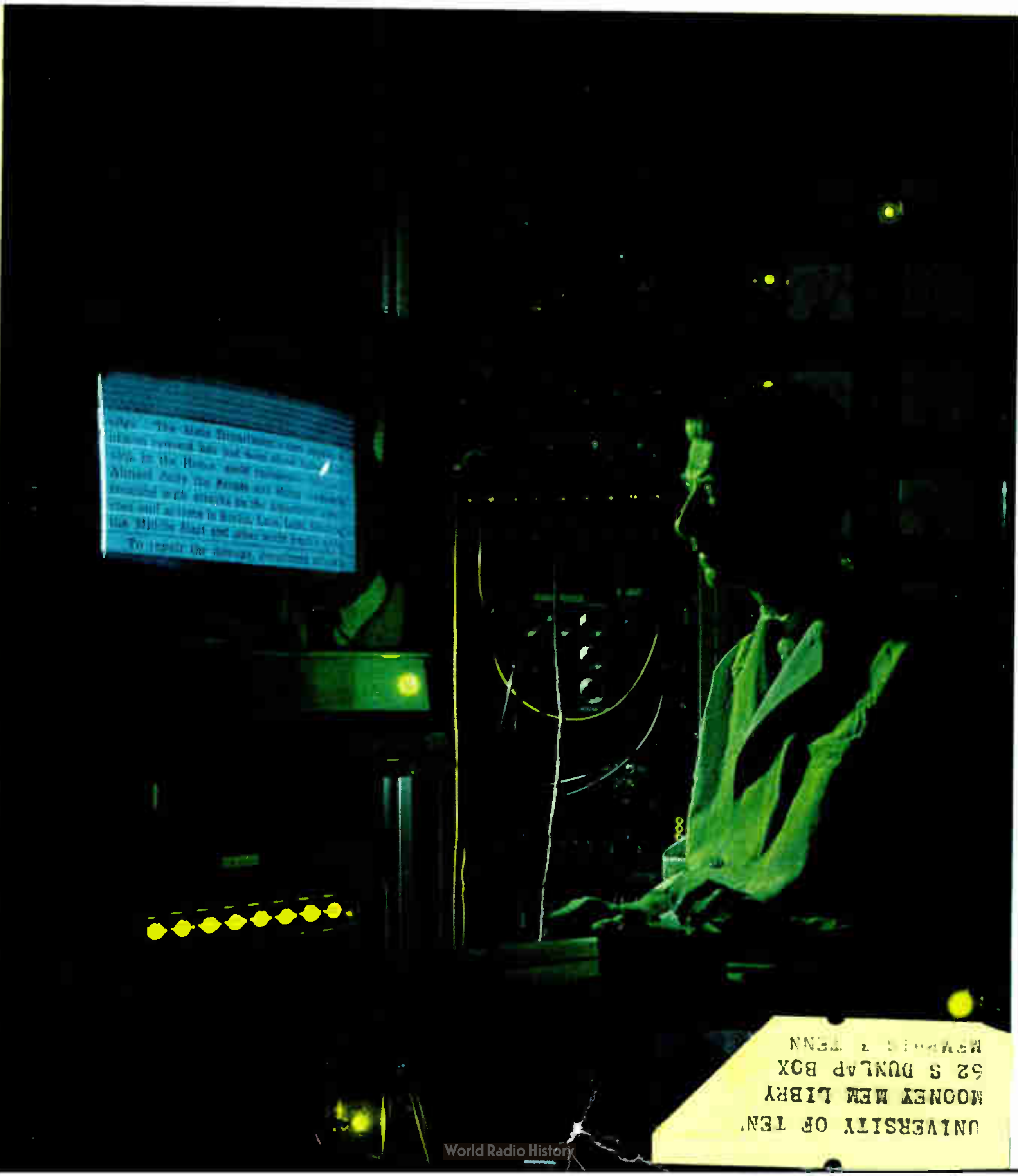
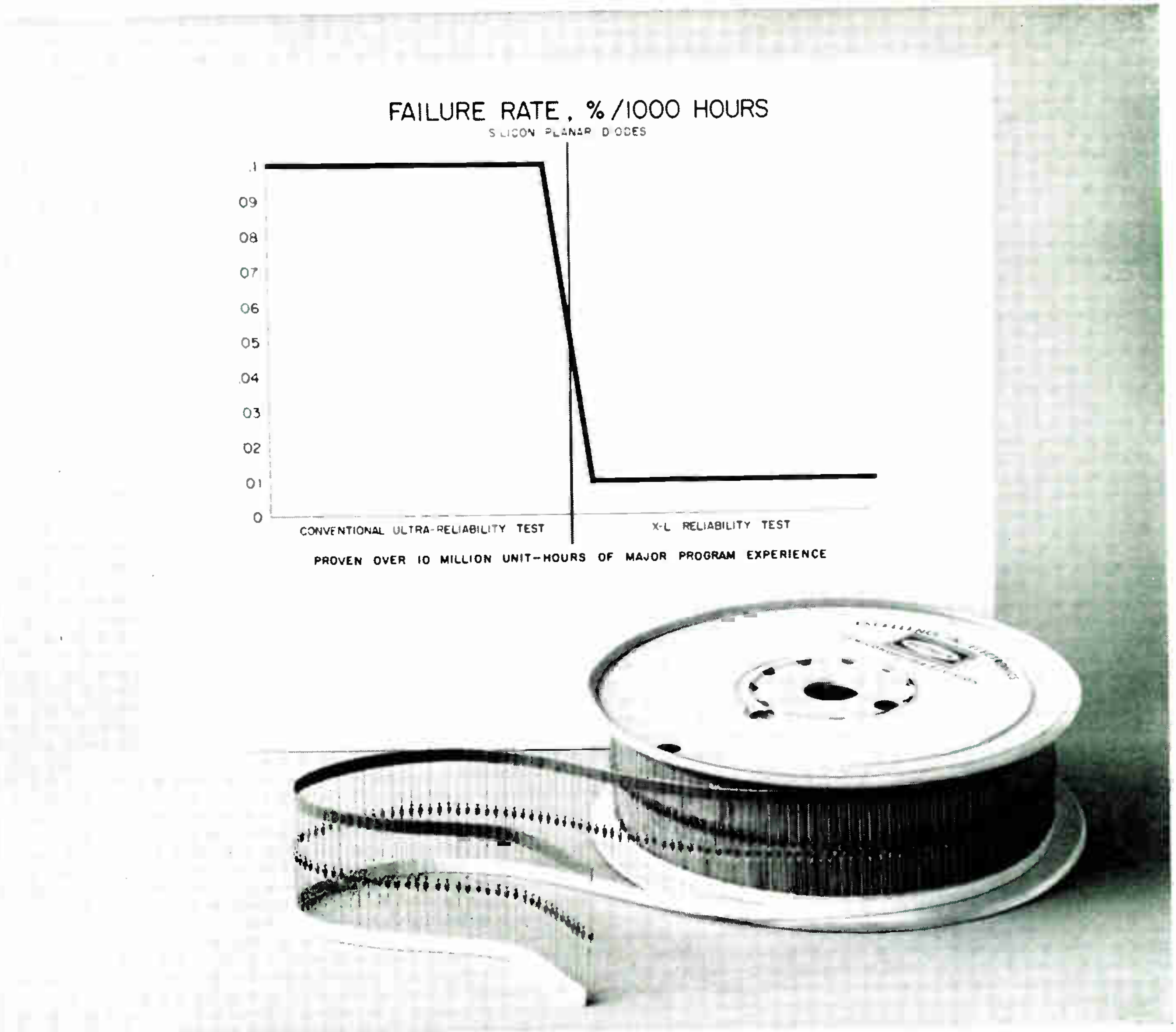
Circuits designed with new devices, p 44





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RAYTHEON

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December 21, 1962

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electronics

December 21, 1962 Volume 35 No. 51

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SIMPLE SQUARE-WAVE GENERATOR. The common free-running multivibrator gives a pretty sick looking square wave and as a result square waves are usually formed by clipping and limiting a sine wave which may require several stages. *With this circuit you need add only four components to the multi to get a good square wave.* By R. O. Gregory and J. C. Bowers, McDonnell Aircraft 47

VARIABLE-WIDTH PULSES: How to Produce Them. Varying the width of nanosecond pulses can be difficult. It is usually done with differentiating circuits, but noise and voltage fluctuation are troublesome. *This circuit varies pulse width over a range of three to one or more and down to 20 nanoseconds. It uses one transistor to start the pulse and another to end it.* By I. Simon, Monroe Calculating Machine 48

REFERENCE SHEET—Antenna Design Reference Data. Here are the physical and electrical characteristics of fifteen common antenna types nicely cataloged for quick reference. *If you have to design antennas, you better tear this article out and hide it before a pass-along reader does—our "perfect-bound" pages tear out easily.* By R. S. Gordon and K. W. Duncan, Sylvania 50

DEPARTMENTS

Suggestion for IEEE

ON JANUARY 1 the Institute of Electrical and Electronics Engineers comes into being.

Formed by a merger of the Institute of Radio Engineers and the American Institute of Electrical Engineers, the new IEEE will be the largest organization of its kind in the world. Its 160,000 members are drawn from two of the most important industries in the country. Electronics alone plays an indispensable role in the defense of the nation.

IEEE will hold its first International Convention in New York in March. There will be a banquet at the Waldorf-Astoria on the 27th and, as yet, no keynote speaker has been chosen. We think one promptly should be, and we have a particular man in mind.

This is a year in which engineering enrollments in colleges have declined. It is a year in which the public has further shifted its romantic attachment from engineers to "more glamorous" scientists. And it is a year in which many engineers, of whom we need more, feel that too many of their important contributions are overlooked or credited to other professionals.

Solution of all of these problems would be aided, with mutual advantages to both the industry and the country, by the right IEEE keynote-speech statements by the right man.

Gentlemen: We give you *The President of the United States.*

MANPOWER SHORTAGE. The points we made in our two recent *Crosstalks* (p 3, Nov. 2, and p 3, Dec. 14) on the declining enrollments in engineering colleges are borne out, we think, by a new report from the Engineering Manpower Commission:

Enrollments this fall in 207 engineering colleges dropped another 2.3 percent, despite an increase of about 10 percent in total college freshman enrollment. Probably, says the commission, only 5.9 percent of all freshmen will be engineering students, compared to 10.8 percent in 1958.

The commission calls this lack of interest in engineering a "mystery," since more students should have been attracted by such factors as: increasing public awareness of the role of engineering, government concern with the problem, higher starting salaries for engineers than in other fields, predictions of growing shortages of engineers, community relations efforts by colleges and the "almost irreducible low of previous freshman engineering classes."

DATA DIGGING. The first chore of a design engineer undertaking a new project is to digest all available background information. When there are a half-dozen ways to skin the cat, much of the initial decision-making is in eliminating unsuitable approaches, before blazing new trails.

If you are an antenna designer—or better yet, if you are not, but work on projects that require the selection of an antenna—this week's reference sheet on p 50 should come in mighty handy. The charts compare the major features of important antenna types, providing a quick and easy way of eliminating those that are impractical for a specific application.

Coming In Our December 28 Issue

WEIGHT REDUCING. Once Columbus showed how to stand an egg on end, the solution was obvious. Likewise, if the focusing magnet of a klystron is removed and electrostatic focusing substituted, the klystron will be much lighter. This is so obvious that now, 25 years after the invention of the klystron, one using electrostatic focusing has been built.

Next week, J. R. Hechtel and A. Mizuhara, of Litton Electronic Tube Corp., tell how—if you don't mind a mixed metaphor—they crunched the end of the klystron to get 15.5 Kw peak power out of a 5-pound tube.

Other features next week include:

- Radar that analyzes soils to help make Army maps
- How to select the best thin-film triode
- Microcircuit servo amplifier with inside-out transistors
- Raster oscilloscopes for faster time measurement
- Chart that enables bypass capacitors to be quickly and accurately chosen.

COMMENT

Life Testing

Your special report on Reliability: 1962 (p 53, Nov. 30) is an interesting collection of information on a subject of major concern to many people at this time.

My only comment is that the economic value of reliability in action is not yet fully understood by *all* those to whom it is vitally important. For example, a case in point is suggested by the question on page 60 of your report, "But are we in danger of life testing ourselves into national bankruptcy?" The answer depends on whether or not the amount of life testing is properly balanced against the final economic consequences of success, or failure, of the ultimate system in whose evolution such testing is a part.

PAUL S. DARNELL
Director
Reliability Engineering Center
Bell Telephone Laboratories
Whippany, New Jersey

Engineering Shortage

I would like to comment on the four suggestions that you propose to ease the "engineering shortage" (p 3, Nov. 2).

Your first suggestion of "recruitment at the high school level" implies that most present engineering jobs can be performed by high school graduates, with which I agree.

As for creating a "correct image of engineering . . . to the public," I doubt if the designers of, say, Telstar, care if the public thinks that they drive locomotives, nor do I think that they were attracted to their profession (when we didn't have Telstars) by public opinion. I further feel that engineering is not something to peddle as one would soap.

In your third suggestion, that we establish "effective . . . engineering curricula," I think that you are getting warm. However, it may be too late in that the educators are not going to throw away all of those large pieces of rotating machinery that they keep in the basements of their institutions simply because they have no application to, say, parametric amplifiers. And they are right, in a way, because they will argue that plotting the windage loss in a synchronous motor has taught thousands of electrical engineers the engineering method, and paramps will come and go, anyway.

For your fourth suggestion, that "engineers teach high school students," this would only tie up a lot of engineers who, everyone is beginning to admit, are in short supply.

As for myself, I favor the educator's suggestion that the engineering curriculum be revamped with less hours, so that he can participate in outside activities such as golf. This will give him the broad background that he will need to manage the kids who are going into pure science and who will be doing —make no mistake—the future engineering.

W. G. BANSHAK
Sunnyvale, California

That first suggestion didn't mean hiring high school students for engineering jobs, but rather stimulating an interest in studying engineering among these students.

As to changing the curricula, take a look at the editorial on page 3 of the Dec. 14 issue, which suggests revisions in lab courses.

A-C To D-C Conversion

In your article, Will D-C Power Cause Interference? (p 30, Sept. 7), the schematic for conversion has an error. Although there is a statement indicating that the schematic is one-half of the conversion circuit, there is doubt that the circuit will work.

The present arrangement is actually a half-wave rectifier shorting the negative cycle through ground. There would be a big waste of power and possibly a burnout of the secondary windings of the rectifier transformer.

FRANK SMAIDRIS
McGuire Air Force Base
New Jersey

The neutral of the star-connected secondary should be connected to the transformer case, not to ground.

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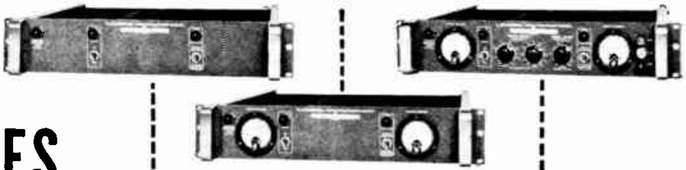

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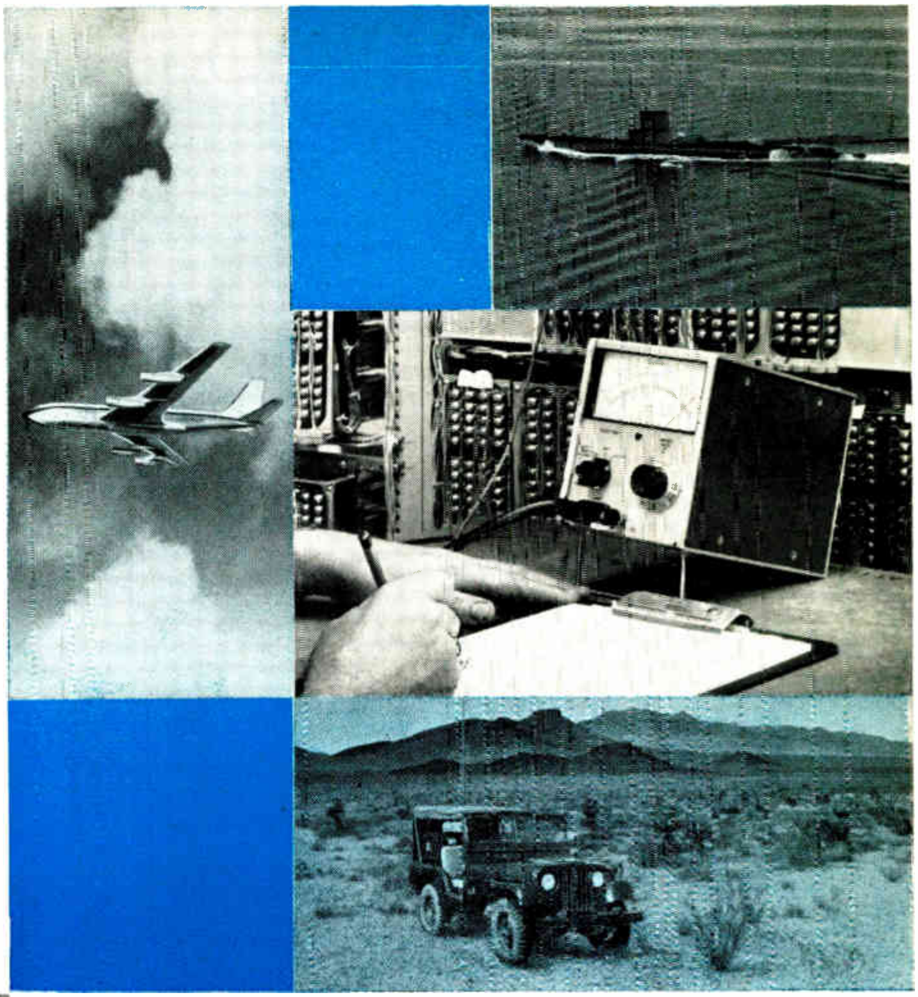

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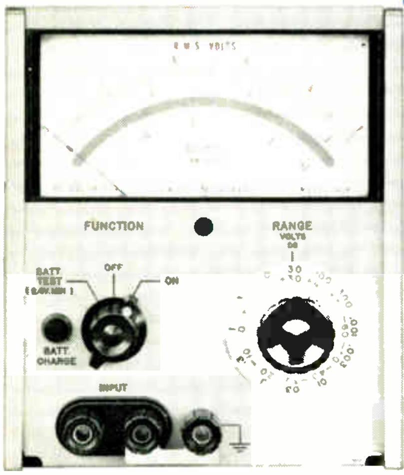

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Nominal Input Impedance:	2 meg-40 pf, 0.001-0.03 v ranges; 20 pf, 0.1-3 v ranges; 15 pf, 10-300 v range
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Power:	4 rechargeable batteries (furnished). 40-hr operation per recharge, up to 500 recharging cycles. Self-contained recharging circuit functions when instrument is operated from ac line
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NASA'S Patent Policy Displeases Both Sides

WASHINGTON—NASA found itself caught in the middle last week at its hearings on the proposed patent waiver regulations (p 12, Nov. 9, and p 3, Nov. 16). The new regulations tend to loosen the space agency's grip on patents resulting from NASA-funded R&D.

Industry, calling for more sweeping relaxation, and Senators Estes Kefauver (D.-Tenn.) and Russell Long (D.-La.), denouncing the relaxation as give-away, were two arms of the pincer. Spokesmen for the California Institute of Technology stood on the sidelines and threw rocks, complaining that nonprofit institutions like itself were completely neglected in the policy.

The most extreme industry view was taken by Robert M. Galvin, president of Motorola, speaking for the Electronic Industries Association. He proposed a policy that would line NASA up with Department of Defense practices of releasing patents to industry. Similar but more moderate positions were taken by spokesmen for the American Bar Association, the National Association of Manufacturers and the Aerospace Industry Association.

Galvin requested that waivers be granted automatically upon request in the three categories previously proposed by NASA. In addition, he said, waivers should be granted for inventions useful in a contractor's field, and when the invention is only incidentally useful to NASA but has substantial promise of commercial utility. Galvin also recommended that waivers be permitted if the contractor applies for a patent within a year from effective date of the contract.

NASA is withholding any decision on the regulations, pending further hearings January 28. The resumption was requested by Sen. Kefauver, who asked other congressmen have a chance to be heard. Kefauver predicted trouble in Congress if NASA adopts its proposed new policies.

Minuteman Works on East Coast, Fails in the West

MINUTEMAN ICBM made its longest flight yet, 5,200 miles, in a successful test flight from Cape Canaveral to near Ascension Island, in the South Atlantic.

Meanwhile, Minuteman struck out for the second straight time at Vandenberg AFB, Calif. It exploded a few seconds after a launch that Air Force had hoped would demonstrate combat readiness.

The missile is now operational at Malmstrom AFB, Mont. The flights at Vandenberg are intended to train launching crews.

British Reportedly Got Ample Warning on Skybolt

UNITED STATES repeatedly told Britain that Skybolt would be dropped if it appeared unsuccessful, according to the *New York Times*. The paper's news service said it was quoting "authorities . . . anxious to set the record straight" before the Kennedy-Macmillan talks.

The warnings were said to date back to an Eisenhower-Macmillan agreement at Camp David in 1959, indicating a cut-off date of 1963. Eisenhower was said to have received three negative reports on Skybolt, but that Macmillan was more optimistic. The sources were quoted as denying that the Polaris base in Scotland was given by the British in trade for Skybolt.

British Defense Minister Thorneycroft told the House of Commons in London last week that no decision was reached on Skybolt during his talks with U. S. Defense Secretary McNamara. Macmillan indicated that Britain is counting on its own stand-off bomb, Blue Steel, until a "better instrument" comes along.

The Pentagon said this week that Skybolt would not be operational until after 1966.

EIA Files Objections To $1.52 Minimum Wage

WASHINGTON — Electronics Industries Association filed exceptions last week to five findings of the Secretary of Labor in his tentative determination to set a minimum wage of $1.52 an hour for electronic equipment contractors under the Walsh-Healey Act.

EIA took exception to findings that the prevailing wage was $1.47 during a survey made in 1960, and that there had since been a 5-cent increase. EIA suggested that retention of higher-paid employees

Mariner Passes Venus, But the Drama Goes On

LOS ANGELES—As Mariner II journeyed into solar orbit this week, the big question became: What did it see on Venus—burning deserts and dust clouds, or conditions that would permit manned exploration?

It may be weeks before radiation and cloud cover data gathered by infrared and microwave radiometers (p 42, Dec. 14) can be decoded, says Jet Propulsion Laboratory.

Mariner gave scientists two anxious moments on Friday. Twice the experiments failed to respond to command signals, but at 1:55 p.m. they answered a command from Goldstone, Calif. At 2:17, Mariner was over the planet's bright side and at 2:37, it passed beyond the radiometer scan area. Closest distance was 21,100 miles at 3:01.

The voyage had been a cliff-hanger all the way—the race against time to launch Mariner II after Mariner I's launch failed, the mid-course correction, the week-long power failure a month ago, and finally doubt whether the batteries could stand the intense heat near Venus. They did during an employment decline may have made it appear there were increases. Also disputed was whether an industry-wide determination was appropriate.

The association also protested that it was not allowed to see the responses to the wage survey questionnaire. Final objection was that making effective date of the final determination 7 days instead of 30 would not give prospective bidders time to compute additional costs.

Enough Ph.D's and M.S.'s Will Cost $4.7 Billion

WASHINGTON—The President's Science Advisory Committee is recommending that $4.7 billion be pumped into the nation's higher education system to provide additional graduate engineers and scientists.

A panel headed by E. R. Gilliland, of MIT, said that the number of Ph. D.'s graduated each year should be increased from 3,400 in 1962 to 7,500 in 1970. Master's degree graduates should be increased from 13,000 in 1962 to 30,000, the report said.

About 60 percent of the $4.7 billion could be provided by the federal government and the remainder by local and private interests. The report recommended strengthening of existing educational centers and the establishment of new regional centers.

The report stressed that a need for "superior" engineers and scientists must be met, not only increasing the number of graduates.

Optical Fiber Probes Reveal Laser Spectrum

BOSTON — Optical frequency discriminator and optical fiber probes are being used at Air Force Cambridge Research Labs to investigate the behavior of ruby laser crystals.

The crystals, because of large fluorescent line width, oscillate at many frequencies. Oscillations at various frequencies are not only intermittent, but the spectrum also varies considerably from firing to firing.

In the experiments, the discriminator spatially separates various frequencies. The fiber probes are positioned so that each picks up light at only one frequency, for monitoring.

Large Real-Time Computer Announced

HUGHES AIRCRAFT reports that it is now testing the first of its H-330 large-scale, real-time computers. The system will be used next year in the Syncom communications satellite project.

While the computer is primarily designed for military applications, Hughes said it can also be used for scientific and other purposes. It is the first commercial computer made by the company. The company has been producing military computers.

Among operating features are 32 channels of automatic buffered input-output, program interrupt and program protection. Main memory effective cycle time is 0.9 μsec and control memory cycle time is 0.45 μsec. Some 65,000 words each of program and data memory can be addressed. Words of 24 to 48 bits will be available.

Relay Goes Up, But Power Is Too Low

NASA REPORTED on Monday that the transmitter of the Relay satellite will be turned off for an indefinite period while telemetry data is analyzed in an effort to determine the cause of an apparent power supply failure.

The satellite was successfully launched last Friday into an orbit with an altitude range of 4,612 to 820 miles. The tracking station at ITT, Nutley, N. J., was receiving telemetry data shortly after Relay went into orbit, but battery power was too low for communications tests. Solar cells failed to boost power sufficiently.

If successful, Relay would have established the first satellite communications links between South America, Europe and North America. Telstar, also silent now, provided a path between Europe and North America. Relay was built by RCA.

In Brief . . .

NEW ISSUE of "Inventions Wanted by the Armed Forces and Other Government Agencies" has been published by the National Inventors Council. It is available free from the Office of Technical Services, Department of Commerce, Washington 25, D. C. The list includes nearly 200 inventions wanted in the electronics and instrument fields.

RALPH J. CORDINER, GE chairman, expects 1963 to be a good year for business. He estimates gross national product will rise from about $554 billion in 1962 to some $570 billion in 1963.

DES MOINES, Iowa, Technical High School will start training computer operators next year with a Burroughs B260 system. Federal and state governments are underwriting $\frac{3}{4}$ of the $$\frac{1}{4}$-million cost.

SEMICONDUCTOR NETWORKS will be used in the improved version of Minuteman to replace discrete components. Autonetics has placed initial production orders with Texas Instruments.

HONG KONG'S transistor radio exports are now three times as high as in 1961 (p 24, Sept. 28). For first nine months of 1962, exports totalled 793,513 sets, including 474,543 to the U.S.

BURNDY CORP. has bought out Glass-Tite Industries' 50-percent interest in Burndy-Escon.

RADIO CARACAS, Venezuela, is buying a 15-transmitter tv system that will cover 97.5 percent of the country's population. The RCA system will include 600 miles of microwave links and will cost $750,000.

OAK RIDGE National Laboratory is replacing its Oracle computer with a system built around Control Data Corp. 1604-A and 160-A computers.

DALMO VICTOR will produce Rotodome antennas for Grumman's W2F-1 early-warning naval aircraft. Order is expected to total $6.5 million when fully funded.

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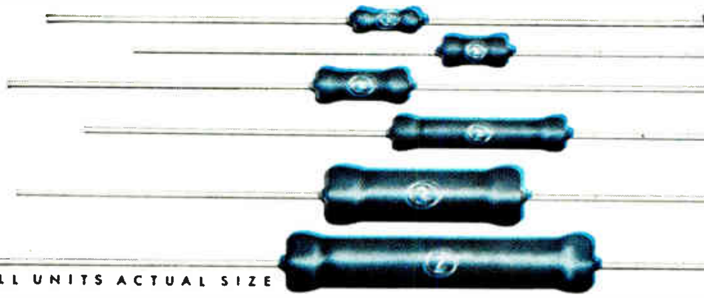

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WASHINGTON OUTLOOK

ENGINEERS ON FCC . . . AND THEN THERE WERE NONE

AN FCC TRADITION was overruled by President Kennedy last week when he named Kenneth A. Cox to succeed the retiring T. A. M. Craven on the Federal Communications Commission. For the first time, no commissioner is an engineer.

Broadcasters opposed to Cox used this fact to try to block his appointment. Cox, chief of FCC's Broadcast Bureau, has broad experience in the government end of broadcasting and is known as a tough regulator. But even some of his admirers at FCC concede merit to the argument that an engineer is needed to bridge the gap between technical possibilities and what the nontechnical members want to do on policy questions. Craven often bridged this gap.

If a communications problem develops between FCC and its engineering staff, the cry may soon arise for an engineer appointee. However, the next term to expire will be that of Frederick W. Ford, in June, 1964. Since the FCC must be bipartisan, Ford—a highly respected Republican appointee—looks like a good bet for reappointment.

IT'S OFFICIAL: SPRINT EXISTS

ARMY HAS FINALLY confirmed that studies of Sprint (p 7, Dec. 14) are underway. The new missile, says Army, could enhance the anti-ICBM capabilities of the Nike Zeus system. Sprint would be faster, could intercept at lower altitudes than Zeus and would carry simpler guidance. Theoretically, Sprint could defend better against saturation missile attacks. Ground support equipment would be like Zeus'.

One R&D concept is called Hardpoint. Study contractors for this are American Machine & Foundry, site requirements; Maxson Electronics, ground support equipment, and Hughes Aircraft, evaluating the overall system and the intercept vehicle. No contractors have been identified for Hardsite, a second phase of the Sprint project.

SATELLITE CORPORATION TAKES SHAPE

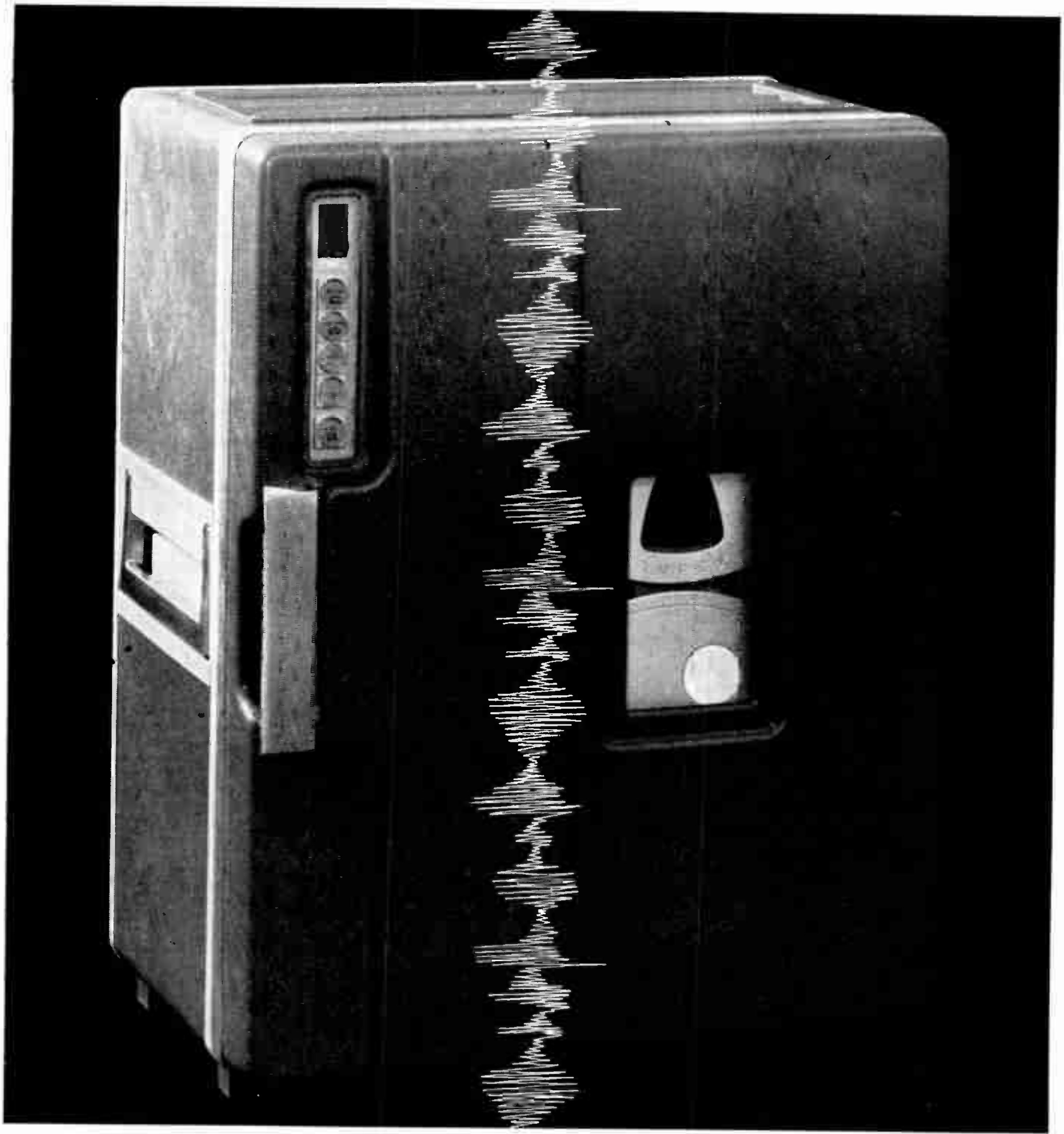
INCORPORATORS of the private company that will run a satellite communications system (p 7, Oct. 12) are expected to agree by early next year on articles of incorporation and by-laws. Companion to this is setting initial capitalization and picking a company president.

FCC has issued proposed regulations under which communications companies must qualify to participate in ownership of the corporation. FCC terms the rules "quite liberal." Industry has some minor questions, however. Final regulations may not be ready for a month.

ROVER MUST PASS TESTS OR FACE AX

WHETHER MORE MONEY will be pumped into Project Rover, the nuclear space propulsion program, depends on the success of a round of tests to be conducted between now and next July. If the project goes well, nuclear reactors could be used for lunar flights in 1970 or 1971 and later, perhaps, for flights to Mars.

Harold Finger, NASA's director of nuclear systems, says Rover is on schedule and—Budget Bureau willing—will continue so. Program costs are expected to total $1.5 billion. Rover got $175 million this year and $260 million has been spent to date. Another $400 million was anticipated for fiscal 1964, but there is pressure in NASA and the Budget Bureau to cut this in half and stretch out Rover, feeding the extra money as available into Apollo and Gemini.



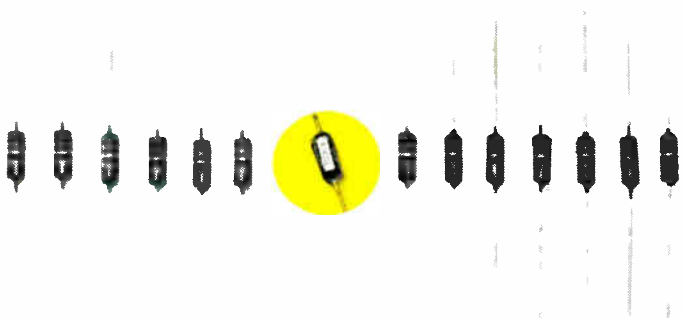
Who'd have thought a 14-track 300 KC recorder could fit into a case this small? **AMPEX**

Here is the portable recorder you've been waiting for: the new Ampex FR-1300. It offers all the performance, all the reliability of much larger rack-mounted instrumentation recorders. Yet it fits into a portable case only 24 inches tall. In fact, it's so compact and lightweight that you'll find yourself treating it like any standard piece of laboratory or test equipment; moving it from job to job or lab to lab. And just look at all you get: 14 tracks, Direct and FM recording, six electrically selected speeds,

recording capability from 300 cps to 300 KC at 60 ips—and all solid-state electronics throughout, all packaged in one portable case. The FR-1300 also features a built-in capstan servo system to guarantee accurate tape speeds, without the need for an accessory motor drive amplifier. For more details write the only company providing recorders, tape and memory devices for every application: Ampex Corporation, 934 Charter Street, Redwood City, California. Worldwide sales, service. **AMPEX**

ZENER DIODES

TRANSITRON'S BROAD LINE OF STANDARD SUBMINIATURE GLASS ZENER DIODES GIVES YOU THE COMPLETE RELIABILITY THAT 99 CIRCUITS IN 100 DEMAND. TRANSITRON'S ULTRA-RELIABLE DIODE — THE CERTIFIED VOLTAGE REFERENCE — DELIVERS THE GUARANTEED STABILITY THAT ONLY 1 CIRCUIT IN 100 DEMANDS.

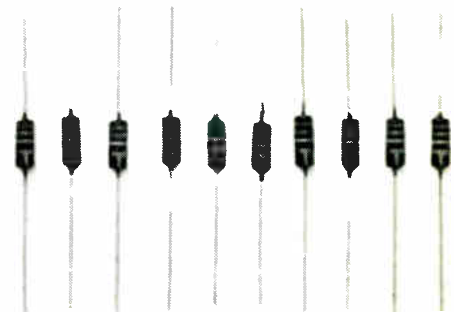


PROVED

The CVR demonstrates a high level of manufacturing competence. It is individually power-aged, temperature-cycled and documented for more than 1,000 hours, demonstrated to provide voltage stability to within ±0.000124 volts; serially registered; and currently available in production quantities.

The CVR is but one example of Transitron's capacity to satisfy a wide range of diode requirements. Made on the same production line that makes all Transitron voltage references, it reflects a research-to-production experience that further improves hundreds of other high-quality Transitron subminiature glass zener diodes.

IMPROVED



Transitron's standard line of regulators and references spans a wide range of voltage, tolerance, power and package requirements. Subminiature glass, micro-miniature glass with an hermetic seal, and high power dissipation types, up to 10 watts, in appropriate standard packages, are all in continuous volume production. All types — including military — are tested and rated in accordance with appropriate MIL specifications.

Popular subminiature glass series available through your Transitron Distributor include 1N761-1N769, 1N702(A)-1N725(A), 1N821-1N829 and 1N3501-1N3504 (CVR), all with power ratings of 250 mW. Also available, 1N746(A)-1N759(A) series with a power rating of 400 mW. For complete listing, write for An Alpha-Numerical Guide to Transitron Silicon Zener Diodes.

Transitron 1952 10 YEARS 1962 LEADERSHIP IN SEMICONDUCTORS

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N.V. Philips' Gloeilampenfabrieken, EMA-Department, Eindhoven, the Netherlands

For Canada: Philips Electronic Equipment Ltd., 116 Vanderhoof Ave., Toronto 17, Ont.

Analyzer, type PM 6505

This new Philips Analyzer, a high-quality instrument of outstanding characteristics and performance, is designed for all measurements on 3-wire and 4-wire transistors of both the PNP and NPN types, and for the measurement of diodes. It also permits simultaneous connection of two transistors for reference measurements and for the matching of pairs.
The highly stabilized voltages and currents are supplied from four incorporated supply units of exceptionally large power. An extra output is provided for the display of diode and junction curves on an oscilloscope (Philips type GM 5639 recommended).

Measuring facilities

- Short-circuit test between collector and emitter
- Leakage currents I_{CEO}, I_{CBO} and I_{EBO}
- Static curves $I_C = f(I_B)$ and $I_C = f(V_{BE})$
- Knee voltage V_{CEK}
- Parameters h_{fe} (AC current gain) and h_{ie} (dynamic input imp.)
- Display of diode and junction curves on an oscilloscope (Philips type GM 5639 recommended)

Measuring and setting ranges

collector supply (V_{CE}, V_{CB}, V_{EB}, I_C)
0-2 V, 0-6 V, 0-12 V, 0-30 V, 60 V
max. power 10 W

driving current supply (I_{CE}, I_{EB})
0-10 μA, 0-100 μA, 0-1 mA, 0-10 mA, 0-100 mA, 0-500 mA
stabilized current supply

basis voltage supply
0-200 mV, 0-500 mV, 0-2 V
also for V_{CEK} measurements

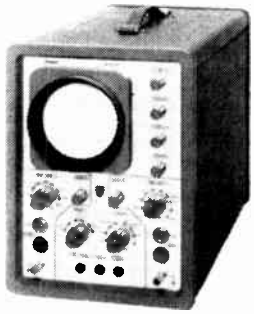
h-parameters (h_{ie} and h_{fe})
0-0.1 kΩ, 0-0.3 kΩ, 0-1 kΩ, 0-3 kΩ, 0-10 kΩ, 0-30 kΩ
0-10, 0-30, 0-100, 0-1000 measuring frequency 420 c/s

Diode voltages (V_D)
0-12 V, 0-60 V, 0-200 V (half sine across diode)

Accuracy of measurement
All three instruments are of the 1.5 class
Accuracy of h-parameters: 5 % after calibration (with built-in calibration circuit)
Knee voltage 2 %

Power supply
110, 127, 145, 200, 220 or 245 V, 40-60 c/s

Dimensions and weight
330 x 400 x 290 mm; 19 kg
(13 x 15 3/4 x 11 7/16 in; 41.8 lbs)



type GM 5639

instruments: quality ***tools*** for industry and research

PHILIPS

NEW SENSORS to Upgrade Satellite

By JOHN F. MASON, Senior Associate Editor, and LEON H. DULBERGER, Associate Editor

Improved techniques and gains from other space programs will be applied

AIR FORCE is reorienting its Satellite Inspector (Saint) program. Taking advantage of the program's delay, because of a cut in funds, the new design will be based on more advanced sensor components. Also, a program definition phase for a more advanced system will be introduced.

One change will be cancellation of the simple flight demonstration program. Experience gained from other space missions will help fill this gap, and the money saved can be plowed into the new sensor development work. Although not yet operational, the new sensors hold greater military potential than the ones scheduled for the original design.

USAF'S OBJECTIVE—The Satellite Inspector's function remains the same: to detect enemy satellites, identify them, and determine what they are up to, and how they plan to do it. Ultimately, the Inspector will carry a kill mechanism. Future craft might even carry a crew.

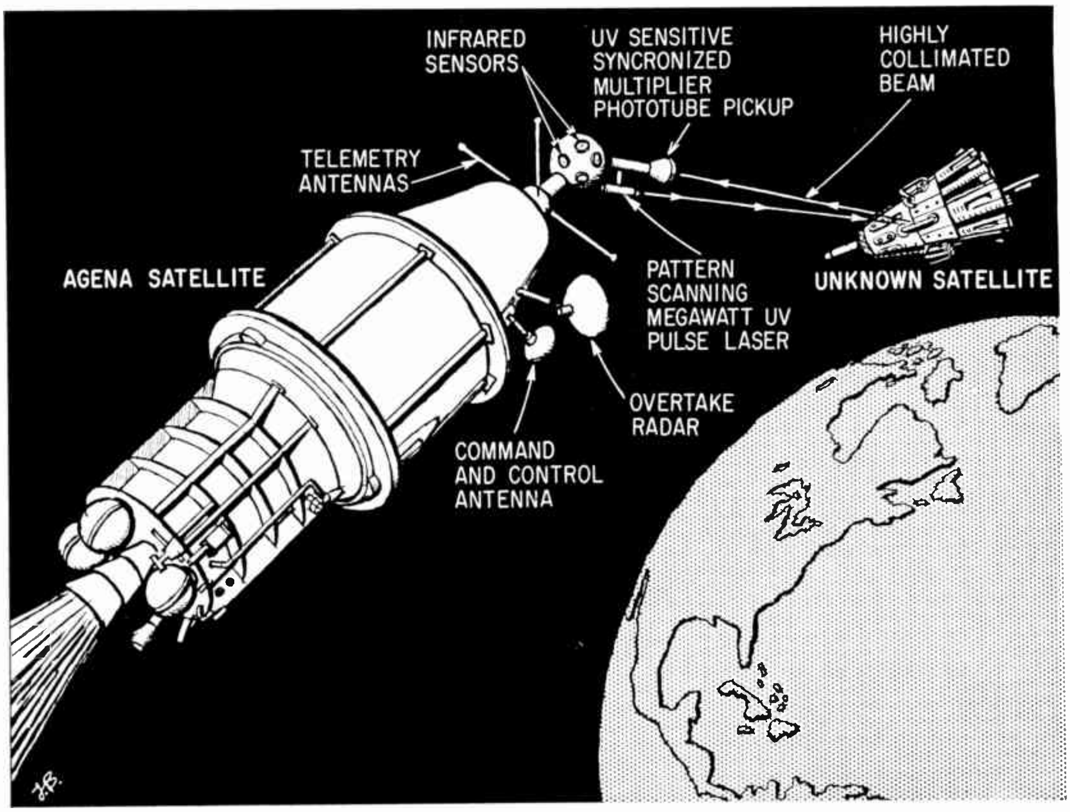
The Inspector craft will be the entire Lockheed Agena D second stage, boosted out of the atmosphere by an Atlas D, and placed into orbit by the Agena itself. The old plan for the Inspector was to place the Agena into orbit about 50 miles ahead of, and above, the enemy satellite. It would home on the satellite by radar, slowing down by retrorockets until it was within 50 ft of the target. Television would then be used to identify the hostile craft.

Although radar definition is not sufficient to identify a satellite, even at the very highest radar frequencies, it will probably still be used to track, match orbits and overtake the unknown craft. A doppler system is probable.

TELEVISION SECONDARY—The sensor that is probably being abandoned is tv.

Use of a television camera for pickup, and illumination of the unknown satellite by ambient light in space, or a strobe light mounted on the inspector craft, would provide a low-definition picture. Thus, positive identification would not be obtained. Tv may still be employed for a secondary role.

INFRARED SENSORS—Another sensor that might be used is passive infrared (ir).



LASER-OPERATED SATELLITE *Inspector might operate like this. High definition picture of target is possible with advanced optical techniques*

Inspector Program

Although detectors for use at ir wavelengths have limited sensitivity, they would provide a gross outline of the target. Hot objects, such as operating rocket motors or nuclear reactors, would be revealed as bright spots. Positive identification of the satellite, however, would not be possible.

LASER METHODS POSSIBLE—Advanced techniques, which may be under study by Air Force, include lasers, and radarlike systems using them. The lasers could operate at visible light or ultra violet wavelengths.

One system could use a laser beam synchronized in a scanning pattern to paint the satellite under inspection with a high-intensity, narrow-bandwidth, coherent light. A pickup multiplier phototube, using a scanning format synchronized with the laser, would follow the beam, and produce a composite picture, in depth, of the target.

Using lasers, measurement accuracies to a few thousandths of an inch, at ranges of a mile or more, are possible. Thus, each wrinkle in the skin, and, nut and bolt, of the unknown satellite would be recorded. Illuminating one portion of the target at a time reduces reflections to improve definition.

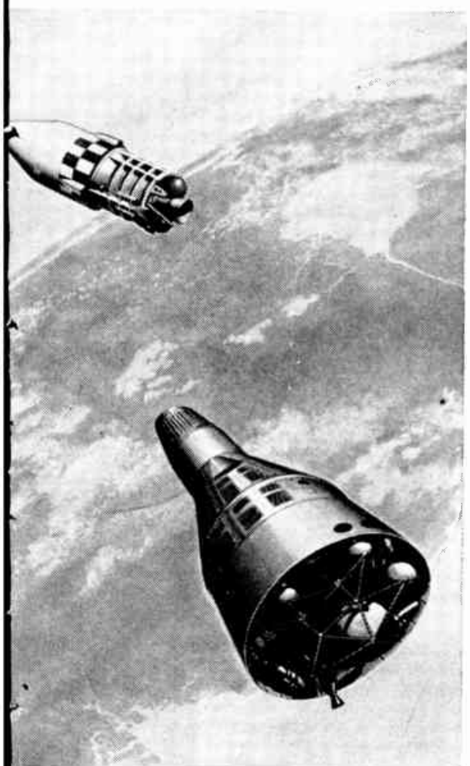
The narrow bandwidth of the laser would allow filters to be used on the multiplier phototube pickup, to eliminate background noise from stellar radiations.

LASER WAVELENGTHS—For applications in the atmosphere, lasers operating in the visible light spectrum are desirable to reduce signal attenuation. Lasers operating from red through orange have been demonstrated by different researchers. Fully documented operation of a green laser may not be far off.

A uv laser would provide the best definition and could be operated in the vacuum of space. Uv radiations provide a high energy return to the detector, and efficient multiplier phototubes optimized for uv applications exist.

The Navy has already announced operation of a rudimentary uv laser. Although it does not lend itself to collimated beam applications, it does demonstrate the feasibility of lasing at uv wavelengths. The Navy device uses gadolinium-activated silicate glass, pumped by xenon flash tubes. Output is at 3,125 angstroms. Spatial analysis of its far-field pattern has not been reported.

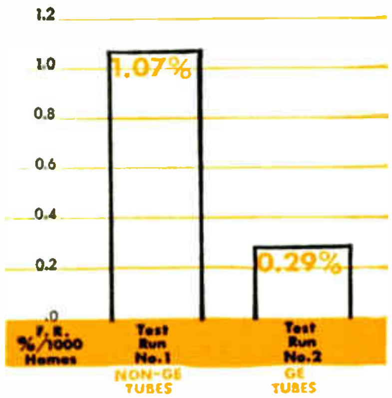
The new Inspector program will require partial termination of USAF's contract with RCA's Defense Electronic Products division, Burlington, Mass., and consequently will affect a number of subcontracts. RCA was building vehicles for the test flight program that has now been cancelled.



TWO-MAN GEMINI *capsule, shown encountering an Agena satellite in this Martin Co. sketch, could be used by USAF to test rendezvous techniques in the Satellite Inspector program*

TIPS *(Technical Information and Product Service)*

6 NEW PRODUCT DEVELOPMENTS



3 million test hours prove G-E tubes give 4 times lower failure rate than other brands

50 TV sets of a leading manufacturer (other than G.E.) were selected for a 3-million-hour life test of G-E and non-G-E electron tubes. The test consisted of two consecutive runs which were identical *except for the receiving tubes*. Run #1 was conducted using the original, non-G-E, tubes. The tube complement of each set consisted of one each of 15 tube types. Each set was operated at normal line voltage, 120v, through 200 cycles of "10 hours on—2 hours off" (plus a down-period of 16 hours each week) for a total of 2000 operating hours. During Run #1 (non-G-E tubes) there were 15 tube failures distributed among 7 of the tube types.

Immediately following the completion of Test Run #1, the same 50 TV sets were re-tubed, using G-E tubes in 14 of the 15 sockets. The remaining type, 6ES8, was not replaced with a G-E type, since it is not manufactured by G.E. The sets were operated and cycled, as before, for 2000 hours. During Test Run #2 there were 4 tube failures distributed among 3 tube types.

Failure rates, on the 14 types replaced for the two test runs, are:

Test Run #1 (Non-G-E tubes)	1.07%/1000 hrs.
Test Run #2 (G-E tubes)	0.29%/1000 hrs.

. . . a 4-to-1 advantage for G.E.!

ACTUAL SIZE

New microwave ceramic triode offers less than 2-second warm-up

G.E.'s new coaxial ceramic triode, the Y1124, offers the designer the advantages of small size and weight, plus electrical performance not possible with either tubes or transistors. The Y1124's exclusive electrical features are:

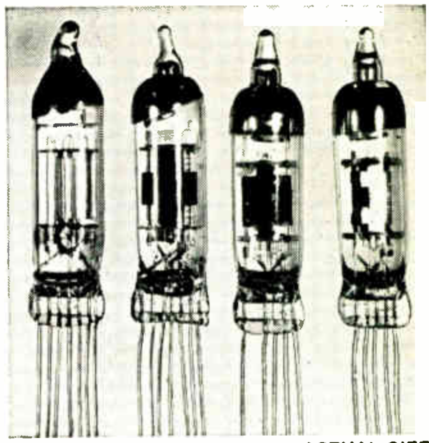
a) Three-second warm-up, which can be reduced to under two seconds with appropriate ballast . . .

b) Operational capabilities up to X-band

Fast warm-up is achieved by increasing the thermal conductivity between the heater and cathode. Warm-up time is defined as the time necessary for the plate current to reach 80% of its three-minute value. Although certain tubes and transistors now on the market can match one or the other of the Y1124's electrical features, none can match *both* of them.

A broad spectrum of missile and defense applications exists for the Y1124, including applications involving sequential start-up and short countdown procedures. For example: missile-arming circuits and telemetering functions.

Besides fast warm-up and high frequency capability, the Y1124 offers the superior environmental resistance to high temperatures (400°C., max.), shock, and nuclear radiation inherent in all G-E ceramic tubes.



ACTUAL SIZE

Now from G.E. . . . pressed-stem subminiature tubes

Four 6-volt pressed-stem tubes have been added to G.E.'s present line of subminiatures. Basic, maximum ratings on the four types are:

a) **5702 high-mu pentode**

plate voltage	165 volts
plate dissipation	1.10 watts
cathode current	16.5 ma
screen voltage	155 volts

b) **5703 low-mu triode**

plate voltage	200 volts
plate dissipation	1.35 watts
plate current	15 ma
grid current	5.5 ma

c) **5744 high-mu triode**

plate voltage	275 volts
plate dissipation	1.3 watts
plate current	6.5 ma
grid current	1.0 ma

d) **5829 double diode**

peak inverse plate voltage	360 volts
peak plate current, per plate	33 ma
DC heater-cathode voltage	360 volts
DC output current, per plate	5.5 ma

Pressed-stem tubes are particularly suited for applications requiring small size and weight . . . ideal for horizontal print board mounting. Flexible leads may be soldered or welded to circuit components without the use of sockets.

GE ELECTRONICS

FEATURING G.E.'s "ACCENT ON VALUE"

ACTUAL SIZE

New 7815 ceramic triode delivers high pulsed-power output at frequencies up to 3000 megacycles

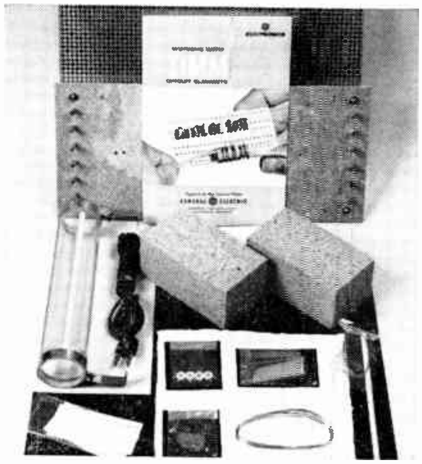
The 7815 is a high-mu, ceramic-and-metal, planar triode designed for use as a grid-pulsed or plate-pulsed oscillator; frequency multiplier; or power amplifier, at frequencies up to 3000 megacycles. Potential applications include use in beacon transponders and distance measuring equipment (DME) where high levels of peak power output at low duty are required.

Typical ratings when used as a plate-pulsed oscillator at 2500 megacycles:

Peak useful power output	2000 watts
Pulse length	5 microseconds
Duty factor	0.0030
Peak plate supply voltage	3500 volts
Peak plate current	3.0 amps.
Average plate current	9.0 ma

Ratings as an amplifier at 1100 megacycles:

Peak useful power output	1500 watts
Peak plate current	1.9 amps.
Peak grid current	1.1 amps.
Pulse length	3.5 microseconds
Duty factor	0.001
DC plate voltage	1700 volts



TIMM circuit elements and accessory kits now available

TIMM circuits represent the *only* known high-temperature, radiation-resistant microminiature system available today.

To help you value-analyze TIMM circuit elements at high temperatures (580°C.), G.E. has prepared an accessory kit containing: An instruction manual, a Vycor* oven (1½" diam. x 8"), ceramic mounting boards, quartz insulating sleeves, ceramic spacers, a thermocouple (Cr-Al), connecting wire, oven safety cover, and insulating sheet.

These circuit elements now available:

Resistors—1,000 ohms to 100,000 ohms rated at ¼ watt (at 580°C.)

Capacitors—20 pf to 200 pf units to 300 vdc (at 580°C.)

Diodes—50 volts max. P.I.V., 2 ma DC plate current, 2.3v self-bias (at 580°C.)

Triodes—As a switch (at 580°C.)
off: E_b=10v, E_g=0v, I_b=100ua max.
on: E_b=7.5v, E_g=+2.5v, I_b=2.0 ma, I_g=200ua

*T.M. of Corning Glass Works

New, broad-application dry reed switch has life expectancy up to 100,000,000 cycles

Simplified design and construction of the 2DR15, plus external magnetic actuation, can result in a life expectancy in the order of 100,000,000 cycles, when operated within ratings. Contact contamination is eliminated by hermetic sealing in an atmosphere of inert gas . . . high-purity gold is the contact material.

The 2DR15 can carry loads ranging from 15 volt-amperes down to microamperes . . . ideal for liquid-level controls, weight-measuring devices, temperature limiters, pressure controls, RPM counters, coin-operated devices, multiple relays, protective devices, etc. Individual reed switches provide greater design flexibility by not limiting the designer to a few standard switching modules. The 2DR15 mounts in any position and is priced lower than most other relays or switching devices.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Please send more value-analysis information about:

- ☐ New X-band ceramic tube
- ☐ Pressed-stem subminiature tubes
- ☐ 7815 ceramic triode
- ☐ TIMM accessory kits
- ☐ 2DR15 dry reed switch

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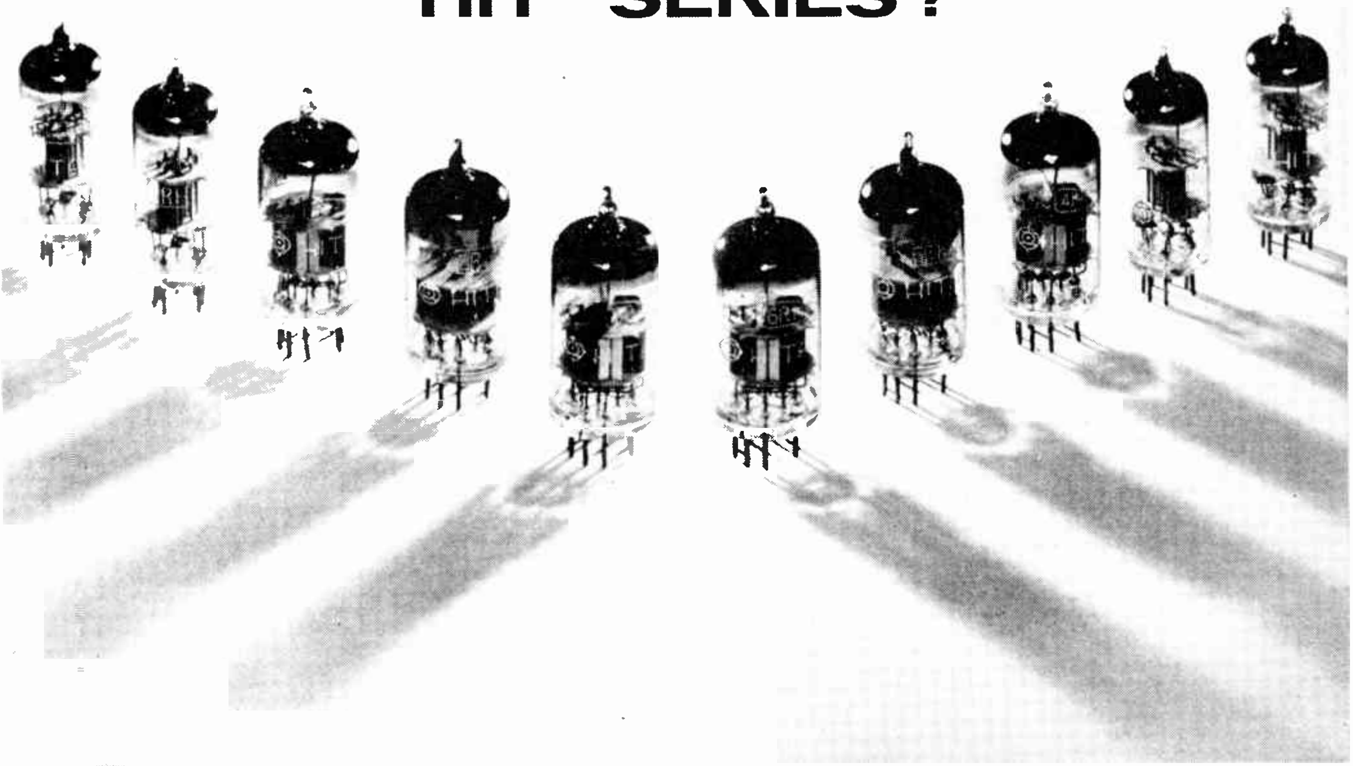
CIRCLE 21 ON READER SERVICE CARD

WHAT IS THE "HH" SERIES?



The "HH" series is Hitachi's new superior line of television receiver tubes, the ultimate in far-reaching reception of television waves.

For RF amplifier of VHF television tuners, specify the 4R-HH2 and 6R-HH2 which feature very high transconductance, high sensitivity and low noise. These twin triode tubes replace the 4BQ7A and 6BQ7A without change of circuit.

For frequency convertor and local oscillator of VHF television tuners, specify 5M-HH3 and 6M-HH3 twin triodes which replace the 5J6 and 6J6 without change of circuit.

The "HH" series is another fine quality line from Hitachi, one of the most completely integrated electrical manufacturers in the world.

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The art of high temperature ceramic metalizing has been developed to new heights by CENTRALAB engineers. The most exacting tolerances can be readily achieved, as can the most permanent bond. Whether metalizing for the attachment of metal hardware or in preparation for hermetic sealing, CENTRALAB'S techniques will satisfy the most critical requirements.

* Temperature limits and tensile strength are functions of the geometry of the part and/or the melting point of the brazing alloy. This high temperature metalizing is a suitable base for brazing as high as 2,000°F. and can be used with BT, silver or copper brazing alloys. For applications requiring reduced operating temperatures —to 350°C.—Seals can be supplied at reduced cost. Bond strengths are routinely achieved as high as 14,000 psi. All seals are 100% tested on a mass spectrometer, with no leaks detectable to 1x10—9 std. cc/sec.

For additional technical data, write for CENTRALAB Bulletin EP-1360.

-6207

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CIRCLE 23 ON READER SERVICE CARD

SENATOR McCLELLAN *speaks out at a meeting of Senate Investigations Subcommittee, which he heads*

JIMMY HOFFA *telling his side at a news conference*

TEAMSTERS Opening Drive on

Senator McClellan warns industry that Hoffa would bring big changes

JAMES RIDDLE HOFFA, an old-style labor leader, pugnacious and ambitious, has his sights set on the electronics industry.

His targets today are on the fringe of the industry: the 17,000 installers of electronic equipment who work for Western Electric in 44 states and the 24,000 employees of the New York Telephone Co. who repair central office equipment.

But in the near future he will be zeroing in on plants in all phases of electronics. He will shoot for any firm where his International Brotherhood of Teamsters thinks it has a good chance to enlist workers in its ranks. This includes plants where employees are already represented by unions and plants where they are not.

"Some electronics plants have been making fat profits and we expect to make substantial gains there," Harold J. Gibbons, Teamster vice president, told ELECTRONICS.

The outcome could be a revolutionary reorganization of the electronics industry as it is known today.

U. S. Senator John L. McClellan, (D-Ark.) chairman of Senate Investigations Subcommittee, has been probing Hoffa's activities for years and outside of the Teamsters itself probably knows more about them than anyone else. He told ELECTRONICS: "Hoffa would have a very significant impact on your industry."

ROD CLAY, *leader of Teamster drive for 24,000 New York Telephone Co. workers*

HOFFA'S AIM—How successful will Hoffa be?

No one knows, but Hoffa's ambitions must be taken seriously.

The Teamsters live up to their image of hard-driving, aggressive go-getters of new members. And they thrive on their reputation, which in some respects might have killed a weaker organization. Since being ousted from the AFL-CIO in 1957, they have swelled their ranks by 300,000. They now number more than 1,700,000. Hoffa's announced goal: 8,000,000 by 1966.

There may be some air in this, but the Teamsters also boast of a $40 million treasury and they are willing to earmark big lumps of it for organizational drives.

The Teamsters work hard at these campaigns. Leaflets are sent out, batteries of telephones with recorded messages extolling Teamster advantages are set up and meetings both large and small are held with workers. The campaign for the New York Telephone employees, now mounting in intensity, will make use of 50 full-time organizers before it is over.

ELECTRONICS DRIVE—No timetable has yet been drawn up for

RAISED HANDS *indicate support for Teamsters Union at recent meeting of New York Telephone Co.*

Electronics

the broader assault on the electronics industry. This will probably depend on when the Western Electric and New York Telephone drives are completed—and on how well the Teamsters do in these efforts.

Victory in one or both would hearten them no end as both groups are currently represented by the Communications Workers of America, headed by Joseph A. Beirne, an old thorn in Hoffa's hide.

The National Labor Relations Board has already set dates for the Western Electric election. Results should be known early in January.

The Teamsters set up staffs from national headquarters to handle the Western Electric and New York Telephone drives, but, according to Gibbons, the electronics campaign would be handled differently. National headquarters would supply funds and organizers but these would be allocated to individual Teamster locals who would direct their own campaigns. Support from headquarters would be proportionate to how much opportunity there is in a particular area.

However, some Teamster locals have been doing a good job with no help from national headquarters. Teamster Local 210 in New York

City, for instance, already has 2,500 electronics workers on its rolls—one third of its membership. But "the potential in this area is tremendous," according to Joseph Konowe, secretary-treasurer of the local.

He says Local 210 hopes for 150,000 electronics members in a few years.

Teamster headquarters could provide no total of present electronics membership but a partial list of the firms to some extent involved includes the following:

Minneapolis-Honeywell, Trav-Ler Radio, Jensen Industries, J. F. D. Mfg., Gould-National Batteries, Columbia Wire & Supply, FXR, Stanley Transformer, Continental Connector.

THE HARD SELL—Hoffa, for all his energy, probably will not play a large personal role in the electronics drive. Legal matters occupy too much of his time. So does cracking the whip on rebellious elements in his scattered empire.

A man who well might move into electronics, though, is Rod Clay, now heading the New York Telephone drive. If not, he is typical of the men who will.

At 45, Clay is muscular and youthful, looking every inch the ex-college football player he is.

At a recent meeting of New York Telephone workers Clay, an automobile salesman when he joined the Teamsters 17 years ago, assumed his usual determined stance on the speaker's platform. He was in his shirtsleeves and one of his hands rested on his hip.

He told them many things—jokes, anecdotes, stories of what other workers earn—all calculated to make them more dissatisfied with New York Telephone Co. and their present union.

Clay, in all of this, was making use of a technique he had originally learned on the car lots: the hard sell. And it is this, perhaps more than anything else, that characterizes Teamster organizers and the drives they stage.

Little appeal is made to a worker's politics. Instead, the pitch is to his pocketbook. He is told that if he joins the Teamsters everything possible will be done to get him 60 or 70 cents more an hour.

Teamster organizers couple these promises with descriptions of Teamster power—no empty boast as regards industries dependent on trucks for pickups and deliveries, such as small electronic plants in outlying areas.

"We neither look for a fight, nor run away from it," Clay says. "We meet force head on."

Clay even capitalizes on Hoffa's reputation.

"You can walk into Jimmy Hoffa's office and you won't find any plaques or citations saying what a nice guy he is. Employers don't give citations to union leaders when they're getting a lot for their members."

Narrow-Band TV to Carry Cloud Pictures to Earth

NARROW-BAND TV signals will carry cloud cover pictures from meteorological satellites to ground stations in a system now being checked out by NASA.

The satellite's camera stores photographs on a special purpose polystyrene layer within its vidicon tube. Photos are then sent to earth by an f-m transmitter. On the ground, the pictures are built up line by line on a facsimile machine.

The system is designed for the Nimbus meteorological satellite, scheduled for launch next fall. However, there may be a preliminary flight test on a Tiros satellite.

Coney Island Checkout

BIOLOGICAL *measurements pack with self-contained transmitter is shown in an improbable application: counting heart beats of a roller coaster rider. Hughes Aircraft says Air Force will actually use it to study parachutists*

Rochar
electronique
France

and

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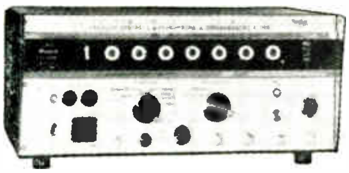
present

a complete line of all solid-state frequency time-interval period COUNTERS

basic instruments

	A 1149	A 1213	A 1197	A 1211
Max. Frequency	> 22 MC	> 2.2 MC	> 220 KC	> 220 KC
Count capacity	99.999.999	999.999	99.999	99.999
Counting time	0.1–1–10 Sec.	0.1–1–10 Sec.	0.1–1–10 Sec.	0.1–1–10 Sec.
Standard frequency	5 MC	1 MC	100 KC	100 KC
Standard stability (± 1 part in....)	10^7 a week 10^8 a week	10^6 a week	10^6 a week	10^6 a week
Standard frequencies outputs	1 c/s; 10 c/s;...10 MC	1 c/s ; 10 c/s;... 1 MC	1c/s; 10 c/s;...100 KC	1c/s; 10 c/s;...100KC
Frequency measurements I_1 Input characteristics	50 mV to 100 Vrms Z=100 KΩ/50μμF	50 mV to 100 Vrms Z=100 KΩ/50μμF	0.2 V to 100 Vrms Z=500 KΩ/30μμF	d° A-1197
(2 frequency inputs) I_2	200 mV to 100 Vrms Z=100 KΩ/30 μμF	200 mV to 100 Vrms Z=100 KΩ/30μμF	1 V to 10 Vrms Z = 10 KΩ	d° A-1197
Period measurements	1 or 10 periods	Period input: I_2	(A-1149 and A-1213)	or I_1 (A-1197 and A-1211
Time Interval measurements	Polarity: +; Sensitivity: 5 to 8V; Z=10 KΩ/100μμF		Polarity + Sensitivity: 6 to 50V	+ and – polarity built in pulse shaper
Pulse duration and radio measurements	•	•	•	•



A 1149

Plug-in and accessories such as
TYPE A 1215: Aperiodic divider permitting direct counting

up to ›60 Mc

TYPE A 1212: Preset time-base
TYPE A 1170: Universal codeverter

and some other extra features

according to their very low consumption all this instruments can easily be

DC powered.

ask for built-in battery power-pack models, [8 hours duty] and DC to AC converters.

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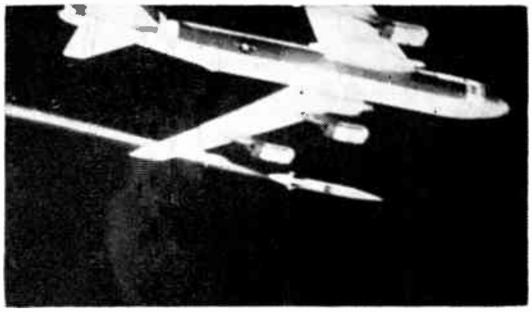



FIRST *two photos of this Skybolt missile show pre-ignition smoke. The last two shots show the first stage being fired*

SKYBOLT: Engineering Failure

System development was on schedule, to be operational in 1964

AS OF MONDAY morning the Skybolt missile program was still moving to oblivion. In Washington, the Department of Defense was still making "no comment." In London, the British were voicing surprise and dismay to the world. And in Los Angeles, more than one engineer was heard to say, "this is the worst thing to hit southern California since they killed Navaho."

Once word leaked out that the 1,000-mile-range air-launched ballistic missile was slated for cancellation (ELECTRONICS, p 7, Dec. 14) events moved swiftly towards their climax that is taking place even now under sunny Bahama skies.

The British, who had been depending on Skybolt to add its ½-megaton nuclear punch to their aging Vulcan bomber fleet, and who had picked up 5 percent of Skybolt's development tab, were outraged. Defense Secretary McNamara flew to London for a stormy session with Defence Minister Thorneycroft.

LONDON MISSION—The British press was up in arms, claiming that the U.S. welshed on a deal that traded Skybolt for the Polaris base at Holy Loch.

What could McNamara offer to make up to Britain for the loss of Skybolt? Air Force's operational Hound-Dog air-launched missile has only a 600-mile range, is slow and bulky and can be shot down. The cost of building bases and nuclear subs for Minuteman and Polaris could break Britain's financial back. It began to look like Britain would have to go it alone with its rocket-powered airborne bomb, Blue Steel.

ENTER THE CHIEF—Wednesday, President Kennedy got into the drama. At his press conference he described Skybolt as "the most sophisticated weapon imaginable . . . (requiring) . . . the kind of engineering that's beyond us." The President went on to say that we had sunk a ½ billion dollars into Skybolt, would need 2½ billion more.

Meanwhile at NATO meetings in Paris last week the U.S. cast out some other proposals: the British could have Skybolt, lock, stock and umbilical cord if she would pay for it herself. If the price wasn't right, she could join with the other NATO allies in developing the bird.

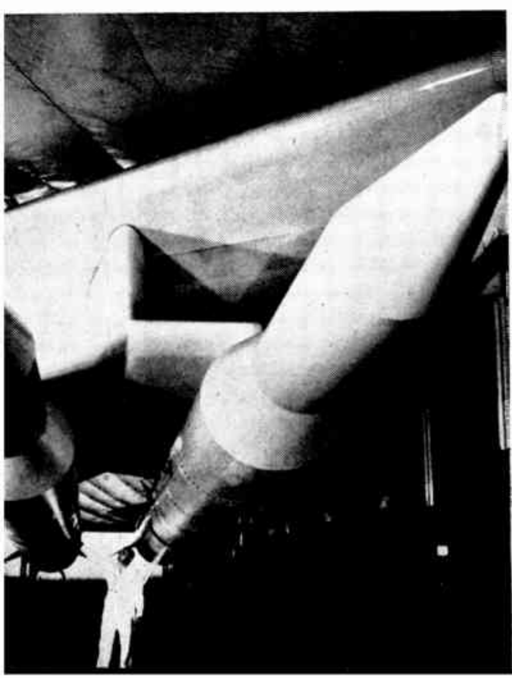
FIVE FAILURES—The engineers who designed Skybolt's guidance say it is simple and basically reliable.

Out of five tests, one was almost successful and one was a total failure. On two tests the first stage fired while the second didn't; on the last test the first stage didn't fire and the missile took the deep six. In at least one test, a defect as small as a scratch on the window of the navigation system may have caused failure. In spite of the five failures, Air Force says Skybolt is on schedule and plans to have an operational bird by 1964.

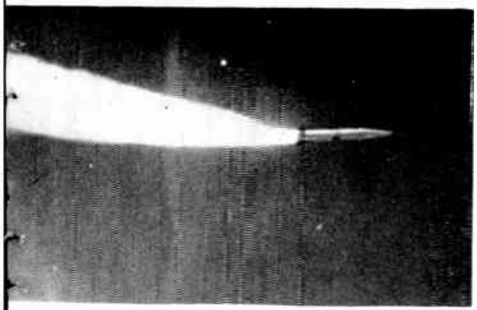
Other missiles have had impressive failure rates. Polaris A-3 has failed six tests out of six and is still being developed. Thor and Atlas batted low before making the first team. Titan's record is nothing to write home about.

POLITICS?—Is the cancellation of Skybolt based on technical or political grounds?

Britain has speculated that the present administration in Washington wants to put her out of the



INERT *Skybolts in position on wing of bomber*



or Politics?

league as an independent nuclear power. A better guess is that U. S. wants to take the decision of war-vs-peace out of the hands of individual RAF pilots.

WHAT HAPPENS NOW?—Cancellation of Skybolt would slash the life of our manned bomber force. B-52 production is ended and the RS-70 is a long way off.

The project means a lot to the Los Angeles area: prime contractor Douglas has some 14,000 workers directly employed on the project. Nortronics division of Northrop is responsible for the guidance; GE's Missile and Space Vehicles division is doing the atmospheric reentry equipment and Aerojet-General is building the propulsion.

Cancellation of Skybolt would put all our retaliatory power into two baskets: ICBM's and Polaris. Neither is invulnerable.

Minuteman, even nested in concrete silos, can be knocked out by a direct hit with, say, a 55-Mt bomb. Polaris is prey to hunter-killer submarines.

Skybolt, launched from a 600-mph pad, would have been hard to knock down, hard even to get a bead on its launch site. It would also have been a penetration aid for bombers carrying 21-Mt gravity bombs, still too big to deliver by missile. It could knock out both anti-aircraft missile sites and anti-missile-missile sites. In any crisis, B-52's carrying four Skybolts and three gravity bombs each could be airborne but subject to recall before the first missile attack hit.

Small Computers Star

Fourteen computers are featured in fall conference displays

PHILADELPHIA—Fourteen complete operating computer systems were among the $10-million worth of equipment displayed this month at the Fall Joint Computer conference. Among those shown for the first time were:

• General Precision's LGP-21. It weighs 90 lbs, is the size of a file drawer and will perform all operations of the desk-size LGP-30, although at slower speeds. Magnetic disk memory stores 4,096 31-bit words. Average access time is 25 msec.

• H-W Electronics' desk-size H-W 15K. It has a drum memory for 4,096 25-bit words. With optimum programming, all instructions are executed in 25 μsec. Like the LGP-21, price is slightly less than $20,000.

• RCA's Micropac. This 90-lb, 2.7-cu ft digital computer, with over 1,600 micromodules, is for military tactical uses. Its random-access core memory is expandable from 2,048 to 8,192 38-bit words.

• Thompson Ramo Wooldridge's TRW-230. A general-purpose computer for scientific and engineering uses, it is a commercial version of the AN/UYK-1 military computer.

• Packard-Bell's PB440 general purpose computer. It features a bi-axial memory in addition to a conventional ferrite-core memory.

• Philco announced, but did not show, the new 4000 stored-program series (p 8, Dec. 14). Core storages contain 8,192 to 32,768 characters of 6 bits plus a parity bit.

INPUT-OUTPUT—More than two-thirds of the exhibitors displayed peripheral equipment.

Farrington Electronics is producing for Univac an optical character reader that converts printed information directly to magnetic tape for computer input. It uses a flying spot scanner, can handle up to 312 documents a minute.

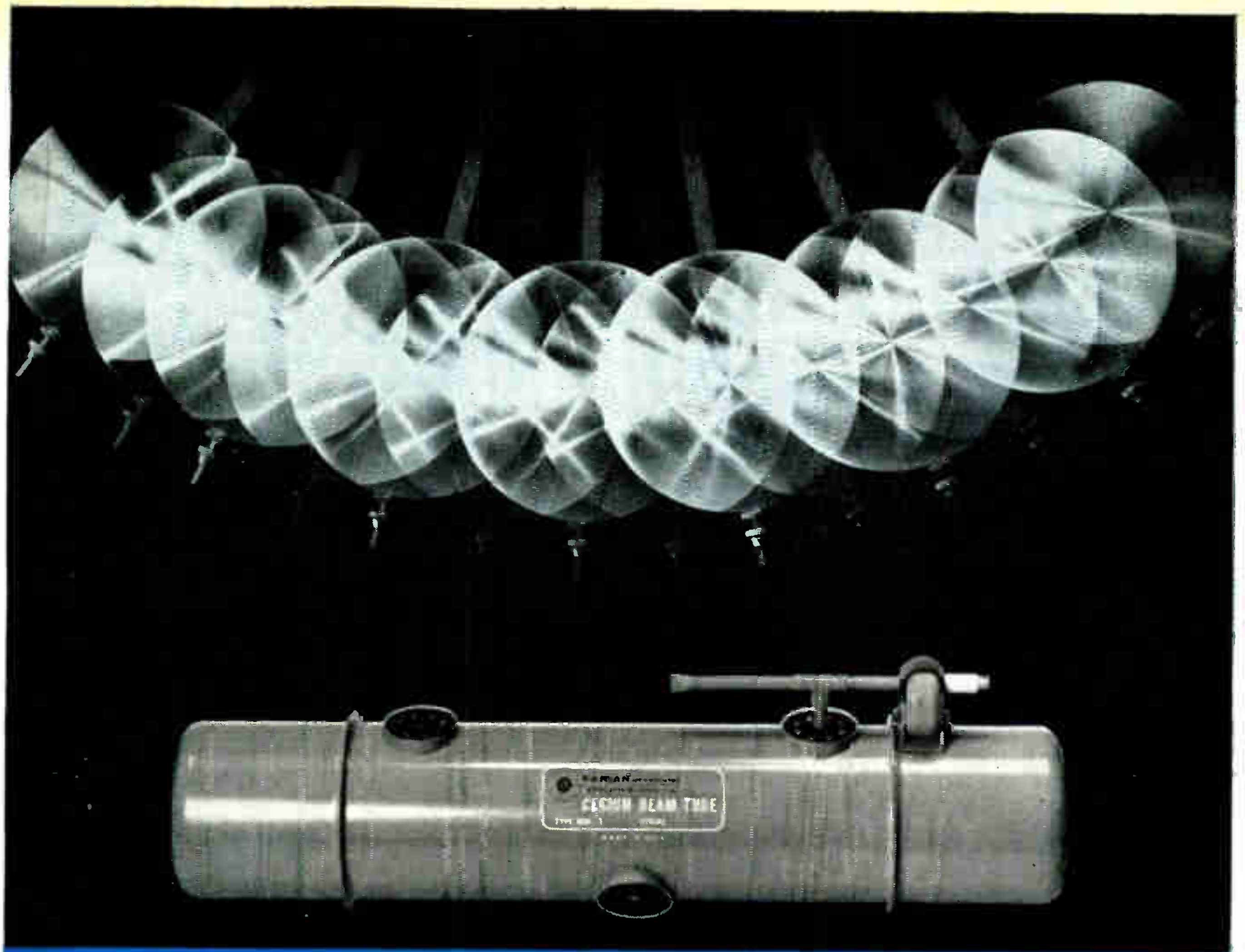
OPTICAL *character reader made for Univac*

Cognitronics showed a unit that provides audio output of information, for automatic alarms, digital-to-audio output and other uses. Solar cells read tracks selected from a film containing up to 32 tracks.

STORAGE—Ampex introduced its large LZ memory and two others. The LZ can perform a complete cycle in 1 μsec. Word lengths can vary from 18 to 72 bits; capacity is 4,096 to 16,384 72-bit words.

LFE Electronics had a high-speed digital display system for military and control systems. It can form 500,000 characters a second and display 10,000 at once on a crt. A Bernoulli disk memory repeats the presentation 50 or 60 times a second, giving a flicker-free image.

Bryant Computer Products' Auto-Lift design eliminates head-to-drum contact in magnetic storage drums, preventing a major cause of failure. A tapered drum moves toward the heads as drum speed increases. At full speed, the heads fly on a laminar film of air that rotates with the drum.



NEW FROM BOMAC

CESIUM ATOMIC BEAM RESONATOR FOR ULTRAPRECISE FREQUENCY CONTROL APPLICATION

Now system designers can obtain a compact basic reference component to provide atomic precision in advanced work. The Bomac BLR-1 cesium beam resonator has the highest known degree of intrinsic reproducibility. There is no necessity for calibration against a primary standard. The tube has been developed with particular attention to those factors influencing accuracy, long-term stability, and long life. Consider these state-of-the-art features: **ACCURACY**—Resonator frequency is specified in terms of zero field hyperfine transition frequency to ± 2 parts in 10^{11}. **INTRINSIC REPRODUCIBILITY**—No calibration is required, at the factory or in the field; recent comparison tests show reproducibility capability to ± 5 parts in 10^{12}. **LONG TERM STABILITY**—Specified to ± 1 part in 10^{11} during service life. **SIGNAL/NOISE RATIO**—Better than 1000 in 1 second averaging times. **SIMPLICITY**—Designed for simple installation, in the manner of other vacuum tubes; all critical components are housed in a rugged stainless steel vacuum envelope. **LONG LIFE**—Bomac guarantees a one-year operating life or a five-year shelf life with no voltages applied.

Applications include laboratory and field frequency standards, precise timekeeping, navigation and communication systems, physical research. Bomac will provide technical assistance to designers to aid in realizing the maximum performance possible with the BLR-1 resonator. Write for details.

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MEETINGS AHEAD

INFORMATION SYSTEMS MEETING, Engineers Joint Council, American Association for Advancement of Science; Bellevue-Stratford Hotel, Philadelphia, Pa., **Dec. 27.**

MILLIMETER AND SUBMILLIMETER CONFERENCE, IRE; Orlando Section; Cherry Plaza Hotel, Orlando, Florida, **Jan. 7-10.**

RELIABILITY & QUALITY CONTROL SYMPOSIUM, IRE-PGRQC, AIEE, ASQC, EIA; Sheraton Palace Hotel, San Francisco, Calif., **Jan. 21-24.**

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS WINTER GENERAL MEETING & EXPOSITION, IEEE; Statler and New Yorker Hotels, New York City, **Jan. 27-Feb. 1.**

MILITARY ELECTRONICS WINTER CONVENTION, IRE-PGMIL; Ambassador Hotel, Los Angeles, Calif., **Jan. 30-Feb. 1.**

QUANTUM ELECTRONICS INTERNATIONAL SYMPOSIUM, IRE, SFER, ONR, Unesco Building and Parc de Exposition, Paris, France, **Feb. 11-15.**

INFORMATION STORAGE AND RETRIEVAL SYMPOSIUM, American University; International Inn, Washington, D. C., **Feb. 11-15.**

ELECTRICAL & ELECTRONIC EQUIPMENT EXHIBIT, ERA, ERC; Denver Hilton Hotel, Denver, Colo., **Feb. 18-19.**

SOLID STATE CIRCUITS INTERNATIONAL CONFERENCE, IRE-PGCT, AIEE, University of Pennsylvania, Sheraton Hotel and U. of P., Philadelphia, Pa., **Feb. 20-22.**

PACIFIC COMPUTER CONFERENCE, AIEE; California Institute of Technology, Pasadena, Calif., **March 15-16.**

BIONICS SYMPOSIUM, United States Air Force; Biltmore Hotel, Dayton, Ohio, **Mar. 18-21.**

IEEE INTERNATIONAL CONVENTION, Institute of Electrical and Electronics Engineers; Coliseum and Waldorf-Astoria Hotel, New York, N. Y., **March 25-28.**

ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS SYMPOSIUM; IRE-PGNS, AIEE, IAS, University of California, UCLA, Beverly, Calif., **April 10-11.**

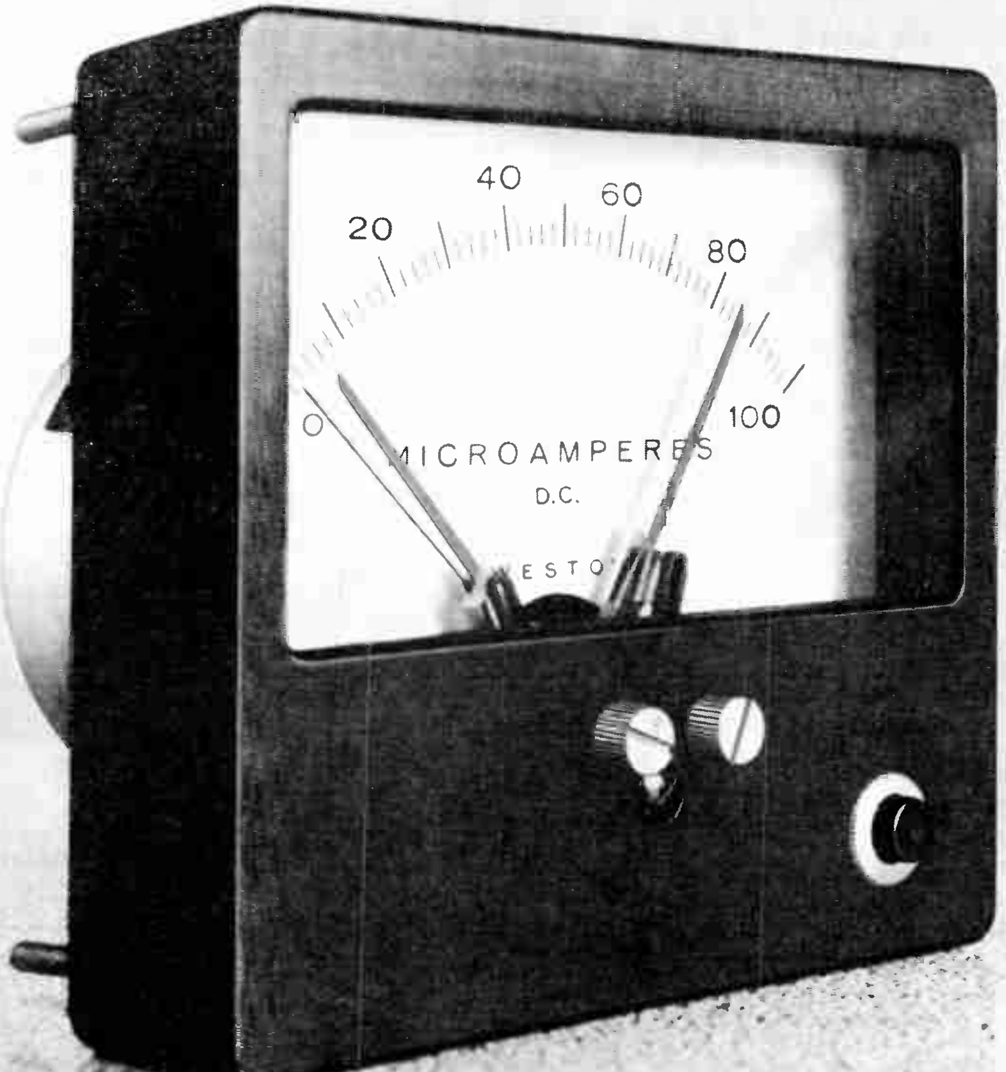
OHIO VALLEY INSTRUMENT-AUTOMATION SYMPOSIUM, ISA, et al; Cincinnati Gardens, Cincinnati, Ohio, **April 16-17.**

ADVANCE REPORT

ANTENNAS AND PROPAGATION SYMPOSIUM, IRE-PGAP; *NBS Boulder Laboratories, Boulder, Colo., July 9-11, 1963. March 1 is the deadline for submitting in duplicate a 100-word abstract and a 1,000-word summary to: Herman V. Cottony, Chairman Technical Program Committee, 1963 PGAP International Symposium, Boulder Laboratories, National Bureau of Standards, Boulder, Colo. Conference theme is space telecommunications. Original contributions are looked for in the following fields: antennas, propagation, radio astronomy, electromagnetic theory, propagation in plasmas, space telecommunications.*

NEW

FROM WESTON



CONTACT

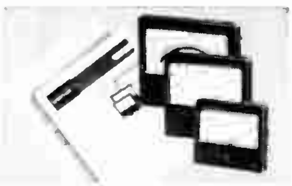
DOUBLE-ACTION PRINCIPLE ASSURES RELIABILITY OF CONTACT CLOSURE

MagTrak™ Relays combine magnetic attraction with a load current contact aiding circuit. This combination increases contact pressure by a factor of 100 times on the most sensitive ranges. Weston's new MagTrak design gives you greatly increased reliability plus easy resetability.

You can always depend on MagTrak—even for low voltage operation and after long periods of inactivity.

- Sensitivities as low as 10 μa, full scale
- Can operate as a pyromillivoltmeter
- Available with high or low set points, or both
- Standard, self-contained, full-scale ranges: 10 μa to 5 a and 20 mv to 500 v or higher
- Kilowatt loads can be switched when accessory power package is used
- Scale length: 3.47 inches

Weston supplies the most complete line of relays available. More are now in use than any other kind . . . proof of their dependability. Write for new catalog or applications assistance from our experienced relay engineers. Dept. 312.



NEW RELAY CATALOG gives details on MagTrak. Another Weston catalog describes the matching line of Series 1900 Panel Instruments, pictured above. Send for both today.

WESTON INSTRUMENTS *Division of Daystrom, Incorporated, Newark 14, New Jersey*

Aerospace Instrumentation • Bimetal Thermometers • Calibration & Test Equipment • Panel & Switchboard Meters • Photosensitive Devices • Precision Metal Film Resistors • Relays & Tachometers • Systems Design & Development

TARZIAN ZENERS...
Reliability at Low Cost

250 milliwatt Fig. A

Tarzian Type	.25T5.6	.25T6.2	.25T6.8	.25T7.5	.25T8.2	.25T9.1	.25T10	.25T11	.25T12	.25T13	.25T15	.25T16	.25T18	.25T20	.25T22	.25T24
Breakdown Voltage (V_B)	5.6	6.2	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	25	25	25	25	25	12	12	12	12	12	12	12	12	4	4	4
Breakdown Impedance (Ohms)	3.6	4.1	4.7	5.3	6.0	7.0	8.0	9.0	10	11	13	15	17	20	24	28
Jedec Type	1N708	1N709	1N710	1N711	1N712	1N713	1N714	1N715	1N716	1N717	1N718	1N719	1N720	1N721	1N722	1N723

Tarzian Type	.25T27	.25T30	.25T33	.25T36	.25T39	.25T43	.25T47	.25T51	.25T56	.25T62	.25T68	.25T75	.25T82	.25T91	.25T100
Breakdown Voltage (V_B)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	4	4	4	4	4	4	4	4	4	2	2	2	2	1	1
Breakdown Impedance (Ohms)	35	42	50	60	70	84	98	115	140	170	200	240	280	340	400
Jedec Type	1N724	1N725	1N726	1N727	1N728	1N729	1N730	1N731	1N732	1N733	1N734	1N735	1N736	1N737	1N738

400 milliwatt Fig. A

Tarzian Type	.4T6.8	.4T7.5	.4T8.2	.4T9.1	.4T10	.4T11	.4T12	.4T13	.4T15	.4T16	.4T18	.4T20	.4T22	.4T24
Breakdown Voltage (V_B)	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	25	25	25	12	12	12	12	12	12	12	12	4	4	4
Breakdown Impedance (Ohms)	4.7	5.3	6.0	7.0	8.0	9.0	10	11	13	15	17	20	24	28
Jedec Type	1N957	1N958	1N959	1N960	1N961	1N962	1N963	1N964	1N965	1N966	1N967	1N968	1N969	1N970

Tarzian Type	.4T27	.4T30	.4T33	.4T36	.4T39	.4T43	.4T47	.4T51	.4T56	.4T62	.4T68	.4T75	.4T82	.4T91	.4T100
Breakdown Voltage (V_B)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	4	4	4	4	4	4	4	4	4	2	2	2	2	1	1
Breakdown Impedance (Ohms)	35	42	50	60	70	84	98	115	140	170	200	240	280	340	400
Jedec Type	1N971	1N972	1N973	1N974	1N975	1N976	1N977	1N978	1N979	1N980	1N981	1N982	1N983	1N984	1N985

1 WATT Fig. B

Tarzian Type	1T5.6	1T6.2	1T6.8	1T7.5	1T8.2	1T9.1	1T10	1T11	1T12	1T13	1T15	1T16	1T18	1T20	1T22	1T24
Breakdown Voltage (V_B)	5.6	6.2	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	100	100	100	100	100	50	50	50	50	50	50	50	50	15	15	15
Breakdown Impedance (Ohms)	1.2	1.5	1.7	2.1	2.4	3.0	3.5	4.2	5.0	5.8	7.6	8.6	11	13	16	18

Tarzian Type	1T27	1T30	1T33	1T36	1T39	1T43	1T47	1T51	1T56	1T62	1T68	1T75	1T82	1T91	1T100
Breakdown Voltage (V_B)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	15	15	15	15	15	15	15	15	15	5	5	5	5	5	5
Breakdown Impedance (Ohms)	23	28	33	39	45	54	64	74	88	105	125	150	175	220	260

Fig. C

Tarzian Type	VR-6	VR-7	VR-8.5	VR-10	VR-12	VR-14	VR-18	VR-20	VR-24	VR-28	VR-33	VR-39	VR-47	VR-56	VR-67	VR-80	VR-90	VR-105
Breakdown Voltage (V_B)	6	7	8.5	10	12	14	18	20	24	28	33	39	47	56	67	80	90	105
Test Current (Ma)	25	25	25	25	12	12	12	12	4	4	4	4	4	4	2	2	1	1
Breakdown Impedance (Ohms)	4.1	5.0	6.0	8.0	10	12	17	20	28	35	50	70	98	140	200	280	340	400

10 WATT Fig. D

Tarzian Type	10T5.6	10T6.2	10T6.8	10T7.5	10T8.2	10T9.1	10T10	10T11	10T12	10T13	10T15	10T16	10T18	10T20	10T22	10T24
Breakdown Voltage (V_B)	5.6	6.2	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	1000	1000	1000	1000	1000	500	500	500	500	500	500	500	150	150	150	150
Breakdown Impedance (Ohms)	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
Jedec Type	1N1803	1N1804	1N1805	1N1806	1N1807	1N1808	1N1351	1N1352	1N1353	1N1354	1N1355	1N1356	1N1357	1N1358	1N1359	1N1360

Tarzian Type	10T27	10T30	10T33	10T36	10T39	10T43	10T47	10T51	10T56	10T62	10T68	10T75	10T82	10T91	10T100
Breakdown Voltage (V_B)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	150	150	150	150	150	150	150	150	150	50	50	50	50	50	50
Breakdown Impedance (Ohms)	3	4	4	5	5	6	7	8	9	12	14	20	22	35	40
Jedec Type	1N1361	1N1362	1N1363	1N1364	1N1365	1N1366	1N1367	1N1368	1N1369	1N1370	1N1371	1N1372	1N1373	1N1374	1N1375

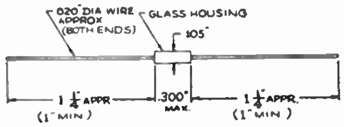


FIGURE A

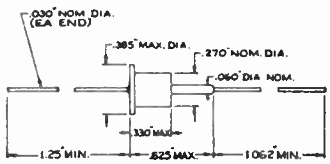


FIGURE B

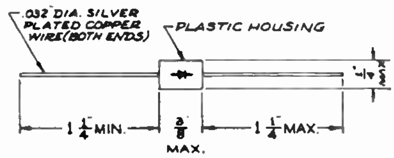


FIGURE C

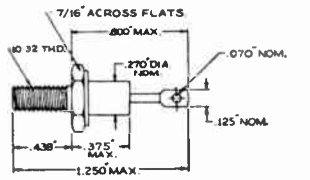


FIGURE D

Need a Zener? Then chances are one of the above will meet your needs. If not, send an outline of your requirements. Engineering assistance and samples are available. A card will bring you Bulletin 61 VR 11.

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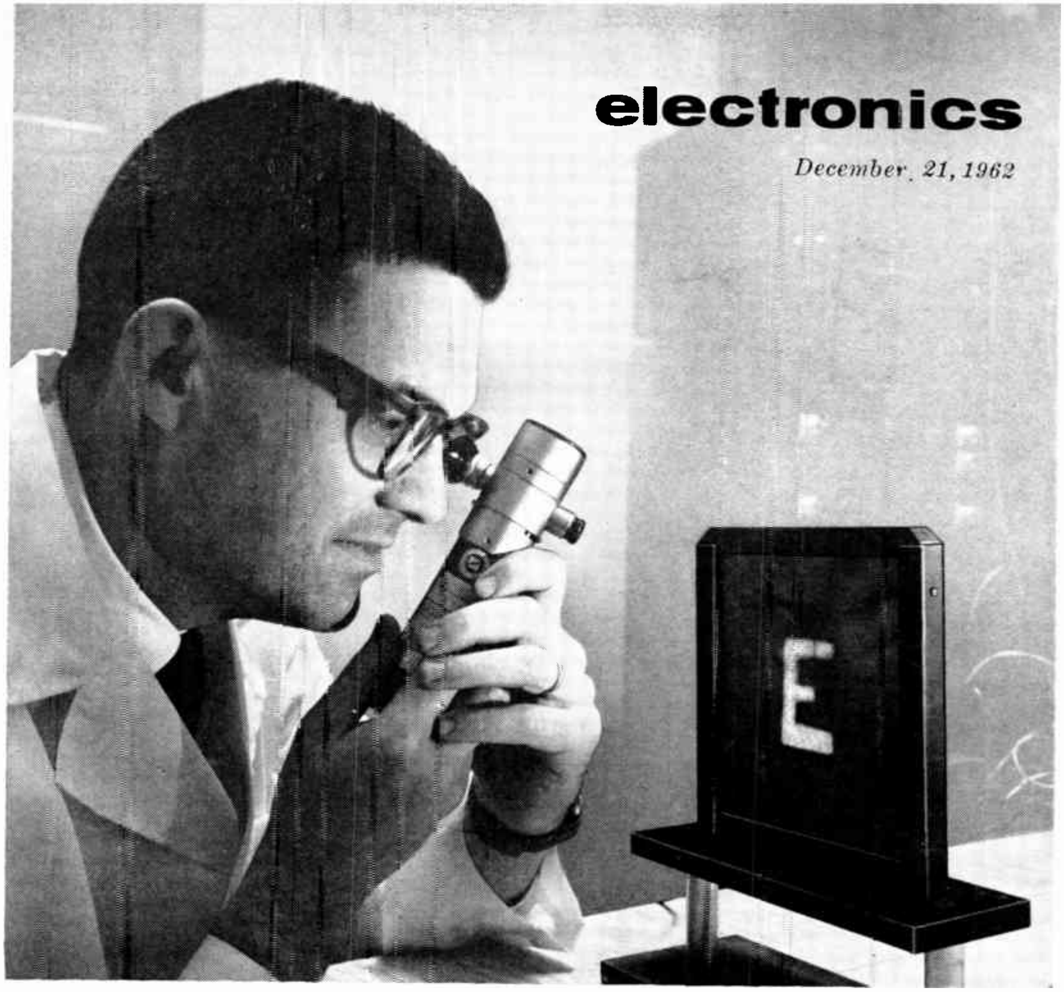


LIGHT OUTPUT *level of an image-processing panel is measured by author Hook*

FIRST STEP IN CHARACTER RECOGNITION

IMAGE PROCESSING

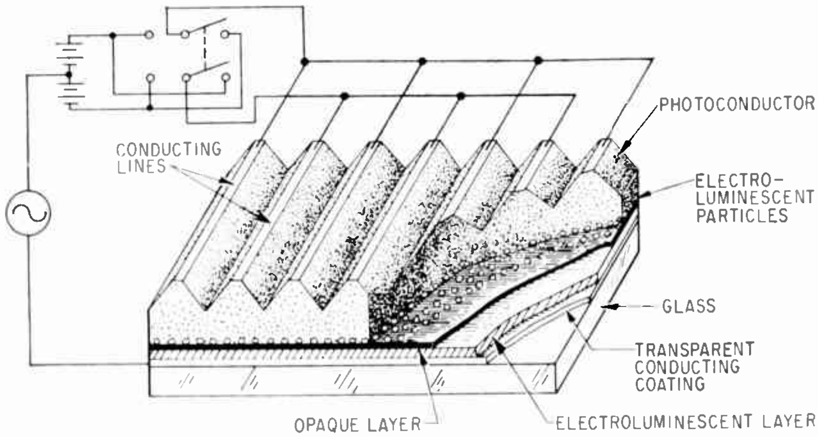
WITH OPTICAL PANELS

Speck removal, hole filling, line thinning and similar preprocessing of characters to be recognized has been accomplished using the natural program of optoelectronic panels. Fiber optics and other external optical circuits permit even more of these operations, all at speeds comparable to those of a high-speed digital computer

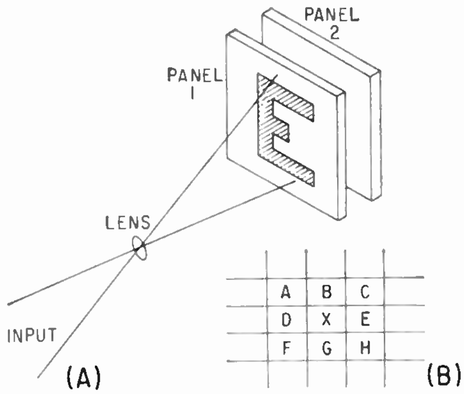
By H. O. HOOK and H. WEINSTEIN, RCA Laboratories, Princeton, N. J.

OPTOELECTRONIC panels can perform logic operations as well as provide visual displays. This property can be used to reduce errors in character-recognition systems by preprocessing the characters. Processing time is comparable to that of a high-speed digital computer. Also, the capabilities of these panels can be extended by using external optical circuits.

Character-recognizing equipment is sometimes confused by nonessential properties of some characters, such as serifs and varying line



CURRENT *from illuminated areas of photoconductor is supplied to both output and feedback electroluminescent layers of image-processing panel —Fig. 1*

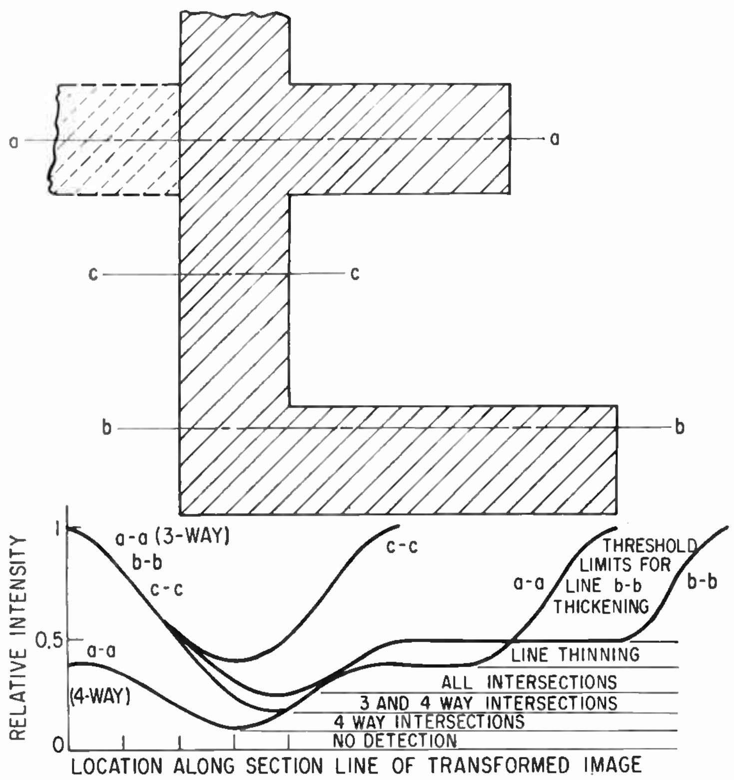


COUPLED *image-processing panels can be used for line thinning and smoothing in characters (A); character modification can be based on state of neighboring elemental areas (B) — Fig. 2*

MAKING IT READ RIGHT

Optical character readers for direct input of typed or printed materials into information-processing systems are often confused by minor variations in type style, holes, specks, gaps or other variations in the reproduction of a character.

Optoelectronic panels can preprocess these characters so that they are presented unambiguously to the optical character reader

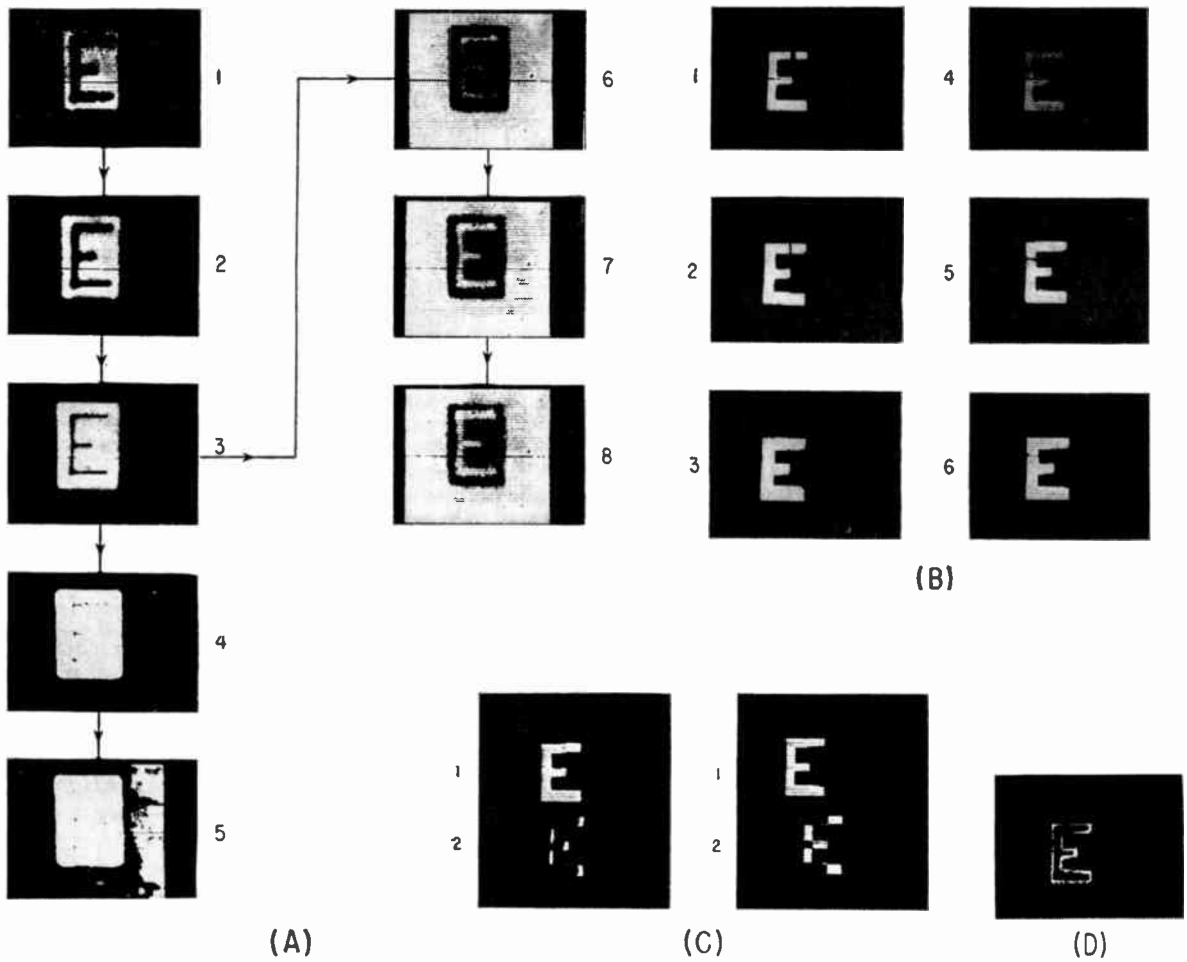


INTENSITY *distribution is shown for image transformed so that a point on original becomes a uniformly illuminated disk with radius equal to line width—Fig. 3*

widths. One approach to solving this problem is preprocessing of the character. Research with optoelectronic panels has demonstrated several image-processing transformations that can be used. For example, where preprocessing is required to handle a variety of character types, coupled panels can be used for controlled character modification.

PANEL PROPERTIES—Logic for the image-processing transformations is inherent in the panels themselves, which provide their own natural program. Because of this characteristic and because the operations are performed in parallel, processing speed is comparable to that of a digital computer.

Optical-feedback storage light-intensifier panels[1] are capable of enough basic logic operations (threshold logic and negation) to perform any desired logic function. In addition, neighborhood interaction is easily obtained by cascading spaced storage panels or by optical operations on the input image. For example, line thinning of an alphabet character has been demonstrated using two spaced panels in cascade. If the thinning operation is allowed to continue far enough, it not only enables intersections to be detected but permits two, three or four-way intersections to be distinguished. Several such natural programs have also been devised for motion detection. These programs differ in complexity and output. The simplest, in which the leading edges of moving objects are



THINNING, *intersection detection, reversal and thickening are shown at (A) and filling of horizontal and vertical gaps at (B). Motion detection (C) is shown for less than (left) and more than one line width. Outline (D) results from photoconductor fatigue—Fig. 4*

displayed, requires one panel.

The panels are two-dimensional, iterative arrays of simple elements. The panels are easily made using techniques based largely on refinements of spray painting processes. Panels have been made containing 2.5×10^5 elements, and panels with 7×10^5 or more elements can be made using existing techniques.

PREPROCESSING—A variety of preprocessing methods have been considered for several systems proposed to accept widely varying character shapes. Preprocessing has been directed toward character modification, needed because particular recognition criteria have been chosen or a specific analyzing method is to be used. Computer programs have been reported for such preprocessing or smoothing operations as speck removal, line thinning, and fill-in of notches, corners and holes.[2,3,4] Several pulse-shaping and integration methods have also been suggested and used in scanning systems.[5,6]

In a general sense, all smoothing reduces overall system resolution, which is either degraded uniformly over the entire character field or within selected regions. Thus smoothing is controlled destruction of the fine structure of an image to meet the specific requirements of a particular analyzing method and recognition system design.

In describing a spatial computer for recognizing alphanumeric symbols, smoothing using neighborhood logic is discussed.[7] In this method, the state of an elemental area is determined by its surroundings. The image is selectively modified in accordance with a set of logic statements, resulting in such changes as speck removal and fill-in of notches, corners and holes. Smoothing functions are derived to allow character edge orientation to be used for recognition.

Two coupled optoelectronic panels can perform explicit smoothing functions. Such panels provide a distributed system that can modify character form without regard to character orientation and that can operate simultaneously on all elements of the character field.

The panel in Fig. 1 consists of a photoconductive layer, an electroluminescent light-feedback layer, an opaque layer to prevent output light from being fed back to the input and an electroluminescent layer to produce light output. The areas of the photoconductor layer that are illuminated supply current to the output and to the feedback electroluminescent layers, causing them to produce light.

Light fed back to the photoconductor is sufficient to maintain current flow after input light has been removed. Image spreading is limited by light absorption of the photoconductor and the nonlinear relationship between current and electric field. If the electric field is unidirection, the photoconductor permits more current flow for a given light input. The use of d-c bias and the electrode structure permit the photoconductor to operate with unidirectional current, while the required alternating field is provided to the electroluminor. Reversing d-c bias polarity provides rapid erasure and can be used as a step in image reversal and motion-detection.

PANEL COUPLING—If one panel is placed near another, each elemental area of the photoconductive layer of the second panel is optically coupled to a region of the electroluminescent layer of the first panel, as in Fig. 2A. The extent of this region is proportional to photoconductor sensitivity of the second panel and to panel spacing, and its size varies inversely with output light intensity of the first panel. Thus light intensity at any point represents a weighted summation of a neighborhood.

In these panels, light to the photoconductor must reach a threshold before the electroluminescent layer in series with it produces appreciable output. The properties of the photoconductor provide each elemental area with light-integrating capability. These threshold and integrating characteristics provide means for controlled image modification. By adjusting light output level and exposure time, the rate and extent of speck removal, line thinning, and dilation of holes and cavities can be controlled. The processing can be stopped by removing power from the first panel. The modified image can then be stored by the second panel for observation and analysis.

CHARACTER READING — In some proposed character-reading systems,[2,3] smoothing is based on spatial quantization of the character (a white area is zero and a black area is one). The state of each elemental area is logically determined by formulating a Boolean expression using the state of the eight neighboring elemental areas. A separate expression is derived for each type of modification desired. For example, in Fig. 2B, specks are removed by replacing the contents of cell x with

$$f = X[(A + B + D)(E + G + H) + (B + C + E)(D + F + G)]$$

This expression, which can also be used in relation to small bumps along straight lines, applies only to single isolated or paired cells. Larger areas cannot be adequately treated without using continuity properties around isolated cells. This restriction does not apply to optically coupled storage light intensifier.

IMAGE PROCESSING—The use of optoelectronic panels can be illustrated by a simple imaging process cascaded with threshold selection. The process is a transformation in which each point on the original is reproduced on the image as a uniformly illuminated disk. Illumination is proportional to the luminance of the original point. This transformation is shown in Fig. 3 for several sections through a character.

Threshold ranges under these conditions are indicated on the intensity curves. Zero illumination from the character line is assumed. Lines are thickened for a large range of high thresholds, and lines are thinned for a smaller range of lower thresholds. At progressively lower thresholds, all intersections are displayed, then three- and four-way intersections and finally only four-way intersections. With a threshold near zero, no information is displayed.

A better approximation of the point-to-disk transform is produced in the out-of-focus image of a good lens than the spaced panel arrangement in Fig. 2A. An image can be reversed by an optoelectronic panel by storing the image on a panel, removing the image, reversing the d-c field across the photoconductor and momentarily flooding the photoconductor with uniform light. This can be used for several transformations.

MODIFYING IMAGES — Line thinning is shown in parts 1, 2 and 3 of Fig. 4A, intersection detection in parts 4 and 5, and image reversal and line thickening after thinning in parts 6, 7 and 8. Parts 1 through 5 of Fig. 4A represent successive exposures to the defocused input (larger integrated exposure), which can be equated to decreasing the threshold. The images in parts 6, 7 and 8 of Fig. 4A are the result of reversing the d-c bias after obtaining the image shown in part 3 and following with successive exposures to uniform light flooding.

The techniques for image reversal and spot removal provide a method for filling small holes and closing small gaps in the image. For example, holes may be closed or removed from the black region of a black image on a white background. By reversing the image, the holes are converted to black specks surrounded by white areas. Exposure can then be continued until the specks are removed. Finally, the entire image is reversed.

The capability of optoelectronic image-processing panels for hole filling was demonstrated using input characters having gaps. The panel was exposed successively to the defocused image of a character. Filling a gap in a horizontal and a vertical line is shown in Fig. 4B.

An image-processing panel can be used to obtain motion and new target detection (area moving target indicator). The entire image appears in the first frame, as shown in parts 1 and 3 of Fig. 4C. Direct-current bias is reversed and the next (displaced) frame is applied to the panel. The image of the second frame appears only where there was no image for the first frame.

The fimbriation (outline) produced by overexposure of an image-processing panel is shown in Fig. 4D. This effect occurs because of fatigue in the intensely illuminated regions of the photoconductor, which does not occur in the less intensely lighted edges.

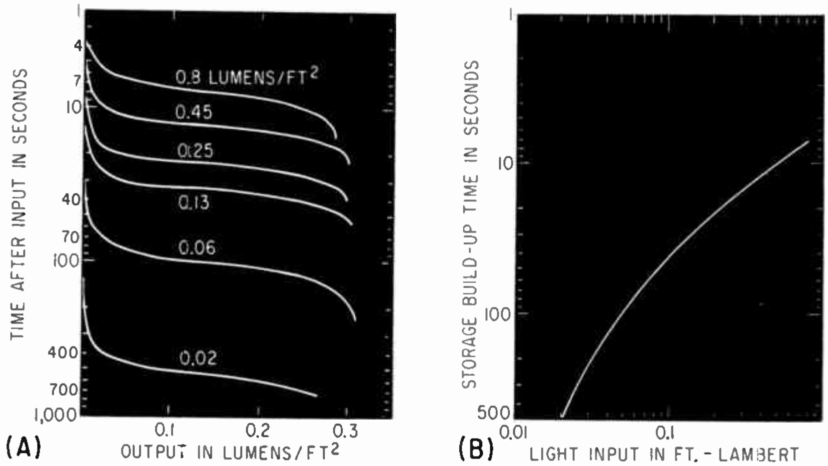
EXTERNAL FEEDBACK — Although the transformations that can be obtained with internal feedback are limited, many types of transformations can be obtained with external feedback. An essential part of any type of transformation is intrinsic spatial shifting. A tool for achieving such shifts is an external optical path that would enable an image stored on an image-processing panel to be displaced and fed back to its input. However, such a feedback path would reexcite the panel.

Spatial shifting was investigated using a calibrated electroluminescent panel as a light source. Exposure characteristics of the panel are shown in Fig. 5A. These characteristics show that a steep rise (indicating that the processing panel has entered its storage phase) occurs when light output of 0.03 lumen per square foot was recorded. The exposure characteristics in Fig. 5B were plotted at this light level. Thus, if light of only 0.1 lumen per square foot were fed back, the panel would be reexcited and would store the image within 40 seconds.

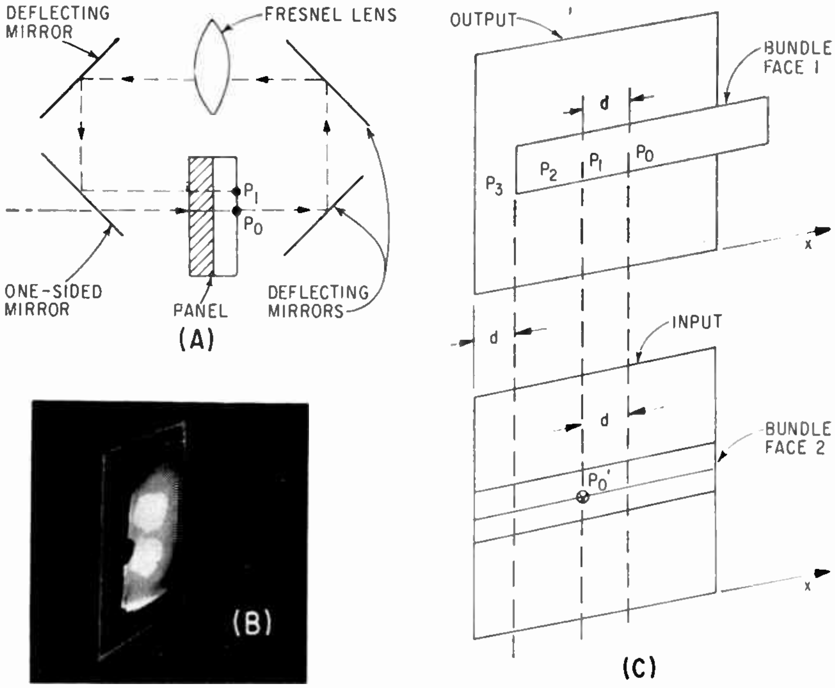
The characteristics confirm that an optical feedback path can provide sufficient loop gain.

A shifted image can be obtained on the output electroluminescent layer if a feedback path is used in which the output image is focused on a region of the input that is spatially shifted from where the image was originally displayed. A feedback path of four orthogonal mirrors with an f:0.7 Fresnel lens was used to focus the displayed image on the photoconductor, as in Fig. 6A. The shifted image in Fig. 6B appeared on the panel. To avoid the inherent attenuation of this arrangement, the alternate system in Fig. 6C was constructed. The feedback path consists of a fiber optics bundle[8] coupled to an image processing panel that is constructed on a substrate of optical fibers.

The fiber optics substrate is coupled directly to the fiber optics bundle. The other end of the bundle is coupled directly to the input photoconductor layer and is displaced distance d along the x axis.



CALIBRATED *electroluminescent panel was used to determine light level at which processing panel enters storage phase (A), and exposure characteristics (B) were plotted at this level—Fig. 5*



EXTERNAL *feedback path was used for spatial shifting of original image (A). Image originally stored on panel and shown at upper position was shifted to lower position using external feedback (B). Optical feedback path is provided by fiber optics bundle coupled to panel (C)—Fig. 6*

SPATIAL SHIFTING—Elemental spot P_0 originally stored on the image processing panel reexcites the panel at P_0', resulting in a shift of the image in one dimension to P_1. As the process continues, images identical to P_0' appear repetitively. A simple light intensifier (short storage) can cause P_0 to decay as P_1 appears. Motion results in steps and one image appears to move across the panel.

Spot P_3 appears after a time delay beginning from the moment the original image was stored. This delay is a function of panel time response, amount of shifting and relate dfactors. Thus delay for a whole image is controllable.

The shifting process can be displayed by constructing the fiber bundle so that each elemental point can be tapped into an external indicator as well as the feedback path.

Shifting in two dimensions can be achieved by displacing the end faces of the fiber bundle in two dimensions. Adding rotation of the bundle faces results in a spatial sequence in which the members undergo a known transformation of both rotation and translation.

The contributions of E. C. Giaimo and J. Murr are acknowledged. The research was sponsored by the Air Force Cambridge Research Laboratories, Office of Aerospace Research.

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New Trends in Low-Power FERRITE

Passive ferrite limiters can serve a number of useful functions in microwave systems. Article tells where and how to use them profitably

VERSATILE FERRITES

Ferrites have many applications in microwave circuits, because of their magnetic properties, low conductivity and low hysteresis losses. They are used in circulators, isolators, duplexers, parametric amplifiers, attenuators and others. Their use in passive limiters depends on the absorption of surplus signal power by secondary spin-wave modes excited in the ferrite material, typically yttrium-iron garnet crystal

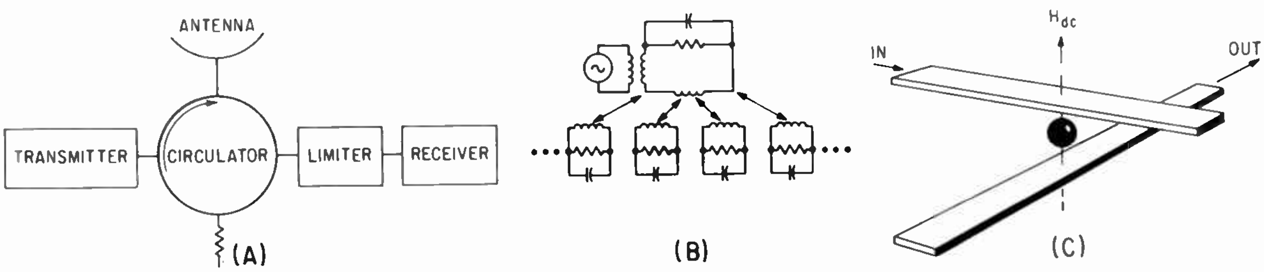
SYSTEM PERFORMANCE can frequently be improved by passive low-power microwave limiters. One well-known application is protection of a sensitive receiver against burn out, see Fig. 1A. A low-power limiter is used between a duplexing system and a receiver. When the transmitter is off, the limiter exhibits low loss and does not materially affect performance. except for possibly adding some frequency selectivity. When the transmitter is on, the limiter attenuates any leakage power through the circulator that is above the limiter threshold, thereby protecting the receiver.

A limiter can also find use as a power-levelling device. Amplitude variations from a microwave oscillator could be suppressed by a limiter at the oscillator output. If the limiter is free of phase distortion, it can prevent a-m to p-m conversion in f-m systems.

Another application is the protection of a sensitive receiver from a large jamming signal. If no precautions are taken, a large signal can saturate such a receiver, causing suppression of adjacent weak signals. However, if a low-power ferrite limiter is used in front of the receiver, the large signal can be limited without suppression of small signals.

At frequencies below the microwave range, a common form of a limiter is a diode clipper, using its highly nonlinear characteristic to obtain limiting action. At microwave frequencies, a diode clipper can still be used by going to low-loss, fast-acting semiconductor diodes. This becomes less desirable at the higher microwave frequencies since even the best diodes exhibit performance degradation with increasing frequency.

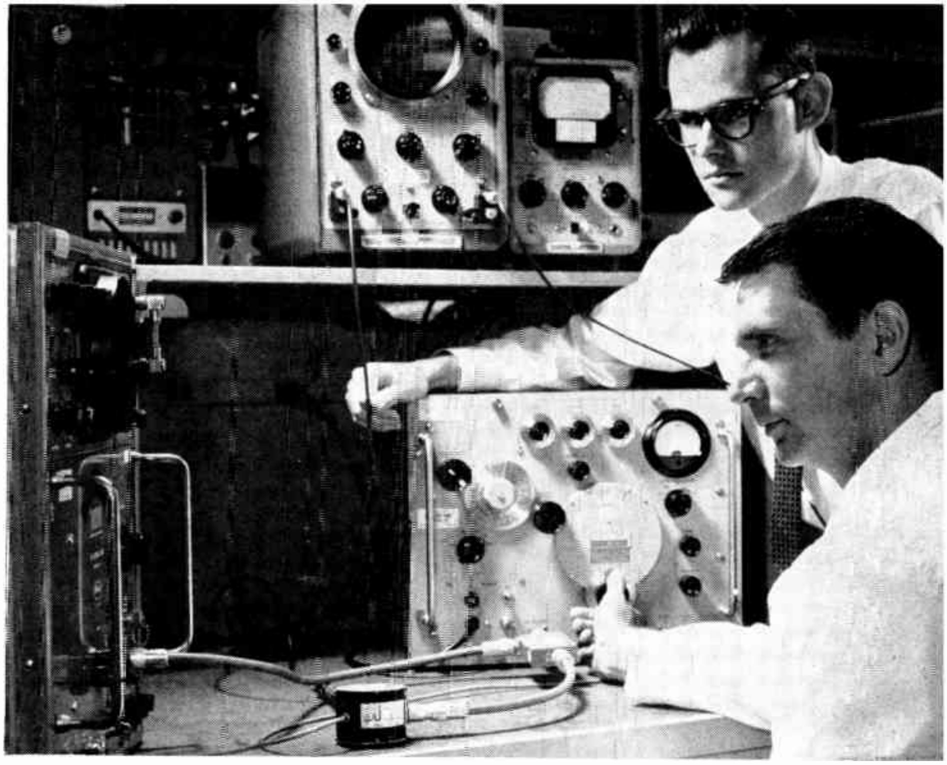
An alternate approach to low-power limiting at microwave frequencies is to use the nonlinear characteristics of ferrites. This fairly complicated problem was analyzed by Suhl[1] in 1955. A sample of ferrite contains a large number of possible modes of oscillation. The most familiar of these modes is the uniform precession mode, which is the mode usually excited in microwave ferromagnetic resonance. Many other modes are also present, however, and must be considered in an analysis of the nonlinear behavior of ferrites. This situation can be represented by the circuit of Fig. 1B. Here a signal source couples to the uniform precession mode in the ferrite, and an array of so-called spin modes also couple to the uniform precession mode. Suhl shows that because of this latter nonlinear coupling of modes, these spin modes can be driven into oscillation, thereby absorbing power from the uniform precession mode. One effect of this coupling is to cause a saturation of this uniform precession causing limiting. This mechanism is analogous to that of the passive para-



MICROWAVE LIMITER *for receiver protection against transmitter power or large received signals, (A); a ferrite resonator's many modes: uniform precession mode couples most readily to an external circuit, and in turn couples to a large number of spin-wave modes, (B); strip-line circuit in coincidence-mode ferrite limiter uses polished single-crystal ferrimagnetic sphere between two orthogonal half-wavelength center conductors and biased to resonance by a d-c magnetic field, (C)—Fig. 1*

LIMITERS

By K. L. KOTZEBUE
Watkins-Johnson Company,
Palo Alto, California



ADJUSTMENT OF LIMITER *is carried out by author Kotzebue (top right) and coworker*

metric limiter in which the input power is used to pump a subharmonic resonance into oscillation.

It is not always true that the onset of limiting results in a saturation of the main response. The coupling of energy into spin wave modes can also occur away from ferromagnetic resonance, resulting in a second absorption peak, called the subsidiary response. The frequency at which the subsidiary response occurs is a function of the geometry of the sample and its saturation magnetization. It is possible to have the subsidiary absorption peak occur at the same frequency as the usual resonant response. This so-called coincidence mode of limiting is the most useful mode, since flat limiting can be obtained with low threshold powers.

COINCIDENCE MODE LIMITERS —A low-power ferrite limiter operating in the coincidence mode was built by DeGrasse[2]. He used a highly polished sphere of single-crystal yttrium iron garnet (YIG) placed between two orthogonal half-wavelength strip-line resonators and biased to ferromagnetic resonance. This is sketched in Fig. 1C. Such a polished YIG sphere has low loss and results in a low limiting threshold. The limiter operated at 2.65 Gc, had a small-signal loss of 0.6 db and a limiting threshold of −26 dbm. Increasing the input power by 11 db and 21 db raised the output power by 1 db and 3 db, respectively.

Such limiters using YIG spheres will operate in the coincidence mode over somewhat less than an octave range of frequency. The low-frequency limit is determined by the minimum frequency at which the material has acceptable loss. This will, in general, be somewhat greater than that corresponding to the minimum field necessary to saturate the sample. The upper-frequency limit is determined by upper extent of the spin modes necessary to supply the subharmonic resonance. Neglecting anisotropy, this range in frequency for a sphere is

$$\frac{2\gamma}{3} 4\pi M_s > f > \frac{\gamma}{3} 4\pi M_s$$

where f is signal frequency, γ is 2.8 Mc per gauss, and $4\pi M_s$ is the saturation magnetization. For YIG at room temperature with $4\pi M_s$ = 1,800 gauss, this yields an operating range of 1.8 Gc to 3.4 Gc.

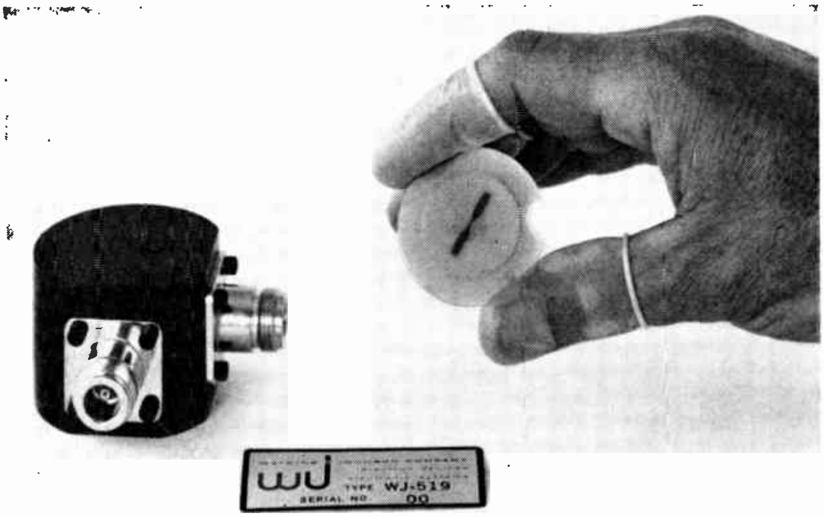
To obtain different operating ranges, it is necessary to choose a material with a different saturation magnetization (in theory it is possible to alter the operating range somewhat by changing the shape of the sample, but this technique has not yet been successful). This is not a simple task since to obtain low insertion loss below threshold it is necessary to use single-crystal material of narrow line width.

A satisfactory approach to lowering the operating range has been to use YIG containing gallium. The gallium lowers the saturation magnetization without excessive broadening of line width. Such YIG with saturation magnetization of about 400 gauss has been produced on an experimental basis. A penalty must be paid for the use of low saturation magnetization material, however, since the amount of coupling of circuit to ferrite is directly proportional to the saturation magnetization. Thus broad-bandwidth operation becomes more difficult at the lower frequencies.

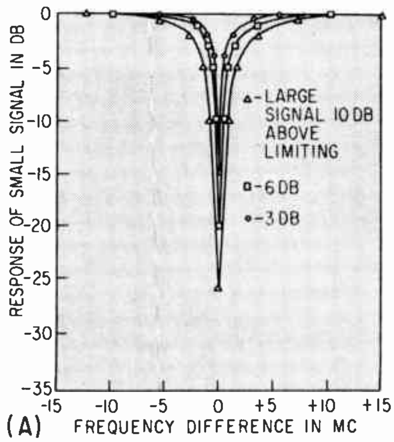
Coincidence-mode operation has also been obtained above the frequency range of YIG by using single-crystal lithium ferrite. Although the loss in lithium ferrite is about an order of magnitude higher than in YIG, it is still low enough to be useful in broadband configurations. As it has a saturation magnetization about double that of YIG, it operates over the frequency range of about 4 Gc to 7 Gc. A fixed-tuned lithium ferrite limiter of 500 Mc bandwidth is shown in Fig. 2, with the r-f strip-line assembly. To date there is no satisfactory method of coincidence mode limiting between 3.4 Gc and 4 Gc, or much above 7 Gc.

CHARACTERISTICS — Some operating characteristics of these limiters are:

Low insertion loss. Coincidence mode limiters are band-pass filters that become nonlinear above a certain threshold level. To obtain low insertion loss below threshold, the ferrite element must have a high



COINCIDENCE-MODE *limiter operation at C-band. The device uses a small sphere of lithium ferrite between orthogonal strip lines—Fig. 2*



FREQUENCY-SELECTIVE *limit-frequency, shown in (A) for a YIG (B); a frequency-selective limiter signals 6 db above limiting thresh-amplitude of the spike in an S-band*

unloaded Q. For a spherical ferrite resonator, this is

$$Q_u = f_o/\gamma\Delta H$$

where f_o is the resonant frequency and ΔH is the linewidth of the ferrite in oersteds. Over most of the region where YIG is useful as a coincidence mode limiter, it can have line widths of 0.5 oersted or less, resulting in unloaded Q's in the range of 1,000 to 3,000. This can yield limiters with less than 1 db insertion loss. The line width of lithium ferrite is 3 oersteds or greater, which means that broader bandwidths are necessary to achieve low insertion loss. As a rule the loaded Q of the bandpass filter has to be at least a factor of ten less than the unloaded Q to have an insertion loss that is no greater than 1 db.

Magnetic tuning: The resonant frequency of such ferrite resonators is not a function of size, but only of the magnetic field that biases the ferrite. Neglecting anisotropy effects, the resonant frequencies is

$$f_o = \gamma H_o$$

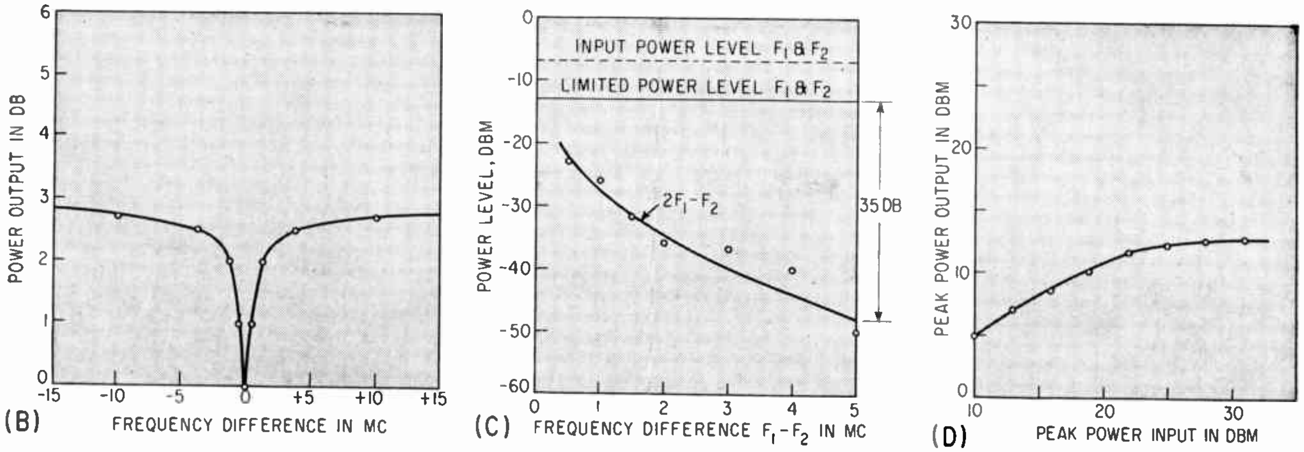
where H_o is the applied (external) magnetic field. If a broadband nonresonant coupling structure is used, it is possible to magnetically tune such a limiter over the entire frequency range of coincidence-mode limiting. The speed at which such tuning can be accomplished is a function of the physical structure of the magnetic and microwave circuits and the amount of drive power supplied to the tuning circuit. Switching times of less than 0.1 μsec have been measured in circuits designed for rapid tuning.

Low-power limiting threshold: The level at which limiting occurs is a function of the line width and saturation magnetization of the ferrite, and the size and configuration of the circuit and the ferrite. The minimum limiting threshold is obtained by using narrow-line-width resonators of minimum size in circuits that have high loaded Q's. In L and S-bands (up to about 3.4 Gc) limiting can be obtained at levels of about −10 dbm to −30 dbm using YIG or gallium-YIG, while in C-band limiting can be obtained at about +10 dbm to −10 dbm using lithium ferrite.

Large dynamic range: The limiting action of such ferrite limiters extends over a large dynamic range. In practice the dynamic range is often limited by the isolation of the passive circuits used in coupling to the ferrite. Typical values of dynamic range which can be obtained are between 20 db and 40 db.

Minimum phase distortion above limiting: The limiting mechanism involved does not cause a large reactive change in the equivalent impedance of the ferrite resonator. Measurements made at selected frequencies have shown phase changes on the order of ±5 deg over a 20-db range of limiting. As frequency is changed, however, the phase distortion also changes and can become on the order of ±30 degrees within the passband of the limiter.

FREQUENCY SELECTION — In the usual amplitude limiter, such as a diode clipper suppression of a small signal will occur when the limiter is limiting on a large signal. This means that a single large signal anywhere within the passband of a receiver will block the receiver over the entire band. This can be particularly troublesome with broadband receivers such as those employing traveling-wave tubes. One solution is to put a narrow-band tunable preselector filter ahead of the receiver, but then the receiver cannot simultaneously receive signals at several widely-separated frequencies. Another solution is to use a limiter that does not suppress a small signal while limiting a large signal. Such a limiter is a frequency-selective limiter since individual frequency components are selectively limited. A coincidence-mode ferrite limiter is such a device.[3] It is a passive parametric limiter, and the ferrite resonator has a large number of overlapping resonant modes. A passive parametric limiter limits by conversion of power to a subharmonic oscillator. If there is only a single subharmonic oscillator, limiting will cease when the signal frequency is changed by an amount which puts the half-frequency component outside of the bandwidth of the subharmonic oscillator. If there are



ing characteristic means that a small signal is not suppressed by a large signal unless the two signals are close in limiter at 2.7 Gc; total output power for two signals well above limiting threshold in a C-band lithium ferrite limiter, does not generate significant spurious frequencies when limiting, illustrated for a YIG limiter at S-band with two old, (C); a fairly large spike will occur at the leading edge of a pulse signal. This graph shows saturation of the YIG limiter, (D)—Fig. 3

two subharmonic oscillators of different frequencies not coupled to each other, but each coupled to the signal circuit, then limiting can occur over two frequency intervals. Or, two signals can be simultaneously limited, each exciting a subharmonic oscillation in each of the two oscillators. But since the subharmonic oscillators are not directly coupled, these two signals will be independently limited.

A ferrite resonator has many modes so closely spaced as to form an almost continuous spectrum. Thus many signals can be simultaneously limited independently, as long as they are spaced at least by an amount which is comparable to the bandwidth of a typical subharmonic oscillator.

Therefore a frequency-selective limiter does not suppress a small signal when a large signal above limiting is present a few megacycles away. This is graphically demonstrated in Fig. 3A: the suppression of a small signal as a function of frequency separation between the large signal and the small signal, and also a function of the level of the large signal. Another consequence of frequency-selective limiting is that the total limited output power is a function of the number of saturating signals present. Thus, if a limiter saturates at 1 mw on a single signal, it will pass a total output power of 3 mw if 3 saturating signals of different frequencies are present. This effect is illustrated in Fig. 3B. A third property of frequency-selective limiting is that significant sum and difference frequencies of multiple saturating signals are not generated, as in conventional limiters. Figure 3C shows the result of one experiment in S-band using a YIG filter. Two signals 6 db above limiting were present, one at frequency f_1 and one at frequency f_2. The largest mixing product within the band of the filter is $2f_1$-f_2. When f_1 and f_2 are 5 Mc apart, this mixing product is down by 35 db.

SPIKE LEAKAGE—One characteristics of low-power ferrite limiters that can detract from their usefulness is spike leakage. This is a short transient pulse at the beginning of limiting, and therefore occurs whenever a pulsed signal is being limited. The physical reason for this spike is that a finite time is required to build up the subharmonic oscillation from thermal noise level. During this transient, limiting will not occur, resulting in a leakage pulse. The size and length of this pulse will depend on the amplitude and rise time of the input; a large signal of short rise time tends to produce a large spike.

As an example of how the leakage amplitude varies with input, a YIG bandpass filter-limiter was operated at 3 Gc with an input pulse of approximately 0.3 μsec. The output pulse became narrower as it was limited. In Fig. 3D is shown the limiting characteristic. On c-w signals the limiting level was -14 dbm. This large difference in power level indicates that the output pulse observed was actually all spike leakage. Spike leakage is inherent in this type of limiter. It is possible to reduce the build-up time of the subharmonic oscillation and thus reduce leakage effects, but this means increasing the limiting threshold and degrading the frequency-selective limiting characteristics.

FUTURE WORK — Two areas where additional effort will be worthwhile are materials research and circuit design. Materials research is needed to develop new ferrite materials to extend the operating range of coincidence mode limiting. It may be possible to dope lithium ferrite to bridge the present frequency gap of about 3.4 Gc to 4 Gc where no adequate material is available. To extend the range of operation above about 7 Gc, a completely new material will probably be needed. This material should possess a line width of less than 10 oersteds and a saturation magnetization of about 6,000 gauss for X-band operation. Also, of possible interest for higher frequency coincident-mode limiting, are ferrite materials with significant internal anisotropy fields.

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(2) R. W. DeGrasse, Low-loss gyromagnetic coupling through single crystal garnets, *J Appl Phys*, 30, p 155S, April 1959.
(3) K. L. Kotzebue, Frequency-selective limiting in YIG filters, *J Appl Phys*, 33, p 747; Feb 1962.

Using a New Device: Field-Effect

Variable frequency Wien-bridge has 20-cps to 40-Kc range, delivers 3.5

WIEN-BRIDGE THEORY

The oscillator (Fig. 1A)—a two-stage, RC-coupled, class-A amplifier—has two loops (Fig. 1B) linking input and output. One, the positive feedback loop, causes the oscillation; the other, the negative feedback loop, stabilizes the amplitude of the oscillations.

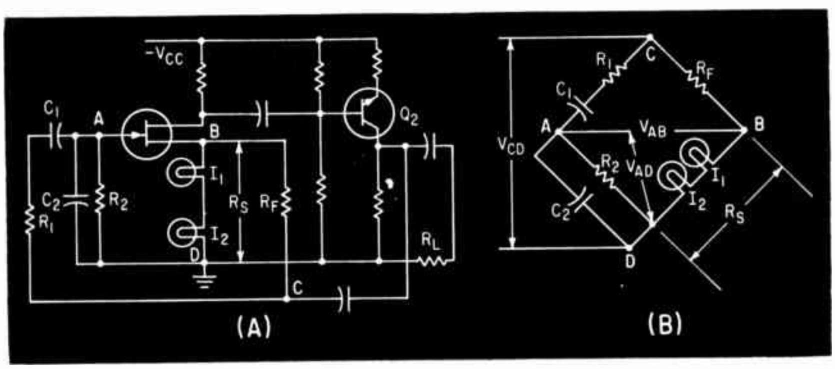
Oscillations occur when there is zero phase-shift between V_{AD} and V_{CD}, at a frequency f_o determined by R_1, R_2, C_1, and C_2 and given by: $f_o = 1/2\pi (R_1 R_2 C_1 C_2)^{\frac{1}{2}}$; the attenuation is calculated from $V_{AD}/V_{CD} = 1/(1 + C_2/C_1 + R_2/R_1)$. If $R_1 = R_2$ and $C_1 = C_2$, then zero phase-shift occurs at $f_o = 1/(2\pi RC)$ and the attenuation becomes 1/3.

The negative feedback loop—a resistive voltage divider—has zero-phase shift at all frequencies and an attenuation $V_{AB}/V_{CD} = R_S/(R_S + R_F)$; R_S is the a-c resistance of lamps I_1 and I_2.

The voltage transfer ratio, β, of the bridge network is the difference between the attenuation of the positive and negative feedback loops: $\beta = V_{AB}/V_{CD} = |1/(1 + C_2/C_1 + R_1/R_2)| - |R_S/(R_S + R_F)|$. If $R_1 = R_2$ and $C_1 = C_2$, then $\beta = (1/3) - (R_S/R_S + R_F)$.

A necessary condition for oscillation is that the product of gain and feedback attenuation be equal to one. Therefore the gain of the amplifier, expressed by the feedback ratio is $A = (1/\beta) = |(1/3) - R_S/(R_S + R_F)|$, or, the necessary feedback for a particular oscillator is a function of the open-loop amplifier gain, $R_S/(R_S + R_F) = (1/3) - (1/A)$. With large open-loop gain, the oscillator has more stability and less distortion.

Two lamps, in series with the negative feedback loop, keep $A\beta$ independent of component aging or temperature changes; their nonlinear resistance increases with signal amplitude—thus bringing amplitude back to normal



SIMPLIFIED WIEN-BRIDGE *oscillator, with two-stage amplifier, (A) and redrawn in bridge form; lamps I_1 and I_2 are part of the negative feedback loop (B)—Fig. 1*

BECAUSE OF their high input-impedance, vacuum tubes, rather than transistors are normally used as active elements in Wien-bridge oscillators. In this circuit, the active element is a 2N2498 field-effect transistor that is smaller and more efficient than a tube and has an equivalent high input impedance. The two stage oscillator is followed by a buffer that delivers 3.5 volts to 2,000-ohm load.

The oscillator's frequency ranges from 20 cps to 40 Kc in four steps and is continuously variable between steps. Both frequency and amplitude stability are good, except at the lower frequencies. Several ways of improving the stability and frequency range are suggested.

EXPERIMENTAL CIRCUIT—The breadboard model Wien-bridge oscillator, Fig. 2, consists of a two-stage oscillator and an emitter follower or buffer. With the buffer, power stages can be added without degrading the oscillator.

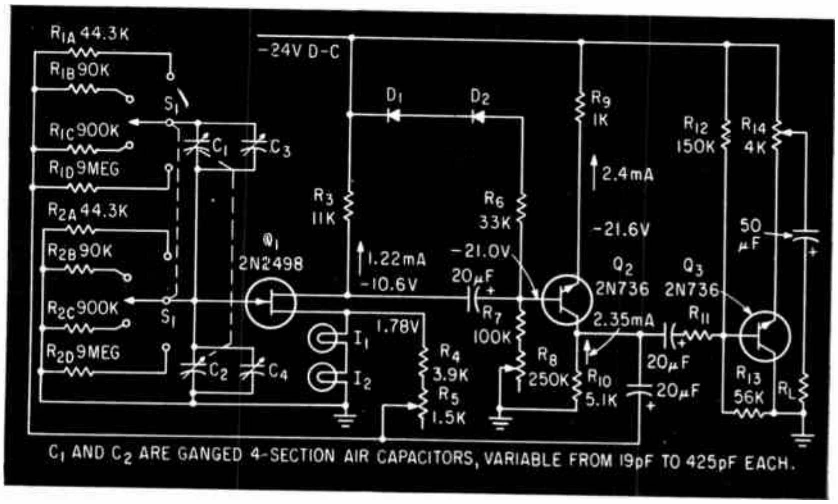
The four frequency ranges, selected by a four-position switch S_1, are: 20 to 200 cps; 200 cps to 2 Kc; 2 Kc to 20 Kc; and 4 Kc to 40 Kc. The signal amplitude is adjustable from zero to 3.5 v rms into a 2,000-ohm load. An 8-ma, 24 v d-c supply is required.

The amplitude is controlled by potentiometer R_{11}; R_{11} attenuates the amplifier signal slightly to prevent unsymmetrical clipping by the emitter follower. The bias point of Q_2 is adjusted by rheostat R_{8}, to insure symmetrical clippings, and the

Transistor Oscillators

By VERN GLOVER
Applications Engineer,
Texas Instruments Inc.,
Dallas, Texas

volts to a 2,000-ohm load. Other field-effect transistor circuits suggested



BREADBOARD MODEL *oscillator uses field-effect transistor 2N2498. Switch S_1 selects one of four frequency ranges; transistor Q_3 is the buffer stage—Fig. 2*

gain is adjusted by R_5 which must be set for minimum distortion. Both R_5 and R_8 need only initial calibration.

Diodes D_1 and D_2 help stabilize the bias point of Q_2 over the temperature range 15 C to 45 C. The lamps I_1 and I_2 are nonlinear resistors in the negative-feedback loop.

The positive-feedback loop consists of ganged variable capacitors, paralleled by mica trimmers, and two sets of resistors connected by a double-pole, four-position switch.

Trimmer capacitor C_3 compensates for inequalities in the variable capacitors and in the input capacitance of the field-effect transistor. The breadboard model operated satisfactorily with several 2N2498 units, even using limit samples having maximum and minimum data sheet values of $I_{D(on)}$, zero-gate-voltage drain current.

FREQUENCY STABILITY — A maximum random variation of 2.77 percent was observed in the low-frequency scale range. All other scale ranges exhibited less than 0.25-percent variation. The maximum variation of frequency on any scale with a 10-percent voltage variation was no more than the maximum random variation of 2.77 percent. The frequency variation observed over the temperature range of +45 C to +15 C was also no more than the maximum random variation of 2.77 percent observed at room temperature.

The maximum amplitude variation over the 20-cps to 40-Kc frequency range was +4.7 percent to −12.3 percent compared to the amplitude at 1 Kc. The amplitude variation with temperature at 15 C was negligible but increased to 6.25 percent from the amplitude at 25 C as the temperature reached 45 C. Below 10 C the waveform started to distort, and above 50 C the amplitude decreased sufficiently to stop oscillation.

DISTORTION — Maximum distortion measured from 20 cps to 20 Kc was 0.81 percent; distortion measurements were not made above 20 Kc because of limitations in the measuring equipment. Visual examination of the waveform indicated no increase in distortion from 20 Kc to 40 Kc.

FREQUENCY LIMITATIONS — The high- and low-frequency ends of the oscillator were determined by the resistors in the positive feedback loop. The maximum value of R_2 was limited by the finite input impedance of the field-effect transistor. At 200 cps—high end of the low-frequency scale—the transistor's input impedance began to reduce the effective value of R_2. Thus, R_2 was made slightly larger than R_1 on this scale range. But this was not sufficient compensation, and the low-frequency scale was the least stable. The worst-case amplitude variation and distortion occurred on this scale.

The voltage developed across R_2

by the source-to-gate leakage current further limits the maximum resistance. If the voltage developed by this temperature-dependent current increases sufficiently to cause the field-effect transistor to approach pinch-off, the oscillator will cease functioning.

Both limitations can be overcome by a larger variable air-capacitor, which would permit the use of a smaller resistor on the low-frequency scale. A larger capacitor would also permit the use of additional larger trimmer capacitors to ease frequency adjustment during calibration. The capacitor used in this circuit was employed only because it was available.

The high-frequency limitation is determined by the minimum permissible resistor values which do not load down the oscillator's second stage. The positive feedback resistors required for the high-frequency range are 44,300 instead of the theoretical 45,000 ohms (from Eq. 1). The output impedance of the second stage is significant enough to increase the effective value of R_1 and explains this apparent discrepancy. Corresponding vacuum-tube oscillators that operate at 20 cps usually also employ a larger variable capacitor than the one used in the breadboard model.

POSSIBLE IMPROVEMENTS — A larger variable air capacitor would permit the use of smaller resistors in the bridge circuit when operating on the low-frequency scale. This would result in improved frequency and amplitude stability.

Another improvement is to increase the open-loop amplifier gain of the oscillator. The calculated voltage gain of the oscillator was

$$A \cong g_m R_3 \frac{R_{10}}{R_9}$$

$$= (1 \times 10^{-3})(11K)\left(\frac{5.1K}{2K}\right) = 28$$

where g_m = transconductance of the field-effect transistor. The measured gain was 27.3. According to Millman[1], frequency stability could be improved if this gain could be increased. This could be accomplished if constant-current biasing of the field-effect transistor were employed. It would permit the use of a larger source load resistance in the field-effect transistor stage in conjunction with a larger supply voltage. An additional transistor amplifying stage could also be added, to prevent loading of the field-effect transistor stage and for additional amplification.

Another circuit improvement is a continuously variable frequency control using two ganged variable rheostats; however, unequal rheostat tracking results in radical variations in output amplitude at the rheostats, and thus varying frequency. If rheostats are used, the large air-dielectric capacitor is eliminated and a smaller package can be achieved.

OTHER CIRCUITS — Several oscillator circuits employing field-effect transistors were investigated. Phase-shift oscillators were found to work satisfactorily except for the disadvantage inherent in such circuits, that is, no simple compensating negative feedback such as the variable lamp resistance in the Wien-bridge oscillator. A phase-shift oscillator which was breadboarded is shown in Fig. 3A. The attenuation of the 4-mesh feedback network is 18.36. The frequency of oscillation is determined by:

$$f_o \approx \sqrt{\frac{7/10}{2\pi RC}}$$

where R and C are the values of one mesh in the ladder feedback network.

A three-mesh network would have an attenuation of 29 and a frequency

$$f_o \approx \frac{1}{2\pi RC\sqrt{6}}$$

The frequency of oscillation of the circuit shown in Fig. 3A can be varied several cycles around 10 cps by varying R_{11}. The variable resistor R_3 permits the gain to be adjusted exactly to compensate for the attenuation of the feedback network.

Another circuit possibility is shown in Fig. 3B. R_1 adjusts the bias for symmetrical clipping and R_2 adjusts the gain. It has possibilities as a fixed, low-frequency oscillator. It appears that for a fixed frequency oscillator, a lamp in the negative feedback loop is not as important and a resistor can be used with reasonable success.

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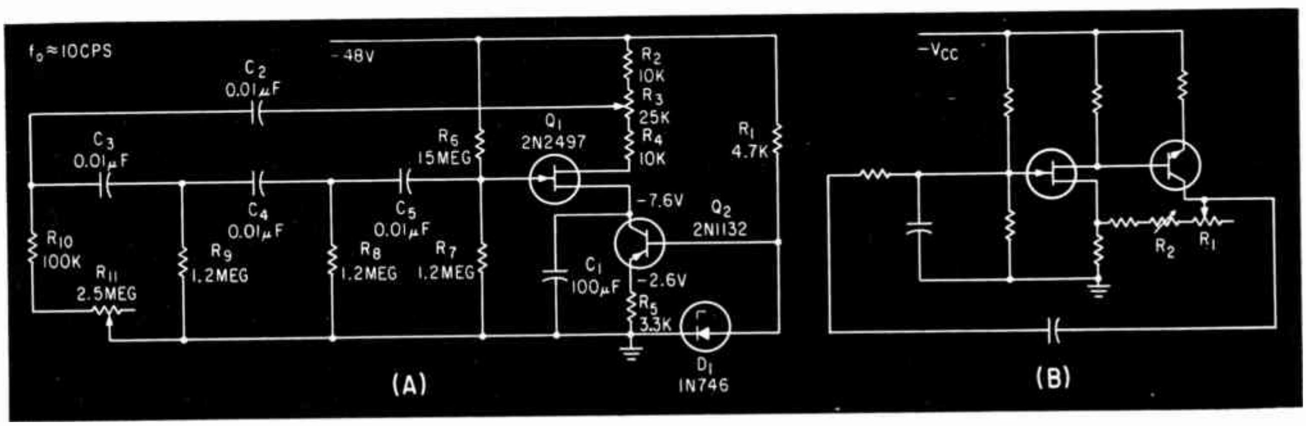
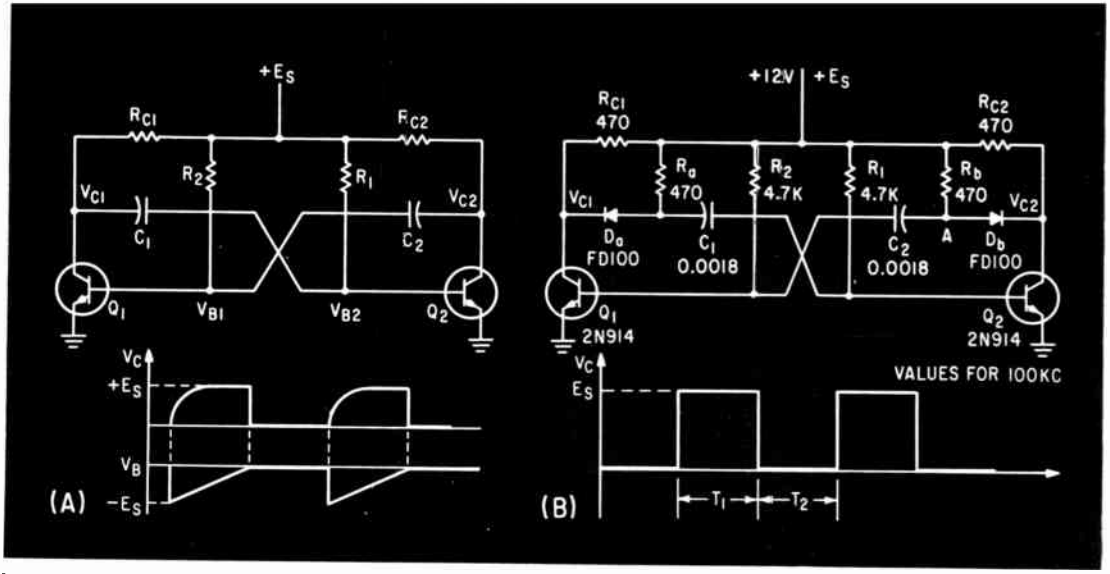


PHASE-SHIFT *oscillator for 10 cps, also uses field-effect transistor (A); fixed low-frequency oscillator does not require lamps in feedback loop; its gain and bias are adjusted by R_1 and R_2 respectively (B)—Fig. 3*



BASIC MULTIVIBRATOR *circuit, shown with its collector and base voltages, (A), can be modified by addition of four components to provide a square-wave collector output voltage (B)*

Simple Square-Wave Generator

By adding only four components to the basic free-running multivibrator circuit, its output waveshape is changed to a clean square wave

By R. O. GREGORY and J. C. BOWERS
Electronic Equipment Division, McDonnell Aircraft Corp., St. Louis, Mo.

A MAJOR LIMITATION of the traditional free-running multivibrator (A) is its inability to give a truly square-wave output. The outputs of a typical multivibrator are also shown in (A). To obtain a square wave, it is generally necessary to add many components.

The rise time of the collector voltage is limited by the time constants $R_{c1}C_1$ and $R_{c2}C_2$. In practice these have a lower limit. R_1 and R_2, which are 10 times R_{c1} and R_{c2}, must in turn be large compared to the on base-input resistance, and C_1 and C_2 must be large compared to the off input and output transistor capacitances.[1]

The circuit shown in (B) solves this problem with the addition of only four components to the basic multivibrator configuration. Its collector voltage waveform is shown in (B). The operation is similar to the circuit of Fig. (A); time T_1 is computed by

$$V_{B2} = 2\,E_s\,[1 - \exp(-t/R_1 C_1)] - E_s.$$

Thus when $V_{B2} = 0$

$$T_1 = R_1 C_1 \ln(2\,E_s/E_s) = 0.69\,R_1 C_1.$$

Also, $T_2 = 0.69\,R_2 C_2$

Therefore the frequency of the square-wave generator is $f = 1/(T_1 + T_2)$.

The collector waveshape is simply explained. Ordinarily, the voltage at V_{c2} is nearly zero when Q_2 is on, thus, when Q_2 turns off the voltage rises, according to the time constant $R_{c2}C_2$, to the value of supply voltage E_s. However, in the new circuit, capacitor C_2 is charged through R_b. Diode D_b prevents the charging current from passing through R_{c2}. Therefore the voltage at V_{c2} reaches the supply voltage as soon as Q_2 has been turned off. The voltage at point A is initially zero and charges through the R_bC_2 time constant up to the supply voltage.

The squareness of the waveforms at V_{c1} and V_{c2} are limited mainly by the transistor and diode characteristics. The circuit has been built in versions operating from several cps to several megacycles.

EASY WAY TO GET A SQUARE WAVE

The usual way to generate a square wave is to start with a sine wave or other shape, filter it, clip it, limit it and otherwise torture it until it resembles the desired rectangle. Authors Gregory and Bowers have a neater solution: generate the right waveform in the first place. It turns out you only have to add two resistors and two diodes to an ordinary free-running multi-vibrator

REFERENCE

(1) R. B. Hurley, "Junction Transistor Electronics", p 420, John Wiley & Sons, 1958.

How to Produce Variable Width

Simple circuit allows triggering of square pulses with adjustable pulse duration down to 20 nanoseconds

IT IS OFTEN NECESSARY to vary the width of a pulse over a wide range. Conventionally, this is done with differentiating circuits, but these are sensitive to noise and voltage variation, especially when dealing with narrow pulses. The circuits presented here largely overcome these difficulties. Their operation is based on using one transistor to start the pulse, and another transistor to end it; pulse widths of less than 20 nanoseconds are easily obtained.

One version is shown in Fig. 1. The input pulse repetition frequency and pulse width does not affect the output pulse width, provided the width of the input pulse exceeds the desired output pulse width.

A high input, in Fig. 1, causes a high positive base voltage at Q_1, because of voltage drops across silicon diodes D_1 and D_2; this holds the emitter of Q_1 positive. The base voltage of Q_3 is the same as the emitter voltage of Q_1, keeping Q_3 switched off. At the same time, germanium diode D_3 keeps the base of Q_2 about 0.3 volt more positive than the emitter; transistor Q_2 is also off and the output is at −6 volts.

If the input now goes negative, the Q_1 emitter tends to follow the Q_1 base voltage, but it reaches only a few tenths of a volt negative before Q_3 is switched on and saturates. The low saturation resistance of Q_3 swamps resistor R_3, which prevents the emitter voltage going more negative. The input signal biases Q_1 in the off position, while the current through R_3 holds Q_3 switched on. Output at this point is zero.

The same negative-going input reaches the base of Q_2 through C_2 and R_1. Integrating circuit C_3R_1 produces a negative-going ramp on the base of Q_2. The slope of this ramp varies with width control R_1, and determines the time Q_2 is driven on When Q_2 goes on, its collector goes positive. Since the base of Q_3 goes to the collector of Q_2, this positive voltage turns off Q_3 and holds it off until the input goes positive and negative again. The width of the pulse is the time from the instant Q_3 went on to the time Q_2 drove Q_3 off again. The voltages are small diode drops, therefore narrow pulses less than 20 nanoseconds are possible. The width of the output pulse is a function of an R-C time constant and semiconductor voltage drops, which are fairly constant over a large variation of d-c potentials.

The circuit of Fig. 1 produces a positive-going pulse which can be amplified and inverted. The transistors are inexpensive switching types with cutoff frequencies over 100 megacycles. The circuit, as given, can drive a 1,000-ohm resistive load for a peak output power of $(6)^2$ volt/1,000 ohms = 36 milliwatts.

HIGH-POWER CIRCUIT—Figure 2 shows another circuit based on the same principle, used to obtain a high-power clock pulse. Transistor Q_1 is a conventional follower to provide a high input impedance and increase the current drive to Q_2. Transistor Q_2 is a high-frequency microalloy diffused transistor that is a fast switch improving the rise and fall times of the input. The emitter of Q_2 is at −3 volts holding Q_2 off until the input becomes more negative than −3 v. This prevents low-voltage noise from triggering the circuit. The maximum V_{EB} of the 2N979 is only about 1 volt, therefore, diode D_1 prevents the −3 volts from appearing directly between emitter and base.

When Q_2 is off, its collector voltage is less than −7.5 v because of the drop across high-frequency silicon diode D_2; assuming a drop of −0.7 volt for a silicon diode and −0.3 volt for a germanium diode, the collector of Q_2 is at −8.2 volts when off. This voltage goes through germanium diode D_4 and appears on the base of Q_3 as approximately −8.2 − (−0.3) = −7.9 volts, which is less than the −7.5 v on the emitter of the *npn*; Q_3 is off. The collector of Q_2 also goes to the base of Q_4, through silicon diode D_5. The voltage on the base of Q_4 is approximately −7.5 − (−0.7) = −6.8 volts, which is more negative than the −6 v on the emitter. Transistor Q_4 is also off.

When the input goes negative, Q_2 is driven on causing the collector to rise toward −3 volts. This will turn on Q_4, the input resistance of Q_4, when saturated, will hold the base of Q_4 at nearly −6 volts back-biasing D_5. The current through R_5 will hold Q_4 on. Diode D_6 prevents the low on impedance of Q_4 from appearing on the collector of Q_2; also, D_6 holds the collector of Q_3 more positive than its base. The positive-going voltage that turned Q_4 on goes through the time constant R_3 R_4 C_1 and turns Q_3 on after a fixed delay, which causes a negative-going pulse driving transistor

Pulses

By IRVING SIMON
Monroe Calculating Machine Co.
Orange, N. J.

ADJUSTABLE PULSES

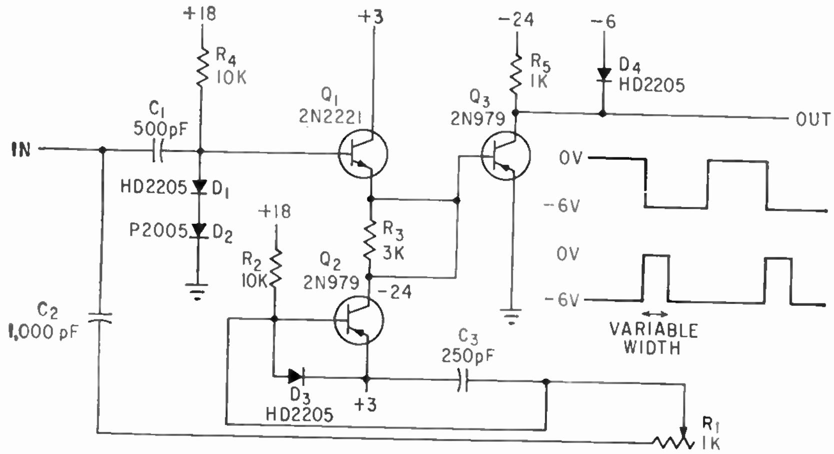
In the field of generating, shaping, stretching, limiting and otherwise processing pulses there are never enough circuits available to solve all possible problems. Author Simon explains a simple circuit that, when triggered, generates a square pulse whose duration can be accurately adjusted to suit the need. One transistor is used to start the pulse, another to terminate it

Q_4 off again.

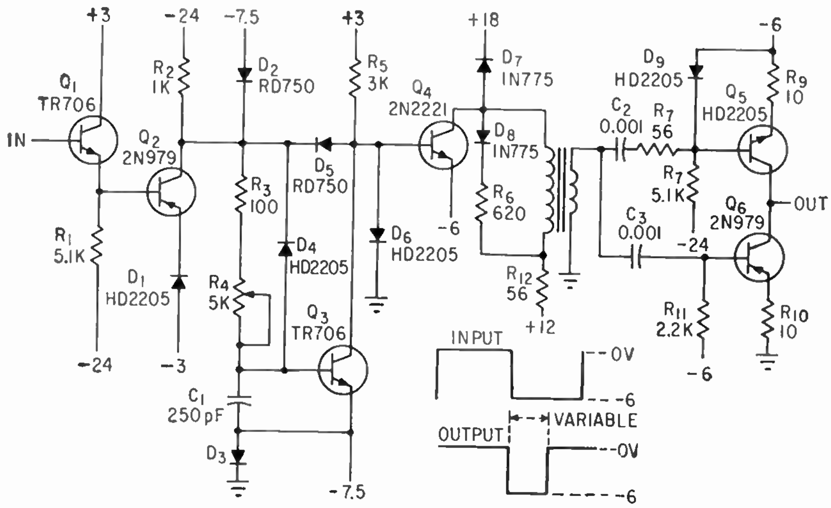
When Q_4 is switched on, a large negative-going voltage appears across the transformer primary sending a current through the windings. Then Q_4 shuts off suddenly; this causes an inductive surge that drives the collector side of the transformer highly positive. High conductance diode D_7 clamps the collector to +18 v, while the energy is dissipated by R_6. This resistor clamps the primary when the positive inductive kick forward biases D_8. The inductance of the transformer depends upon the required width of the output. For widths between 50 nanoseconds and 0.15 microsecond, a homemade 5:1 50 microhenry primary with a high-frequency ferrite core was used. There are many commercial pulse transformers available.

Diodes D_3 and D_6 protect Q_4, if the +18-v supply comes on before the negative supplies. Diode D_6 holds the base of Q_4 near ground while D_3 allows Q_3 to go on reducing the drive to Q_4.

The output of Q_4 is inverted by the transformer producing a positive-going pulse on the secondary. Transistor Q_5 is normally off because the D_9 diode drop keeps the Q_5 base more negative than the emitter. Q_6 is held saturated by the current through R_{11}; at this time the output is at 0 volts. A positive-going pulse drives Q_5 on and Q_6 off driving the output to −6 volts. Resistor R_7 reduces transformer loading when Q_5 saturates. The output is a negative-going pulse. A peak current of 400 ma has been obtained for a peak power output of 6 × 0.4 = 2.4 watts.



BASIC VERSION *of variable-pulse-width generating circuit uses three inexpensive switching transistors—Fig. 1*

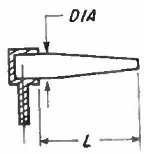
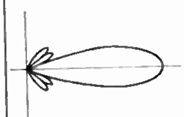


HIGH-POWER *variable-width shaper will handle power output up to 2.4 watts—Fig. 2*

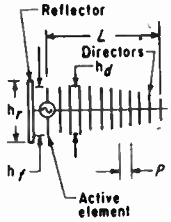
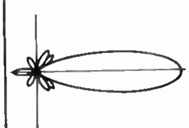
Ready-Reference Data Simplifies

Tabulation of characteristics of fundamental antenna types as to function, application, formulas and operational considerations that suggests many new design possibilities

SURFACE WAVE ANTENNAS

Type	Radiation Pattern	Polarization	Impedance	Gain over Isotropic	Bandwidth	Application or Function
DIELECTRIC ROD  $\frac{D}{\lambda} < \frac{0.626}{\sqrt{\epsilon}}$ ϵ = Dielectric constant of rod generally 2 to 2.5 Rod Taper $\frac{D\ max}{D\ min} \cong 1.6$ $L \cong 4\lambda$ to 8λ	End-fire  HALF POWER BEAM WIDTH $\cong 60\sqrt{\frac{\lambda}{L}}$ Sidelobes −13db	Linear	Vswr: Typically less than 1.5 to 1	$G \cong \frac{8L}{\lambda}$ max. about 17 db	10% Higher for smaller values of ϵ	Principally as radar feeds, and in arrays. From 1 to 6 Gc.

SURFACE WAVE ANTENNAS

Type	Radiation Pattern	Polarization	Impedance	Gain over Isotropic	Bandwidth	Application or Function
YAGI-UDA  $h_r = 0.48\lambda$ $h_f = 0.42\lambda \cong h_d$ $P = 0.2\lambda$ Element Thickness $\leqq 0.048\lambda$ $L = 4\lambda$ to 8λ or greater	End-fire  Half Power Beam Width $\cong 60\sqrt{\frac{\lambda}{L}}$	Linear-parallel to plane containing antenna	Vswr: Fair match to 50 ohm line, typically under 2/1	$\frac{8L}{\lambda}$ max about 17 DB	10%	Principally as tv/fm receiving antennas

Antenna Design

By R. S. GORDON
K. W. DUNCAN

Sylvania Electronic Systems
East, 100 First Ave., Waltham, Mass.

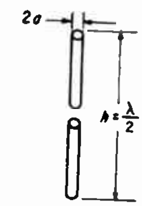
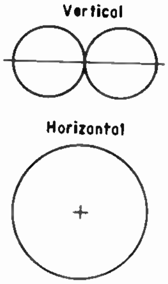
COMPREHENSIVE performance information on a broad range of antennas has only recently been assembled in literature. It is still a lengthy task to extract operating data for practical engineering problems. The most useful data in early stages of a design is a tabulation of possible antenna choices in terms of function, application, and formulas describing their performance.

Many fundamental antenna types have been analyzed and their operating characteristics have been confirmed experimentally, but the data is spread over a large number of texts and professional publications. The material in this reference was assembled, and in some cases developed, to summarize this information and present it so as to offer the greatest utility for engineering practice. This is not intended to substitute for a detailed and rigorous literature treatment of any of the antennas, but to provide a concise survey of the possibilities available for a particular application.

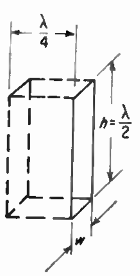
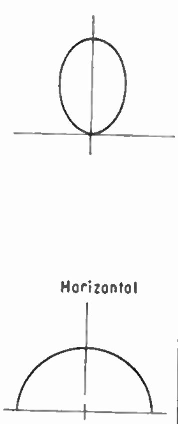
For all antenna types, a lossless condition has been assumed; thus making efficiency depend on specific materials of construction and individual enviroment. Note that gain values are all above an isotropic radiator and where values are shown as typical, they were obtained from reported or observed data.

continued on p 52

RESONANT ANTENNAS

Type	Radiation Pattern	Polarization	Impedance: Radiation Resistance	Impedance: Reactance	Gain over Isotropic	Bandwidth	Application or Function
HALF-WAVE DIPOLE 		Linear Vertical	$R \cong 73$ ohms for thin cyl. dipole. For other thicknesses $\frac{\lambda}{2a}$ / R_R: 40,000 / 69; 4,000 / 67; 400 / 63.6 (For a monopole of $h = \frac{\lambda}{4}$ $R \cong 37$ ohms	Resonant Note: Resonance actually occurs for h slightly less than $\frac{\lambda}{4}$. For $h = \frac{\lambda}{4}$ exactly $X = j\,42$	2.15 db	5 % to 40 %	Communications, navigation, radar, etc from 10 Mc to 5 Gc

RESONANT ANTENNAS

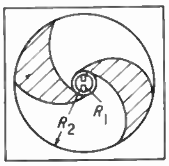
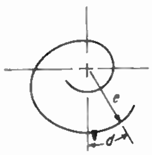
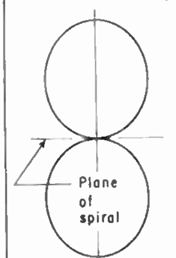
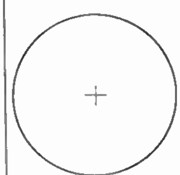
Type	Radiation Pattern	Polarization	Impedance: Radiation Resistance	Impedance: Reactance	Gain over Isotropic	Bandwidth	Application or Function
HALF WAVE SLOT  $w \cong \frac{\lambda}{100}$		Linear Horizontal	$R \approx$ 1,000 ohms for $\frac{\lambda}{4}$ cavity behind slot. For slot open on both sides R = 363 ohms	Resonant Resonance actually occurs for $h = 0.475\lambda$ where R_r = 530 ohms (boxed in) For $h = \frac{\lambda}{2}$ exactly, $X = -j211$	~5 db open slot 2.15 db		Principally as flush mounted antennas on aircraft and missiles from 100 Mc to 35 Gc

FEEL LIKE A LIBRARIAN?

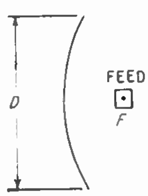
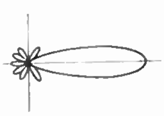
Antenna data appears in a wide variety of published material. The only problem is to dig out the basics of function, application and operating characteristics without extensive research into an ocean of books and papers.

The authors have compiled essential, basic information into a ready-reference package that puts the facts at your fingertips

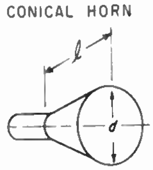
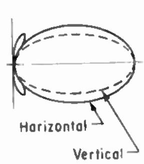
FREQUENCY INDEPENDENT

Type	Radiation Pattern	Polarization	Impedance: Radiation Resistance	Impedance: Reactance	Gain over Isotropic	Bandwidth	Application or Function
EQUIANGULAR SPIRAL  $R_1 \cong \frac{\lambda}{8}$ of highest freq of design $R_2 \cong \frac{\lambda}{2}$ at lowest freq  $\rho = \rho_0 e^{a\phi}$	 Perpendicular to plane of spiral 	Circular	$R \approx 150$ ohms	Magnitude insignificant over band	~5 db	To 10/1	Ecm and telemetry on aircraft and missiles. Occasionally in arrays

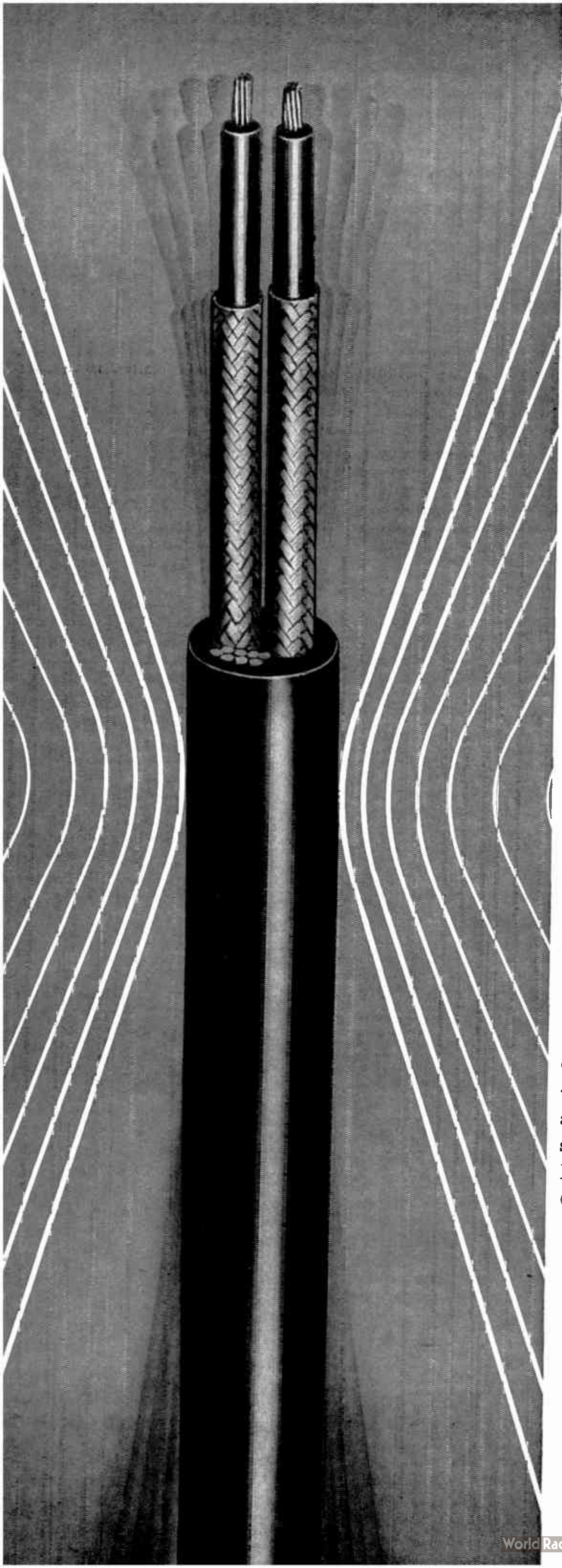
APERTURE ANTENNAS

Type	Radiation Pattern	Polarization	Impedance	Gain over Isotropic	Bandwidth	Application or Function
PARABOLOIDAL REFLECTOR 	Approx. Circularly Symmetrical  HALF POWER BEAM WIDTH $= 70 \frac{\lambda}{D}$ degrees Sidelobes -20 db	Determined by feed	Vswr: Typically less than 1.5 to 1	$\cong \frac{30{,}000}{(HPBW)^2}$ Typical range = 20 db to 50 db	Determined by feed	Radar, communications, radio astronomy and other high gain applications

APERTURE ANTENNAS

Type	Radiation Pattern	Polarization	Impedance	Gain over Isotropic	Bandwidth	Application or Function
CONICAL HORN  te_{11} mode $d \cong \sqrt{3\lambda \ell}$	 HALF POWER BEAM WIDTH Horiz $\cong \frac{70\lambda}{d}$ Vert $\cong \frac{60\lambda}{d}$	Vertical	Vswr: Fairly well matched to waveguide. Vswr from 1.03 to 1.5 for moderate flare angles	$0.52 \frac{\pi d^2}{\lambda}$	1.6 / 1	Similar to pyramidal horn

continued on p 56



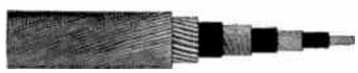
Simplex Electronic Cables...

Reduce Low-Level Signal Noise
Protect Hard Site Communications
Facilitate Ocean Implantment

Typical of designs within the Simplex family of electronic cables is an antimicrophonic construction which reduces externally caused noise to a level of 2 millivolts as compared with a level of 60 millivolts in a typical RG 8/U cable subjected to identical testing.

Simplex can incorporate this long-lasting antimicrophonic design feature into any special cable construction, and high demand items such as 2 conductor #18 and single conductor #16 are stocked for immediate delivery.

Many critical installations require cables that are both pliable and strong. Cables, armored by Simplex with extra heavy corrugated metallic sheaths, provide protection for vital communications at hardened missile sites.



This cable provides power and instrumentation circuits plus tensile strength for lowering and retrieving complicated electronic equipment in ocean depths of several miles. These Simplex cables are of "balanced-torque" construction minimizing residual torque of the armor wires.

The Simplex family of electronic cables offers designs to meet the demands of most applications — plus unusual capabilities in the development and construction of special cables to solve specific problems. For further details write to Department 365, Simplex Wire & Cable Co., Cambridge, Mass.

Simplex

WIRE & CABLE CO.

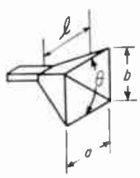
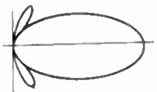
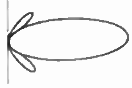
EXECUTIVE OFFICES: Cambridge, Mass.

Plants at Cambridge, Mass., Portsmouth, N.H.,

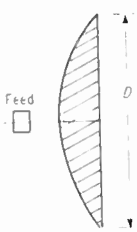
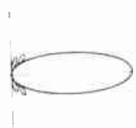
Westbury, L.I., Monrovia, Calif.

CIRCLE 55 ON READER SERVICE CARD

APERTURE ANTENNAS

Type	Radiation Pattern	Polarization	Impedance	Gain over Isotropic	Bandwidth	Application or Function
PYRAMIDAL HORN  $\theta < 40$ DEGREES Dimensions for optimum horn $b \cong \sqrt{3\lambda \ell}$ $a \cong 0.8 \ell b$ te_{10} mode $\ell \cong \lambda(\frac{gain}{15.75})$	Horizontal  Vertical  HALF POWER BEAM WIDTH = Horiz $\cong \frac{80\lambda}{a}$ Vert $\cong \frac{53\lambda}{b}$ Sidelobes - 10 db	Linear Vertical	Vswr: Fairly well matched to waveguide. Vswr 1.03 to 1.5 depending upon length ℓ. Larger ℓ improves match	$7.5\left[\frac{ab}{\lambda^2}\right]$	1.6 to 1	Radar and communications from 300 Mc to 70 Gc. Also used for gain standard.

APERTURE ANTENNAS

Type	Radiation Pattern	Polarization	Impedance	Gain over Isotropic	Bandwidth	Application or Function
DIELECTRIC LENS  $n > 1$ n = index of refraction $= \sqrt{\epsilon}$ ϵ = relative dielectric constant of lens material	 HALF POWER BEAM WIDTH $= 70 \frac{\lambda}{D}$ Sidelobes - 20 db	Determined by feed	Vswr: Typically less than 1.5/1	$4.5(\frac{D}{\lambda})^2$	Determined by feed	Similar to paraboloidal reflector type

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(16) Private Notes "Antennas and Propagation", Dr. Chas. Polk, University of Rhode Island.

(17) A. E. Harper, "Rhombic Antenna Design", D. Van Nostrand, 1941.

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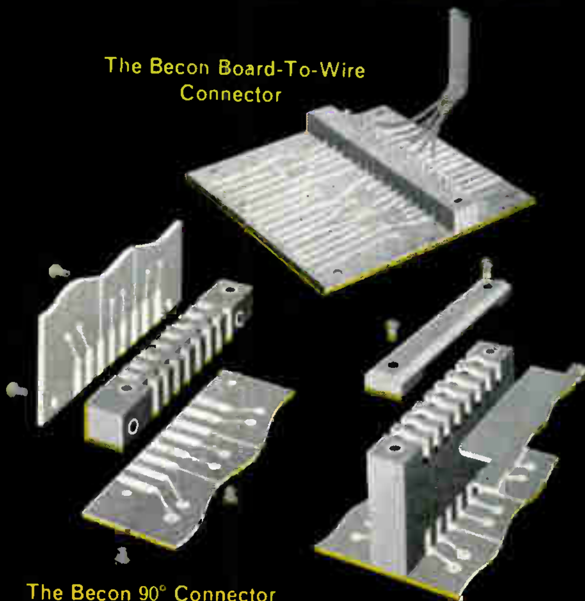

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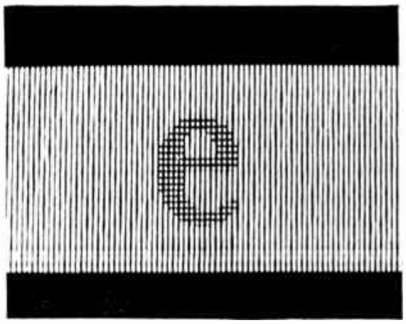
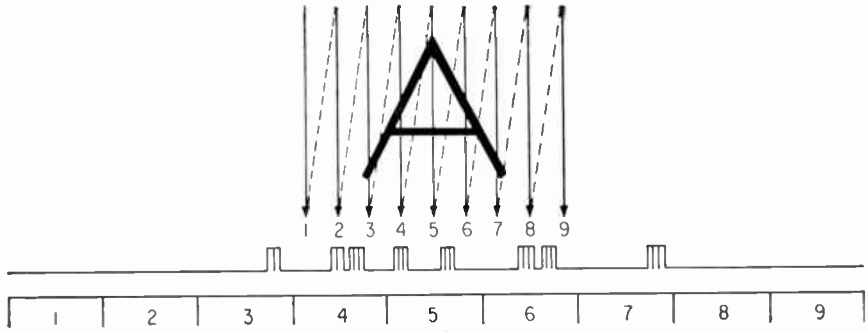

(A)



(B)

SCANNING RASTER *shows sampled video. Each vertical scan line takes 0.5 microsecond, (A); the raster scanning method and an example of the output pulses obtained, (B)—Fig. 1*

Print Reader Recognizes Variety of Fonts

Experimental recognition system adapts itself to different alphabets

By G. L. SHELTON Jr.
Thomas J. Watson Research Center, IBM, Yorktown, N. Y.

AN EXPERIMENTAL system that can automatically read and translate into computer language an almost unlimited variety of printed and typewritten material has been built at IBM Research Center during the past year (ELECTRONICS, p 7, Nov. 30). The system was developed as a research tool to further develop and generalize the recognition methods investigated in recent years.

The print reader is a programmable recognition system, which will recognize in real time, a variety of type styles and alphabets. The system permits different recognition logic to be realized through programming changes and plug-in adjustments.

The basic recognition technique consists in describing the input characters by a relatively small set of measurements. This new representation of the input characters is then compared to the appropriate set of references. The references are first generated by a computer program which has been the basis of a huge number of observations of the characteristics of letters in a given language. The measurement set can be programmed by changing plug-in boards, and the references can be changed through the read-write memory.

Measurements that are used to describe the inputs are essentially independent spatial configurations of black and white points. A measurement set designed to be especially well suited to a particular font group or alphabet (Latin or Cyrillic) can be selected by an iterative computer program that evaluates several thousand measurements for information content, stability and independence. This evaluation and selection procedure uses a representative sample of a variety of type sizes and type styles. However, the measurement set generated for any one font group is general enough to work well for many type styles which were not included in the measurement selection procedure.[1]

The input to the recognition system is supplied by a conventional crt flying-spot scanner, which scans a negative transparency of a document with a vertical raster pattern of suitable dimensions to encompass a single row of print, see Fig. 1. A coarse search scan is used both in line finding and in size normalization. After the search scan has positioned the raster over a row of print, a high-resolution scan is initiated to supply a serial binary representation of the row of print. Currently, this binary video pattern is placed in storage. Certain very wide characters are allowed to overflow from the register.

MEASUREMENTS STORAGE—A small set of measurements, independent of the registration of the printed character, are connected to the storage elements, and the presence or absence of each measurement is stored in an accumulator during each character cycle. The machine system locates lines of print and partitions off individual characters; the system therefore does not require a special document format. Currently, the beginning of a character is defined as the first time interval that the black bit pair AND of the two adjacent vertical scans are satisfied. The end of the character is determined by the first failure of the adjacent scan-line AND. The time between the beginning and the end of a character is defined as the character cycle. At the end of the character cycle, the shift register resets and the measurement set in the accumulator is transferred to a measurement buffer.

In the recognition process, the

VOLTAGE MEASUREMENT / CALIBRATION

MODEL 540A THERMAL TRANSFER STANDARD—Extreme accuracy is provided by the new Fluke Model 540A Thermal Transfer Standard over a frequency range of 5 cps to 500 KC. 540A incorporates a built-in Lindeck potentiometer and galvanometer and requires only that the DC standardizing voltage be provided from an external source. Prime advantage offered by the Model 540A is that the AC and DC voltages on any range are always applied to the same portion of the transfer circuitry on a 1:1 basis. This feature completely eliminates the cause of inherent inaccuracy found in other transfer type instruments in which the AC voltage is first divided down to a lower level before comparison with the DC standard voltage. A search circuit minimizes the possibility of thermocouple overload and permits more rapid measurements of unknown voltages. The frequency range of the 540A can be extended to 50 megacycles by using the Model A55 thermal converters. Current measurements from 2.5 ma to 10A can be made with the 540A by utilizing the Fluke Model A40 current shunts.

MODEL A55 THERMAL CONVERTERS offer frequency specifications to 50MC with complete coverage of the voltage range (from 0.25 to 50 VAC) provided in nine individual converter units.

Great care has been taken in the electrical design and packaging of these units to provide accuracy comparable to NBS standards under less than ideal conditions of temperature, humidity, and vibration enabling them to be used in production areas as well as in the standards or development laboratory.

MODEL 550A TRANSFER STANDARD incorporates: a four dial Lindeck potentiometer, DC reference supply, polarity reversing switch and terminals for external galvanometer. A complete set of accessories is included at no additional cost for convenient interconnection of Models 550A and A55 in any suitable measurement configuration. Price: $395.00.

CALIBRATION: All accuracy specifications are guaranteed by John Fluke Mfg. Co., Inc., to be within the indicated deviation limits from zero error as defined by the National Bureau of Standards without correction figures! John Fluke Company or NBS test reports on Models 540A or A55 are available at additional cost.

All prices F. O. B. factory, Mountlake Terrace, Washington. Prices and data subject to change without notice.

PARTIAL SPECIFICATIONS—MODEL 540A

VOLTAGE RANGES	TRANSFER ACCURACY 5 cps – 50KC	50KC – 500KC
0.5V	← ±0.02% →	← ±0.05%
1-10V	← ±0.02% →	→
20-50V	← ±0.02% →	±0.2%
100-500V	← ±0.03% →	
1000V	±0.05%	

Voltage Ranges: 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, and 1000 V.

(Note: A voltage from ⅔ to 1½ times the voltage specified by the range selector may be accurately measured. The absolute maximum voltage which may be safely applied is 1000 V DC or 1000 V RMS AC). Price: $795.00.

PARTIAL SPECIFICATIONS—MODEL A55

VOLTAGE RATING	TRANSFER ACCURACY 5 cps – 1MC	1MC – 10MC	10MC – 30MC	30MC – 50MC
0.5V	±0.01%	±0.01%	+0.5%	+1.50%
1-10V	±0.01%	±0.03%	±0.10%	±0.10%
20-50V	±0.01%	±0.05%	±0.10%	

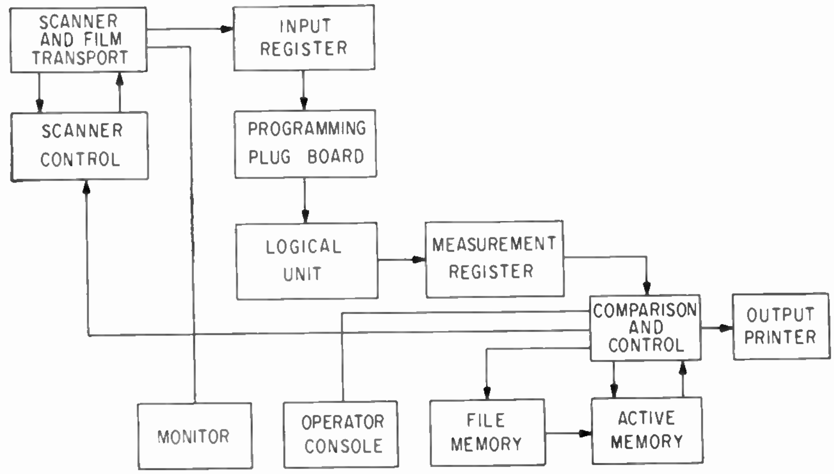
THERMAL CONVERTERS RATED VOLTAGE	PRICE
0.5V	$100.00
1, 2, 3, 5, 10V	$125.00 each
20, 30, 50V	$150.00 each

NOTE: Each converter may be used from ½ to 1 times voltage rating.

FLUKE INSTRUMENTS

John Fluke Manufacturing Co., Inc.
Box 7428, Seattle 33, Washington
PR 6-1171, TWX—Halls Lake, TLX—852

STANDARDS LABORATORY ACCURACIES / PRODUCTION LINE DURABILITY



PROGRAMMABLE RECOGNITION *machine block diagram. Text to be scanned is on 35-mm film; scanning is monitored on large crt screen (cover)* —*Fig. 2*

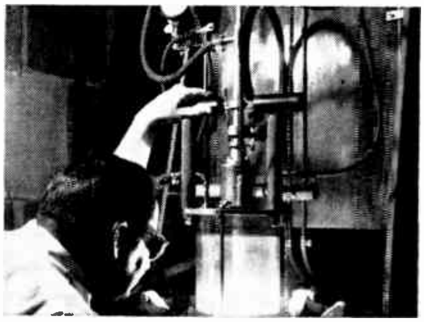
content of the measurement buffer is compared against a set of reference functions, and the input is given the identity of that reference function to which it is most similar. The machine operator can select any one of four similarity measures; however, the measure most frequently used simply accumulates the count of the number of mismatches between the input and the reference function. The reference functions differ from the input functions in that some bits are neither 0 nor 1 but are designated as "don't care." The "don't care" measurements cannot contribute to the degree of mismatch. This type of similarity measure is defined as a minimum distance measure.

MATCH MEASUREMENTS — Input characters are tagged as rejects if the minimum distance exceeds a specified value, or if the distance between the selected identity and the closest competitor is less than some specified amount. The distance measure is metered continuously, and will either terminate a comparison if the distance exceeds a specified amount, or terminate the memory search if the result of a comparison is less than a specified amount. These cutoff features contribute to high machine throughput and are useful in dealing with problems encountered when the system is reading very large alphabets. Block diagram of the system is shown in Fig. 2.

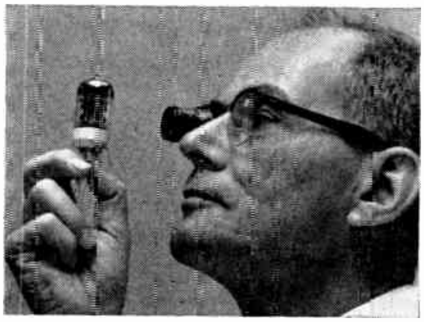
Although a single set of measurements is used for many different type styles, different reference functions may be desired for different systems applications. In order to eliminate the necessity for completely anticipating all fonts that the machine might encounter, an adaptive mode of operation will be incorporated in the ultimate system. In this procedure, each different character of an unknown font is given an identity and then scanned several times, minor distortions of the pattern normally being encountered for each different scan. The set of measurement descriptions generated for a given character are then processed to determine which measurements are stable for that character, and a reference function is established by coding the unstable measurements as "don't care." With this adaptive mode of operation, the system can rapidly get up to normal speed after scanning only a few lines of print in an unknown font. The quality range of the reader is illustrated in Fig. 3.

Any simple recognition system will continually fail to recognize occasional characters which are for some reason dissimilar to the ideal. Several methods of reliably identifying a large part of such rejections are being studied. One such procedure involves a second decision process which is limited to special reference functions that are generated by processing the reference functions of the comparison set defined by the top candidates. Another

What was Bell Telephone Laboratories doing on Monday, October 1, 1962?



Murray Hill Laboratory, N. J. The search continued for new materials exhibiting superconductivity. Some of these materials have been used to produce very strong magnetic fields with the expenditure of very little electrical energy.



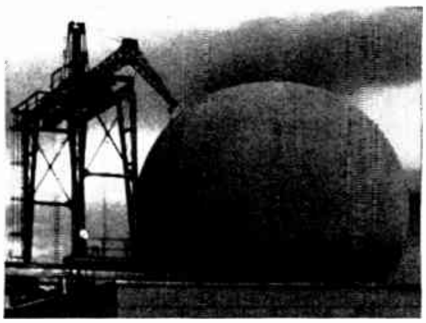
Allentown Laboratory, Pa. We were working with engineers of Western Electric, manufacturing unit of the Bell System, on the manufacture of long-life electron tubes for a new deep sea cable system.

Merrimack Valley Laboratory, Mass. We were increasing the capabilities of a new microwave system designed for low-cost telephone and television communications over distances up to 200 miles. This system is based on advances in solid state technology.

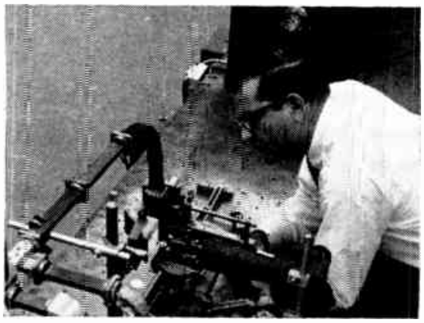
Holmdel Laboratory, N. J. We were developing an electronic switching system using new solid state devices. It will bring telephone customers a whole new range of services.

Indianapolis Laboratory, Ind. We were perfecting improved automatic dialer telephones. One model will permit the customer himself to record 50 frequently called names and numbers and then dial by simply selecting a name and pressing a button.

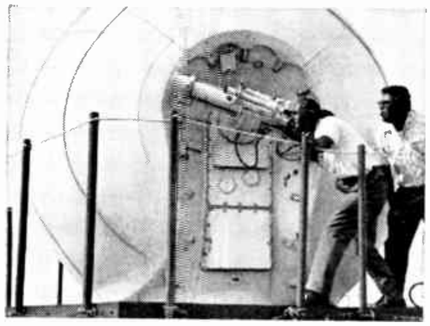
New York Laboratory, N. Y. We were studying the performance of a new data set which converts teletypewriter pulses into tones for transmission over regular voice circuits. Transmitting teletypewriter messages over voice circuits was introduced on August 31, 1962.



Whippany Laboratory, N. J. We were evaluating new radar technology for the NIKE-ZEUS anti-missile missile system under development for the Army. Significant improvements are further tested at four other ZEUS test sites ranging halfway around the world.



Crawford Hill Laboratory, N. J. We were experimenting with the microwave modulation of light from a helium-neon gaseous optical maser. Modulated light may someday be used to carry large volumes of information.

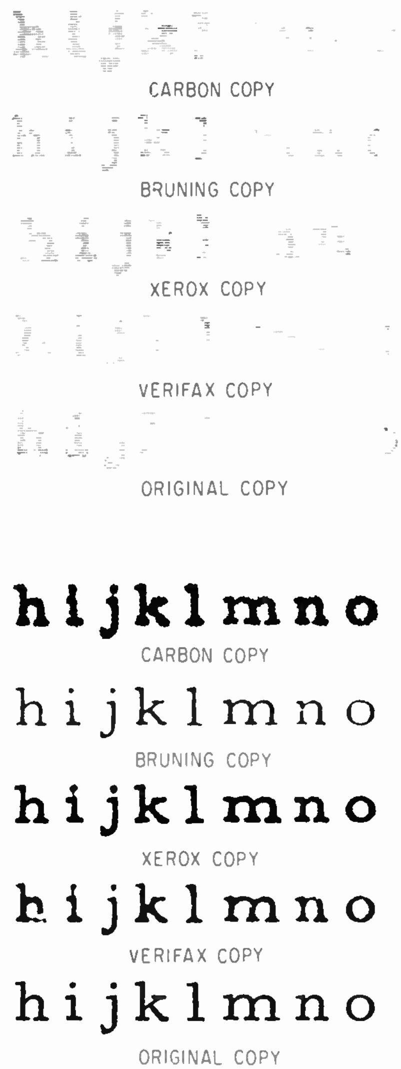


Cape Canaveral, Fla. We were preparing for the 102nd successful use of Bell Laboratories-developed Radio Command Guidance System. On July 10, it was used in the NASA launching of the Bell System's Telstar. This guidance system was originally developed for the Air Force and is operational on the Titan I ICBM.

These were some of the highlights of one day. Engineers and scientists at Bell Laboratories work in every field that can benefit communications and further improve Bell System services. Their inquiries range from atomic physics to new telephone sets, from the tiny transistor to transcontinental radio systems, from the ocean floor to outer space.

BELL TELEPHONE LABORATORIES

World center of communications research and development



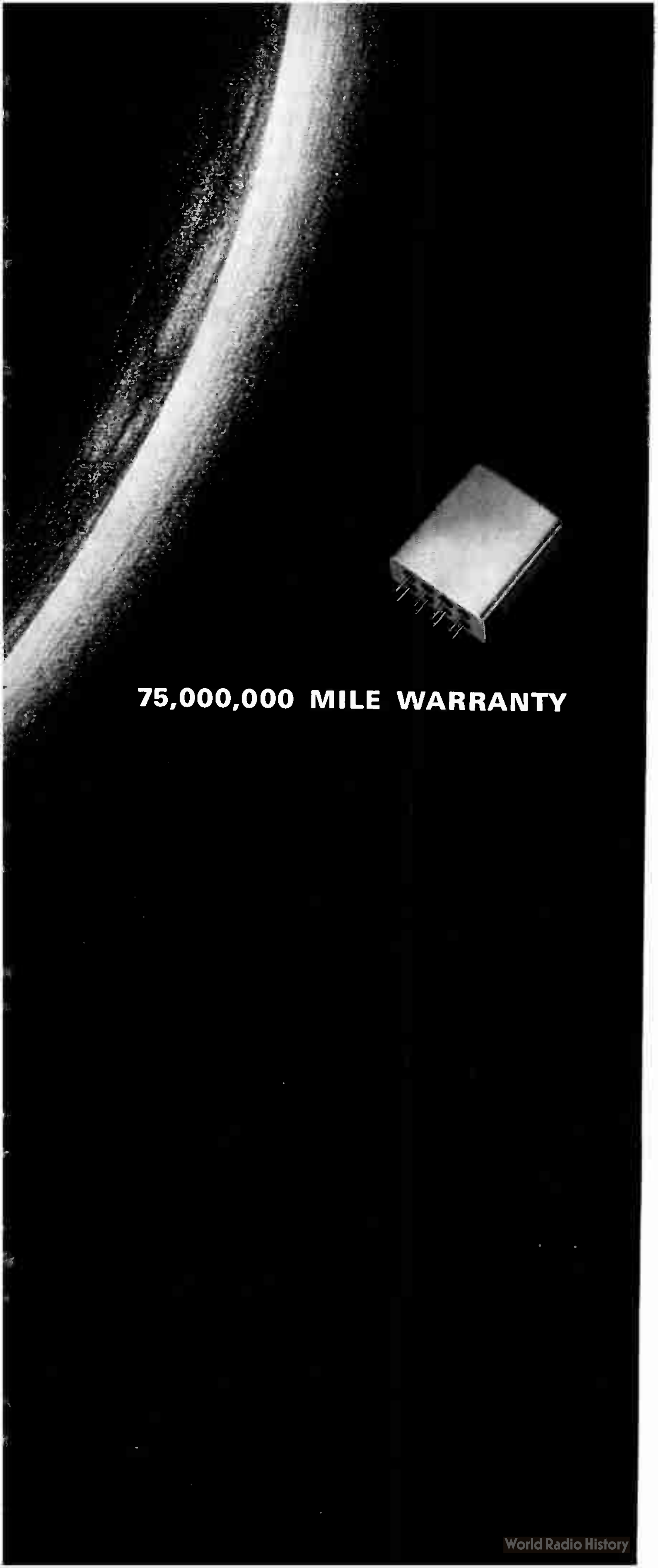
QUALITY RANGE *of letters that can be scanned. No normalization of size is needed; only the most important parameters of each character are stored for comparison —Fig. 3*

procedure involves the generation of a variation of the input by suitably rescanning and comparing this variation with the reference function of the top candidates. These as well as other methods can be realized by programming changes in the processor unit of the reader.

The experimental print reader is probably best described as a special-purpose computer designed to efficiently realize and evaluate many different recognition methods, decision methods and error correction methods.

REFERENCE

(1) L. A. Kamentsky and C. N. Liu, Computer Automated Design of Multifont Print Recognition Logic, to be published in *IBM Journal of R & D*, Jan 1963.



This relay is going on a 75,000,000 mile trip. It's the BR-7 — one of many Babcock relays selected for the maiden flight of America's first active military communications satellite.

As part of the spaceborne payload, each of these subminiature relays has a vital responsibility. Some will be on 24-hour call for switching communications channels. Others will help reposition the satellite if it creeps off station. Still others will take part in carrying out attitude change commands for orienting solar paddles.

All of them will have to perform, without failure... for 15 months.

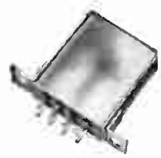
Reliability of this order requires more than just sound engineering and careful fabrication. Absolute assurance is needed that performance will match expectations. In short, a "75,000,000 mile warranty".

Babcock's "warranty" is the Failure Rate Report — a documented prediction of performance based on statistical test and evaluation techniques. The "probability of success" for the space-bound BR-7's is more than 99.9% with a confidence factor of 95%, based on 10,000 miss-free contact operations at rated load — another way of saying these relays will do their job for 15 months or 75,000,000 miles.

We'll be happy to send you our general product catalog listing all Babcock reliability-rated relays available from stock, plus information on Babcock's Reliability Program, the first and most extensive company-sponsored program of its type in the relay industry.

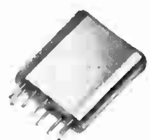
BR-5

MICRO/MICROMINIATURE DRY CIRCUIT TO 1 AMP SERIES
Contact Style Rating: SPDT/1 amp res. @ 32VDC, .050Ω max.
Size: 0.2 x 0.4 x 0.6



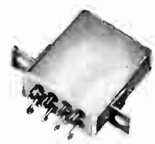
BR-7

SUBMINIATURE DRY CIRCUIT TO POWER SWITCHING SERIES
Contact Style Rating: SPDT, DPDT 2, 5 & 10 amp res. @ 28VDC or 110VAC, 400 cps
Size: .515 x 1.075 x 1.300



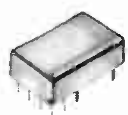
BR-8

MICROMINIATURE CRYSTAL CAN SERIES
Contact Style Rating: SPDT, DPDT/2 amp res. @ 32VDC or 115VAC, 400 cps; 1 amp ind. @ 32VDC
Size: .360 x .790 x .870



BR-9

SUBMINIATURE MAGNETIC LATCHING SERIES
Contact Style Rating: DPDT/5 & 10 amp res. @ 28VDC or 110VAC, 400 cps
Size: .515 x 1.075 x 1.300



BR-12

MICROMINIATURE ULTRASENSITIVE SERIES
Contact Style Rating: SPDT, DPDT 2 & 3 amp res. @ 32VDC or 115VAC, 400 cps; 1 amp ind. @ 32VDC
Size: .400 x .795 x .890, std.; .800 x 1.250 x .415, printed circuit.

BR-14

SUBMINIATURE FOUR POLE, DOUBLE THROW SERIES
Contact Style, Rating: 4 PDT (4 form C), 5, 7.5 & 10 amp res. or 2, 2.5 & 3.5 amp ind. @ 28VDC or 115VAC, 400 cps
Size: 1.000 x 1.075 x 1.300

BABCOCK RELAYS

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CIRCLE 63 ON READER SERVICE CARD

How To Choose Air-Tight Sealing Materials

Data simplifies major problems encountered in sealing most components

By WARREN S. EBERLY

Metallurgist,
The Carpenter Steel Company
Reading, Pennsylvania

METAL alloys, listed in table below, serve about 90 percent of all glass-to-metal or ceramic-to-metal sealing applications for electronic and electrical devices.

In special cases, the possibility exists of adjusting chemical analyses of the alloys to provide characteristics slightly different from those listed and having better sealing properties.

Problem is to seal glasses and ceramics with metals that have closely matched rates of thermal expansion and contraction. Unfortunately, exact matching is a rare

BASIC PROPERTIES OF METAL ALLOYS USED FOR SEALING GLASS AND CERAMICS

	42% Ni-Fe[a]	42% Ni-Fe[b] Gas Free	42% Ni[c] 6% Cr-Fe	45% Ni[d] 6% Cr-Fe	46% Ni-Fe[e] Gas Free	51% Ni-Fe[f]	28% Cr-Fe[g]	29% Ni-17% Co-Fe[h] (ASTM F-15)
Thermal Expansion Coefficients in in. in. per deg C × 10^{-6}								
Temperature Range								
25 C to 100 C	4.63	4.34	6.55	7.60	7.10	9.95	9.16	5.86
25 " 200 "	4.76	4.41	7.08	8.17	7.37	10.1	10.05	5.2
25 " 300 "	4.88	4.61	8.26	8.75	7.5	10.1	10.53	5.13
25 " 350 "	5.02	5.35	9.04	9	7.44	10.02	10.7	4.89
25 " 400 "	5.65	6.41	10	10	4.43	10	10.78	5.06
25 " 450 "	6.9	7.53	10.6	10.5	7.91	10.04	10.9	5.25
25 " 500 "	7.78	8.56	11.5	11.22	8.68	10.21	11.12	6.15
25 " 600 "	9.9	10.01	12.58	12.23	10.02	11	11.26	7.8
25 " 700 "	11	11.15	13.4	13.02	10.99	11.8	11.62	9.12
25 " 800 "	11.99	12.1	14.15	13.7	11.82	12.55	11.65	10.31
25 " 900 "	12.78		14.7			13.1	12.78	11.26
Physical Constants								
Specific gravity	8.12	8.12	8.12	8.14	8.17	8.3	7.6	8.36
Density, lbs per cu in.	0.293	0.293	0.294	0.295	0.295	0.3	0.27	0.302
Thermal conduct								
cal/cm³/sec/C	0.025	0.025	0.029	0.029		0.032	0.054	0.04
btu/hr/sq ft/F/in.	74.5	74.5	87	87		97	158	
Electrical resistivity								
microhms/cm²	72	72	95	95	46	43	63	
ohms/cir mil ft	430	430	570	570	275	258	380	29[illegible]
Inflection pt	650 F		650 F	680 F		1,050 F		
Curie temp	715 F	380 C			460 C			815 F
Melt pt	2,600 F	1,425C	2,600 F	2,600 F	1,425 C	2,600 F	2,600 F	2,610 F
Specific heat	0.12	0.12	0.12	0.12	0.12	0.12	0.14	
Mechanical Properties, as annealed:								
Tensile strength, psi	83,000 120,000[i]	80,000	80,000	80,000	82,000	80,000	85,000	75,000
Yield strength, psi	34,000 70,000[i]	34,000	40,000	40,000	34,000	40,000	55,000	50,000
Elongation in 2 in., %	30 3[i]	30	30	30	27	35	25	30
Hardness	B-76 B-100[i]	B-76	B-80	B-80	B-76	B-83	B-85	B-68
Elastic modulus psi × 10^{-6}	21 21[i]	21			23			20
Composition Analysis, in percent								
Carbon	0.1	0.05	0.1	0.1	0.1	0.1	0.15	0.02
Manganese	0.5	0.5	0.5	0.3	0.5	0.5	0.6	0.3
Silicon	0.25	0.25	0.25	0.3	0.25	0.25	0.4	0.2
Nickel	42	42	42.5	45	46	51	0.5	29
Iron	bal	bal	bal	bal	bal	bal	bal	bal
Chromium			5.75	6.00			28	
Titanium		0.4						
Cobalt								17

a—used for special tubes, transformers, capacitor bushings. Used with hard glasses when employing ring-type seal with feathered edge about 0.002-in. thick. Variation used as core of Dumet wire leads in electronic tubes, fluorescent and incandescent lamps. Provides good seal for soft glasses, diameters 0.008 in. to 0.004 in. Another variation used in making ferrules for passing high current into a vacuum using Pyrex glass

b—use is same as that given under (a)

c—best match for 0120 glass. Suitable for soft glasses such as 0010 for pressure-type internal seal. Chrome oxide, formed during heat treatment, tightly adheres to base metal

d—best match is 9010 glass. Can be used with 0120 glass on external-type seal. Suitable for soft glasses, such as 0010 on pressure type internal seal. Chrome oxide formed during heat treatment adheres to base metal

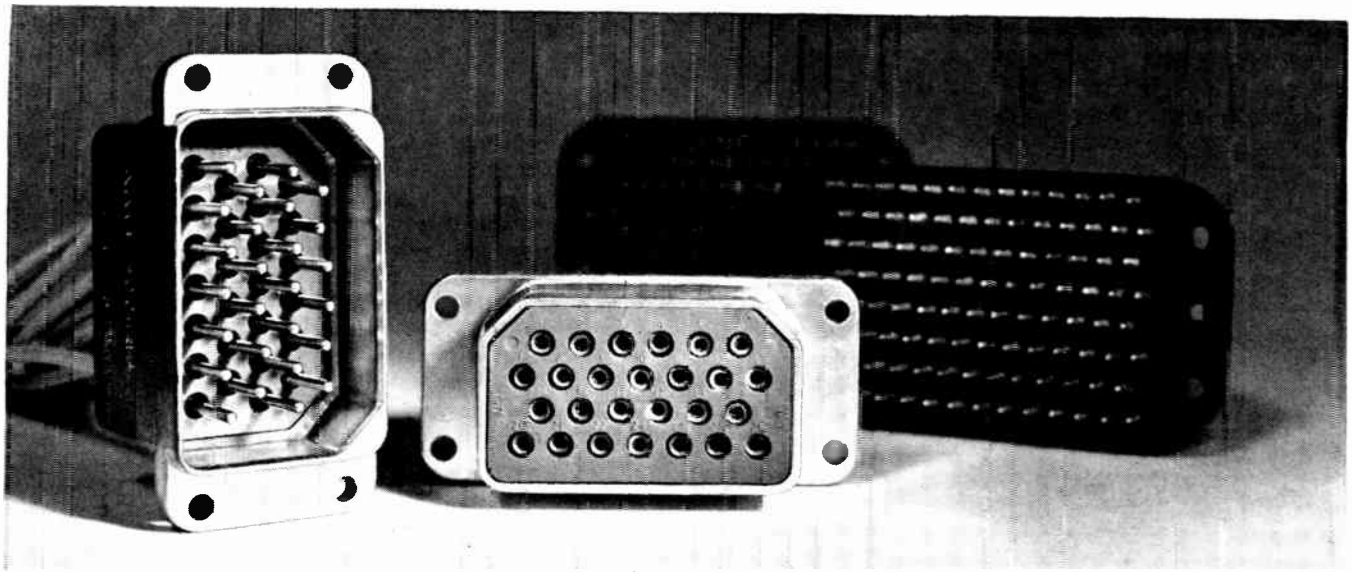
e—suitable for some types of pressure-type seal with soft glasses. Also used in ceramic-to-metal sealing. Matches some enamel coatings. Alloy is gas-free and eliminates need for hydrogen annealing or degassifying

f—expansion properties match several soft glasses for making internal seals. Alloy easy to acid-clean for plating after seal is made

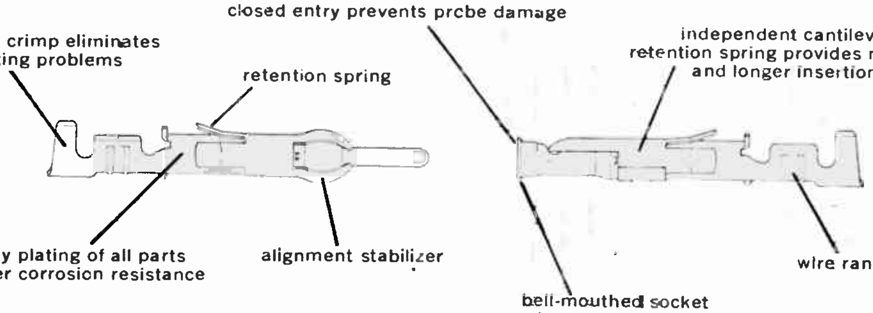
g—expansion properties match many soft glasses for all types of seals. Chrome oxide formed during heat treatment, tightly adheres to the base metal

h—most commonly used metal for sealing with hard or Pyrex-type glasses. Also most commonly used in ceramic-to-metal sealing. Expansion properties more closely match harder glasses and ceramics (up to the inflection point or Curie point of the alloy

i—values for cold-drawn bars and cold-rolled strips



What's unique about these connectors?



3 contact sizes—20, 18 and 16

This stamped and formed contact!

This is the AMPin-cert* TYPE III pin and socket contact—an exclusive development of AMP Incorporated. With it, you can now get reliable connector performance at a much lower initial cost . . . at the lowest applied costs in the industry. Consider these facts:

performance characteristics conform to all dimensional and mechanical requirements of MIL-C-8384A.

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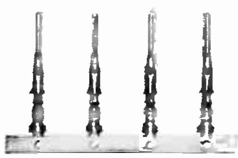
strip-mounted, reel-fed termination with our automatic crimping machine provides rates of 1,600 uniformly crimped contacts per hour.

contacts are available for a wide range of housing block types and configurations—including AMPin-cert "M" (MIL-C-8384), "D" and "D-D" and "W" Series Connectors.

Standard AMP Contact Plating: .00003" non-porous gold over .00003" nickel, special platings available on request.

Put an end to solder-pot uncertainties, hit-or-miss connections, production slow-ups due to time-consuming inspection steps. Get consistently reliable connectors and at the lowest applied costs in the industry. Specify AMPin-cert TYPE III contacts. There is no equivalent! Write today for more information.



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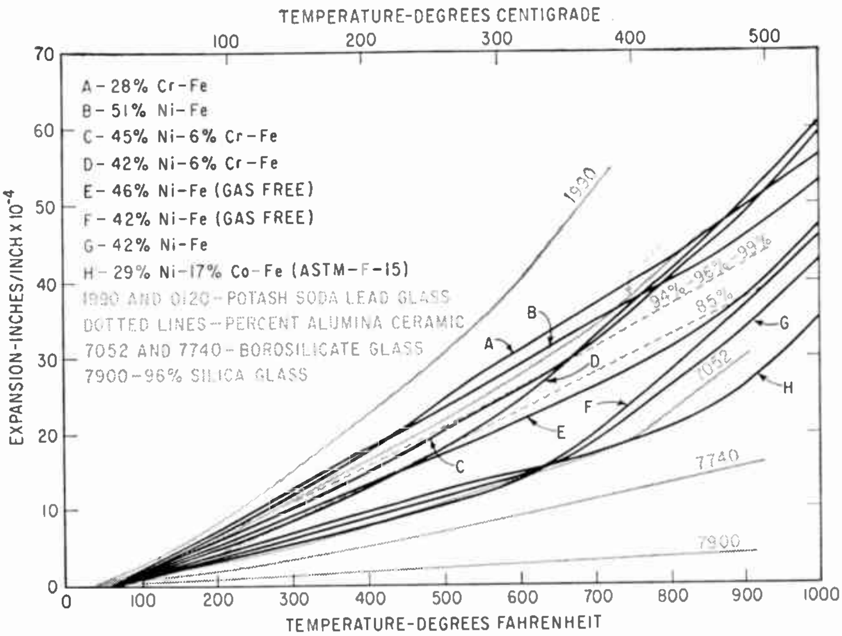
CIRCLE 65 ON READER SERVICE CARD



THERMAL *expansion curves of metal alloys, glasses and ceramics commonly used in making glass-to-metal or ceramic-to-metal seals*—*Fig. 1*

possibility. But if expansion coefficients are reasonably close through the anticipated temperature range, this will avoid undue strains developed in the glass and at the seal when cooled from sealing temperature and annealing temperature.

Most glasses and ceramics used commercially today expand less than conventional metals like copper, aluminum and silver over the same temperature range. This difference in expansion poses a cracking problem as the glasses and ceramics are brittle.

The cracking problem can be solved by employing a matching metal alloy.

Approach to problem is to select a metal that most nearly matches the expansion characteristics of the selected glass or ceramic.

Standard sealing procedures for glass-to-metal sealing involve cleaning the metal, degassification of the metal (if necessary), oxidation of the metal, application of the glass, and annealing.

Standard procedures for ceramic-to-metal sealing involve cleaning the metal, and brazing the metal and ceramic.

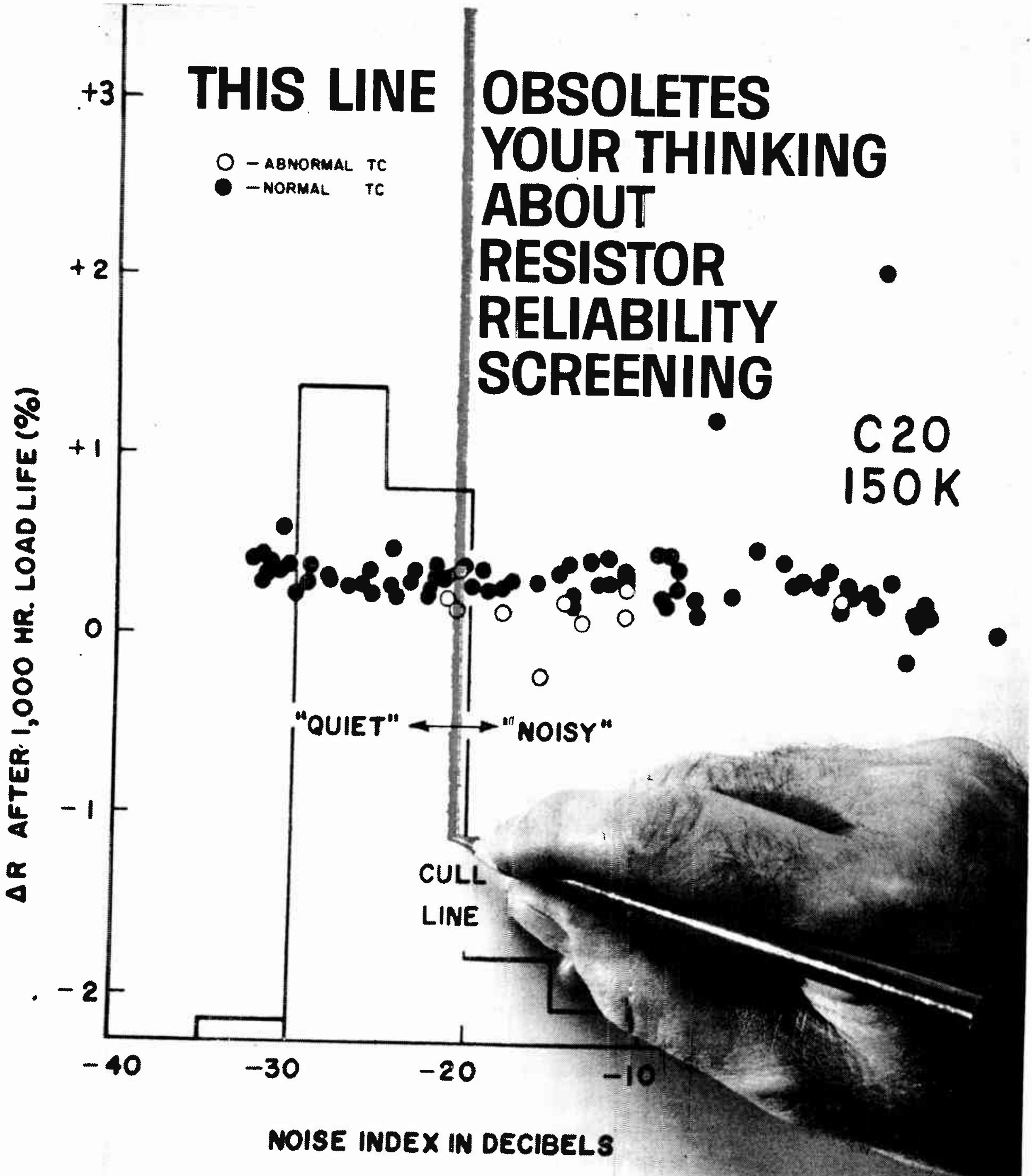
Iron-nickel alloys containing no chromium tend to eject carbon monoxide and carbon dioxide from the metal when heated. This emission can be eliminated by decarburizing the surface of the part with an anneal in a wet hydrogen atmosphere. The carbon content of the alloy is kept as low as possible—less than 0.02 percent. Or the carbon is tied up as low as possible through the formation of a carbide which is stable below the sealing temperature. Manufacturers not equipped to wet hydrogen anneal or to degassify must depend on a gas-free metal alloy.

Several types of seals commonly referred to are as follows:

Internal sealing, where metal rod is enclosed by glass or ceramic; external seal, where the glass or ceramic is enclosed by a metal cylinder; and a tubular seal where the metal cylinder is sealed to a glass or ceramic cylinder. A butt seal has the glass or ceramic cylinder sealed to a flat piece of metal. In a window seal, a flat piece of glass or ceramic is sealed to an opening in a flat piece of metal. Ring type seal, for glass only, is similar to a tubular seal and employs a glass and metal having a difference in expansion. Metal part has a feathered edge inserted into the glass and is able to absorb the difference in expansion.

Figure 1 provides a ready reference of thermal expansion characteristics of the alloys, glasses and ceramics commonly used in sealing x-ray, audio, microwave, electron

THIS LINE OBSOLETES YOUR THINKING ABOUT RESISTOR RELIABILITY SCREENING



It's the reliability CULL* line we can draw on the basis of *current noise level* for any lot of Corning metal-oxide film resistors.

The good guys are on the left. Test them at 2½ times rated power and 25°C. We've been doing it for 23,000,000 part hours without one failure.

If one had failed, you'd have a failure rate of 0.01001%/1000 hours at 90% confidence, 0.00398 at 60%, and 0.00022 at 5%. But none have!

The CULL line falls at different db levels for different styles and sizes of Corning resistors. But we can draw one for any of them that is practical in cost and unsmirched to date for reliability.

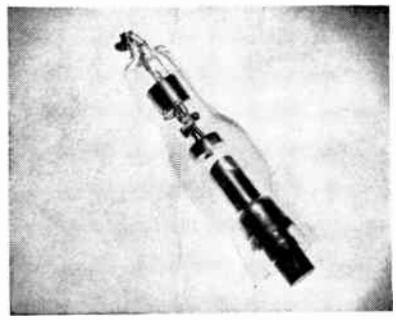
Resistors to the right of the line may be OK, but our findings indicate that all mavericks in TC and load life will be on the noisy side of the line.

Read all about this new, *non-destructive* reliability screening tool, and how we'll put it to work for you at modest cost. Write for our new folder, "Current Noise Level: New Reliability Screening Technique for Corning Metal-Oxide Resistors," to Corning Glass Works, 390; Electronics Drive, Raleigh, N. C.

*Corning Uniformity Limit Level

CORNING
Electronic Components

CIRCLE 67 ON READER SERVICE CARD



HIGH VOLTAGE *x-ray tube is typical of the many types of tubes requiring a vacuum-tight glass-to-metal seal*

and similar tubes; transistors and diodes; ceramic-coated resistors; glass and ceramic insulators; hermetically-sealed transformers, and other electronic products.

Hall Effect Measurements May Settle Controversies

INVESTIGATIONS of Hall Effect in ferromagnetic materials has been carried on for many years by Emerson M. Pugh and his associates at Carnegie Institute of Technology. This work still goes on, now under a grant from the Army Office of Ordnance Research.

Pugh told ELECTRONICS that the Hall effect in all ferromagnetic materials must be divided into two parts. First, the ordinary effect which is proportional to the magnetic field. And second, the extraordinary effect which is proportional to the magnetization.

The two coefficients have been measured for a larger number of alloys with total electron concentrations between 26.8 and 28.6 per atom, and the temperature dependence of these coefficients have been established.

Emerson Pugh's group has been able to verify the distribution of these electrons within the ferromagnetic elements and their alloys.

Work that is now being carried on at Carnegie Tech will provide these measurements on elements and alloys having electron concentrations smaller than 26.8 with the hope that it will be possible to settle the controversies concerning the distribution of electrons within those elements and alloys.

REQUIRED

Excellence In Receiver Selectivity With Minimum Component Population

SOLUTION:

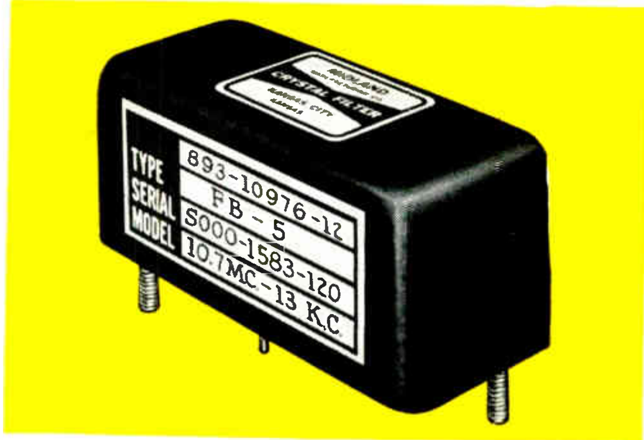
1 Midland filters with guaranteed ultimate discrimination of more than 100 db with 60db/3db BWR < 1.8 **2** A low cost stock filter with virtually no insertion loss

FACT

Midland crystal filters are the result of exact design methods and real production knowhow.

Facts are facts and filters are Midland's business. Their filter and crystal engineering skills and facilities assure the user of top reliability and performance. * This is Midland's Type FB-5 crystal filter produced by the tens of thousands — the only sure proof of production ability. It is an 8 pole — 6 zero precision network that incorporates no added dissipative elements in inband ripple control. Result: Superior selectivity with essentially no midband insertion loss. A quality production component with immediate delivery. Engineering Bulletin NBS-103 is available detailing complete technical information. Prices on request.

** Write for Midland's capabilities and facilities brochure, "Midland — in microspect".*



SPECIFICATIONS

Center Freq: 10.7 MC ± 375 CPS
Bandwidth @ 6 db.: 13.0 KC Min. — 13.8 KC Max.
60 db/6 db BWR: 1.8 Max.
100 db/6 db BWR: 2.2 Max.
Ultimate Attenuation: 105 db. Min., 8 MC to 14 MC
Midband Insertion Loss: 0.5 db. Nominal, 1 db. Max.
Inband Ripple: 0.5 db. Nominal, 0.8 db. Max.
Operating Temp. Range: —55° C to +90° C
Zin/Zout Req: 1100 OHMS ± 5% in parallel with adjustable capacitor 0-5 picofarads.
Dimensions: 2 3/8" L x 1" W x 1 1/32" H

Midland MANUFACTURING COMPANY
Division Pacific Industries, Inc.
3155 Fiberglas Road
Kansas City 15, Kansas

CIRCLE 200 ON READER SERVICE CARD

Harbor Control by OKI Electric

As shipping grows and harbor facilities become more complex, the job of control increases. To meet this problem, Japan has elected to use a millimeter wave radar system. This new system, radically different from those previously used, will be installed in the near future in ports throughout Japan. It combines ultra-high definition millimeter wave radar with CM-wave radar to make a highly efficient all-weather dynamic harbor supervision network. Reception is excellent and even buoys and mooring lines are reproduced with minute accuracy. Range and bearing resolution are accurate to within two to three meters. It is also highly effective under poor weather conditions and at maximum ranges.

The core of this network, the millimeter wave generator, is made by OKI Electric, a leading maker of millimeter wave radar and telecommunications equipment. Presently under development for this system is an improved, higher capacity tube with a serviceable life of 10,000 hours.

For information about these and other electronic system, write to OKI Electric Industry Co., Ltd.

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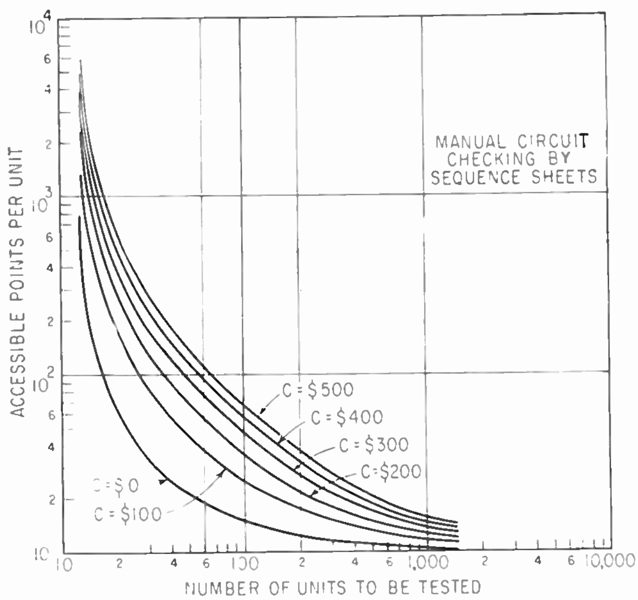
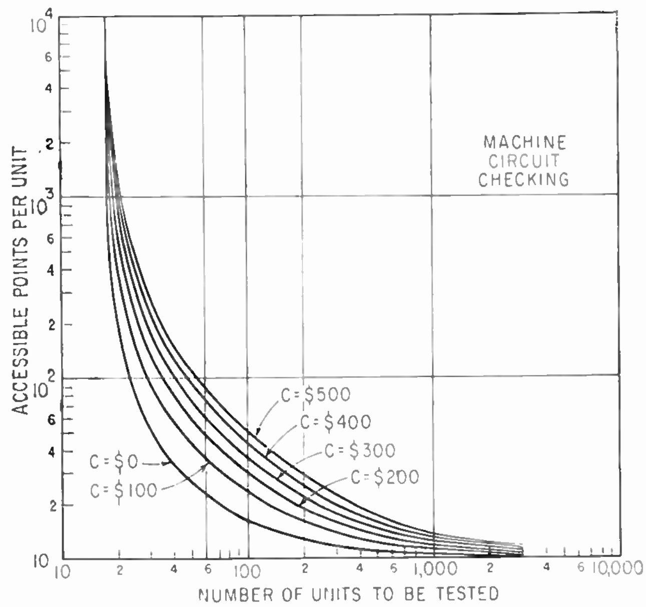
Checking Circuits at Minimum Cost





BREAK-EVEN *charts for sequence-sheet checking (left) and machine checking (right) indicate which method should be used for a given quantity and type of electronic assembly*

Rigid basis provided for optimum selection of checking technique

BY B. D. HRYBYK
Electronics Division
Westinghouse Electric Corporation
Baltimore, Md.

CIRCUIT CHECKING is usually accomplished in one of three ways: circuit check by drawings, by sequence sheet, or using automatic equipment. Since it is not always obvious which of the three methods is the best for a given circuit, a set of curves have been prepared to provide a quick selection method.

SELECTION — The most difficult choice of methods is between sequence-sheet and machine checking. For a given piece of equipment, the most economical circuit check method is not always obvious, particularly when the quantity to be manufactured is small.

Therefore, a study was made to establish a rigid basis for selecting the method of circuit check on an economic basis. Objectives included a simple selecting method and inclusion of the extra program costs required by sequence sheet checking and automatic checking.

Important in selecting the most economical checking method is the number of circuit access points. An access point is an end of an electrical component or wire accessible either for manual circuit checking or able to be connected to an automatic checker. The number of available access points determines the number of tests that can be made, the number of calculations an automatic program will require, and the kind and quantity of interconnection cables required. Costs and savings are directly related to number of access points. Typically, access points for manual checking will exceed those for automatic checking by 50 percent or more.

The following equation was derived to describe the problem

$$U = \frac{(P\,P_c + B_{pr}) + C/H_c}{(P\,P_s - B_h)}$$

where U = minimum number of units required to balance machine or sequence sheet programming costs; $P = P_m$ or P_a = number of access points available for manual or automatic checking; P_c = cost in hours to program and verify an access point; B_{pr} = base number of hours to program a chassis; C = additional costs in dollars peculiar to the unit to be tested; H_c = rate per hour in dollars of operator time; P_s = savings per access point in hours over circuit check by drawings; and B_h = base number of hours required to handle each unit during production.

CHARTS—Two break-even charts can then show whether machine or sequence sheets should be used.

Curves representing steps of fixed cost are plotted against the number of units to be tested and the number of access points per unit.

As an example in using the

CIRCUIT-CHECKING TECHNIQUES

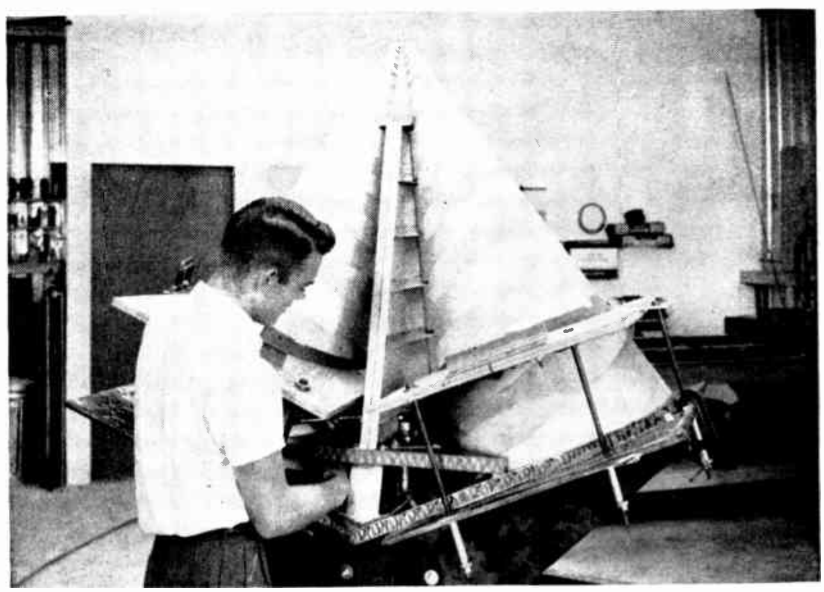
Circuit check with schematics or wiring diagrams involves a method such as marking the drawing for each correct connection. This is time consuming. Sequence-sheet checking follows a written sequence of tests done with a minimum of steps without schematics or wiring diagrams. This is less time consuming. In automatic circuit checking, the tested unit is reduced to its Thevenin equivalent. Then program sheets are made for punching a machine tape and for trouble shooting. Also, a set of cables or fixtures must be made to connect the unit to the testing machine

charts, assume that 50 units of a given device are to be checked. If automatic checking is used, assume 75 access points are available and preparation costs are estimated at $450. The chart for automatic checkout gives a break-even cost of about $300, which is less than the $450 estimated, and thus automatic checkout would not be economical.

For the same unit, assume the number of access points for sequence sheet and manual checking is 125 and that preparation costs are $300. The break-even point for this case on the sequence sheet chart is about $425. Thus sequence sheet checking would be the most economical.

The curves as drawn have proved to have an accuracy of about 20 percent, which is adequate for most purposes. The curves for machine checking also include a multiplier to account for the high cost of programming.

Glass Fiber Makes Antennas Lighter



DUAL-CONICAL *broadband antenna feed is fabricated of glass fiber cones mounted on honeycomb base structure. Radiating elements are painted-on metallic spirals*

GLASS FIBER is used as the main structural element in a broadband antenna feed developed by Dynatronics, Inc., Orlando, Fla. System pointing accuracy of better than one-tenth degree has been obtained in operating tests.

Three primary operating conditions influenced the design. First, the feed rotates to 1,200 rpm. Second, the radiating element support structure must have no appreciable effect on the r-f characteristics of the feed, thus practically no metal could be used in constructing the feed assembly. Third, weight must be kept low since the feed has to be suspended at the focal point of large reflectors.

The dual-channel feed is composed of two oppositely wound conical spiral radiators diametrically opposed about the antenna focal axis. Radiating elements are metallic spirals painted on glass fiber cones.

The cones are built in layers, similarly to glass fiber boats. First, a master mold is precision machined on a metal lathe. This mold is then used to lay-up the laminated fiberglass structure, using glass cloth and epoxy resin binder. After the cones are formed, they are joined together on a supporting base made of a honeycomb and sheet-plastic sandwich. Side plates, also of sheet plastic, provide additional strength to maintain rigidity under rotational stresses.

Baluns, which carry the r-f energy from the cone tips to the base, are made of copper coaxial lines encased in a supporting structure of styrofoam. These are fabricated by positioning the coax tube, under tension, in a machined metal mold filled with the proper amount of unexpanded styrofoam beads. The mold is closed, then immersed in hot water where the absorbed heat expands the styrofoam to form the balun casing.

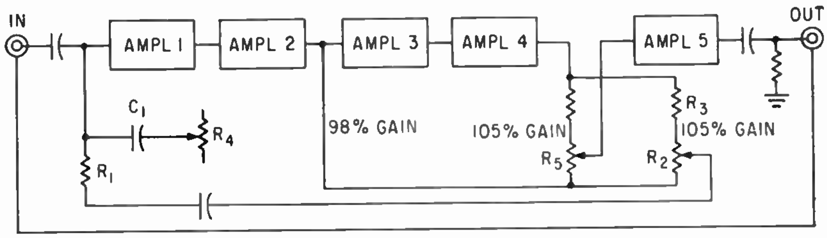
After the complete feed is assembled, it is mounted on a test jig where it is dynamically balanced at operational speeds. Imbalance could result in distortions affecting the r-f characteristics and possible destruction of the assembly.

The feed shown in the photo is one of two built for 30-foot autotracking antennas on Atlantic Missile Range tracking ships. Somewhat similar—and much larger—feeds are being built for Pacific Missile Range's 60-foot antennas.

These broadband feeds provide a 10:1 bandwidth in any range in the 100-4,000 Mc region. They can be used from the normal telemetry band up to the higher frequencies used with space probes.

Electrometer Uses Admittance Neutralizer

Device has infinite input resistance and zero input capacitance



ANNOUNCED by Micronia Amplifier Corp., Box 269, Port Washington, N. Y., the MC-201A a-c electrometer measures a-c voltage between 20 μv and 300 mv in 8 ranges with input impedance adjustable between +100 megohms through infinity to −100 megohms and capacitance between +10 pf through zero to −10 pf. Capacitance of the input cable can be neutralized between 100 pf through zero to −30 pf. Frequency range is 10 cps to 100 Kc. As long as the instrument is connected to a finite external impedance, it can be operated in a completely stable condition while its own internal input impedance is infinite or even negative.

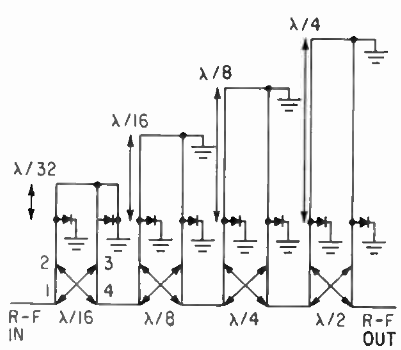
Operation of the admittance neutralizer portion is shown in the sketch. Amplifier 1 is a field-effect transistor, amplifiers 2, 4 and 5 are impedance conversion amplifiers and amplifier 3 is a low-gain, in-phase amplifier. Resistor R_1, connected to the field-effect transistor input, carries the resistance-compensating current. Potentiometer R_2 is the negative-resistance control that makes it possible to vary the compensating current between reasonable limits of under-compensation and over-compensation. These limits are established by gain stability of the field-effect transistor and amplifier 2 impedance converter which reproduces the input signal between 97 and 98-percent amplitude with less than 0.1-percent change in 8 hours and the similar high-gain stability of amplifiers 3 and 4 whose output is mixed with the 98-percent signal through R_3 and R_2. Total signal swing is 98-to 105-percent and enables user to set gain to unity.

Capacitor C_1 carries the compensating current to neutralize device input capacitance and trimmer R_4 raises or lowers the compensating current and can produce negative capacitance. Amplifier 5 is the output impedance converter presenting less than 40 ohms to the external load. Potentiometer R_5 compensates for load changes.

CIRCLE 301, READER SERVICE CARD

Digital Phase Shifting at UHF Frequencies

NEW from Hyletronics Corp., 185 Cambridge St., Burlington, Massachusetts, is a digital phase shifter for uhf frequencies providing real-time delays in sixteen equal steps between zero and one uhf period. The unit was designed for operation at 600 Mc and has a phase error less than ±4 degrees with overall insertion loss between 1 and 2 db. It is 8-in. in diameter and has a power handling capacity of 2 w although it could be designed to handle in excess of 1 Kw. The sketch shows 4-bit phase shifter operation. The r-f input at arm 1 divides equally in the 3 db directional coupler (arms 2 and 3) with a 90-degree phase difference and become incident on diode switches. When the diodes conduct, incident signals are reflected and add in phase at the output (arm 4) and pass on to the second step phase shifter. When the diode switches are back biased, they are in the transmitting state and r-f pathlengths are increased to the short circuit behind the diode thus accomplishing a real time delay equal to twice the added line length. Antenna steering is one application of the device. (302)

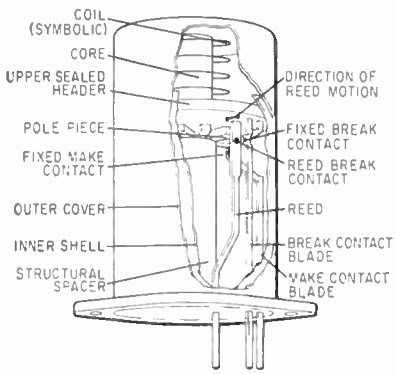


Reed Relay Features Simple, Positive Switching

RELEASED by Thermosen, Inc., 375 Fairfield Ave., Stamford, Connecticut, the Multireed relay combines the advantages of glass-sealed switches with those of heavier current-carrying capacity, multiple contacts and compact size. Contacts are rated at 1 ampere maximum (resistive), 30 v-a maximum d-c, 75 v-a maximum a-c, 250 v maximum. Contact resistance is 50 milliohms maximum. Coil voltages

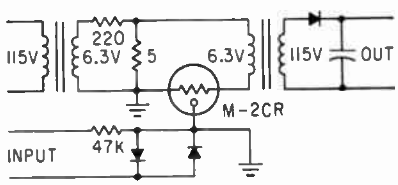
CIRCLE 75 ON READER SERVICE CARD→

are 6, 12, 24, 48 v d-c, 0.85 w, 2 w continuous and 4 w short time. Operating time is 15 ms maximum, at 2 w, 8 ms including bounce. Release time is 4 ms maximum including bounce. Up to eight break-before-make contact groups are enclosed in



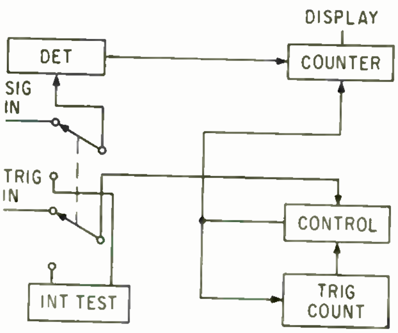
a single, inert-gas filled, hermetically-sealed chamber. The relay coil is outside. Each contact group has its own reed-armature moving between two fixed contacts. Cantilever spring armatures operate at very low stress levels and there are no hinges, pivots or friction points to create wear or malfunctions. Contacts are outside the working air gap permitting greater contact mass. Contact materials are gold-plated silver alloys.

CIRCLE 303, READER SERVICE CARD



Adjustable Resistor Has Built-in Memory

MANUFACTURED by Memistor Corp., 270 Polaris Ave., Mountain View, California, the Memistor M-2CR is an electronically adjusted resistor with a rate-of-change of resistance controlled by application of d-c current in a third electrode. Over active range, conductance rate-of-change is proportional to control electrode current and is essentially independent of resistance value. Resistance range is from 30 to 2 ohms (0.033 to 0.5 mho). It consists of a sealed plating cell containing an electrolytic bath, a resistive substrate upon which metal is deposited and a metal source electrode. Two leads are attached to the substrate and resistance between these leads can be reversibly controlled by passing plating current into the third lead. The device is like a transistor with a built in integrator since the resistance between two leads (substrate) is controlled by integral of current (total charge flow) rather than by instantaneous current. In an integrator circuit (sketch p.76), conductance of device is nondestructively sensed by low voltage a-c between 60 cps and several Mc. Back-to-back silicon diodes protect against overvoltage. Normal d-c drop between source and substrate is 0.2 v with plating current of 0.2 ma. Plating is 40 mw. The circuit provides d-c output of 0 to 3 v with input of 10 v. It can be used to modulate low-level, high-frequency r-f and it is insensitive to shock and vibration. It can use current pulses as low as 0.5 μsec to give continuous analog readout of pulse counts between zero and several Mc. (304)



Detecting Below Normal Pulses of a Pulse Train

RECENTLY announced by Control Logic, Inc., 11 Mercer Rd., Natick, Massachusetts, the model PD102 missing pulse detector determines and displays the number of pulses in a pulse signal train that fall below a preselected level. Determination is either by relative amplitude or voltage-microsecond area. The unit accepts positive signal inputs from 50 mv to 1 v at widths from 0.2 to 1 μsec. Repetition rate is up to 100 Kc and duty cycles of up to 10 percent may be measured. Trigger input is positive 5 to 10 v, with 2 to 5 μsec width. Each input pulse is compared against the detection level setting on the unit. If the signal pulse is below this level, an output pulse is sent to a counter. A selectable sample of 10 to 10,000 inputs, in decade increments, is counted and displayed on the readout as a direct ratio or percentage of sampling length. The unit can be used for continuous signal sampling or on a one-shot basis. The test signal can be monitored and at the end of the sample period, the accumulated missing pulse count is displayed, the detector is reset and a new sample period is started. One application is in production testing of magnetrons. The modulator pulse is used as the trigger input and the r-f output pulses become the test signal input. It can also be used in magnetic drum, tape and core testing where read and write operations may be tested.

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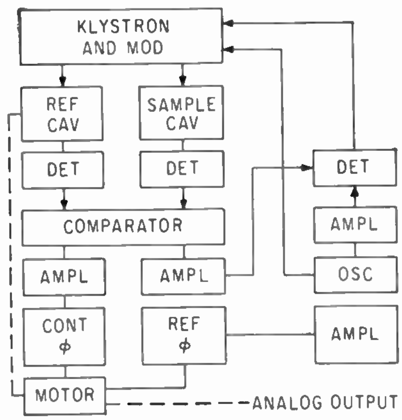
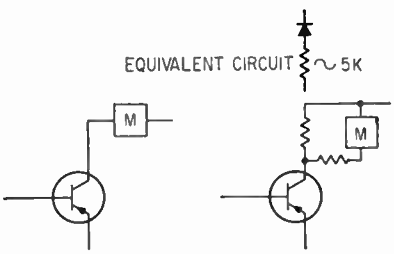


Microwave Refractometer With High Resolution

RECENTLY released by Colorado Research Corp., Broomfield, Colorado, is an all-transistor absolute microwave refractometer operating near 9.3 Gc providing for detailed examination of the refraction index (dielectric constant) of various gaseous media. Theory of operation is based on fact that resonant frequency of a microwave cavity is directly dependent on net dielectric constant of gaseous medium within the cavity. Measurement is by comparing frequency of exposed sampling cavity with a sealed reference containing an inert gas. Readout is by a 13-bit analog-to-digital shaft angle encoder. As shown in the sketch, a stabilized X-band source provides the swept frequency source. The klystron excites two transmission-type cavities, one sealed from atmospheric variations and compensated against temperature variations to an effective thermal expansion coefficient of five parts in 10^8 per degree C. Sampling cavity is compensated to same extent. Outputs from the two cavities are detected and compared in a phase detector. Output from phase detector is source for variable phase winding of a servo motor that drives tuning probe of reference cavity. Frequency of reference cavity is varied till null is obtained between sample and reference. Displacement corresponds to indicate refractive index. Readout is by shaft angle digital encoder. Readings can be incorporated into computer systems concerned with correcting errors due to variations in propagation velocity, and refractivity measurements in radio propagation and meteorology. **(306)**



Audible Alarm Replaces Visual Indicator

DEVELOPED by Steven Norton Engineering Co., POB 139, Boston 19, Massachusetts, the Masid miniature semiconductor audible signal indicating device occupies 0.5 cubic inch, weighs 1 ounce and has no radio interference. The unit requires between 0.2 and 28 v at currents between 0.1 and 5 ma to emit a shrill 1 Kc whistle that can be heard over 100 db noise. At a given voltage, the device can be quieted and have its current demand diminished by insertion of a series resistor. The device can operate in any environment, even underwater, is reverse current protected, can operate either a-c or d-c and cannot ignite explosive mixtures. The unit has many applications where a voltage difference must be signaled and an indicator lamp would not be noticed. The sketch shows typical application as a transistor state indicator. **(351)**

Literature of the Week

INTEGRAL ACTUATOR SWITCHES Micro Switch, Freeport, Ill. Data sheet covering additional varieties of integral actuation for "V3" type switches is available.
CIRCLE 307, READER SERVICE CARD

CONSTANT FREQUENCY POWER SYSTEMS The Ideal Electric & Mfg. Co., Mansfield, O. Bulletin 450 covers constant frequency power systems for use where power interruptions cannot be tolerated even for a fraction of a second. (308)

MASK ALIGNMENT SYSTEM Kulicke and Soffa Mfg. Co., Fort Washington, Pa. Bulletin 675 describes a precision machine for the alignment of glass masks and wafers in the production of semiconductors and microcircuits. (309)

OMEGATRON POWER SUPPLY Vacunetics, a division of E. I. Doucette Associates, Inc., 246 Main St., Chatham, N. J. Four-page folder describes model D-1 omegatron power supply for partial pressure analysis of residual gases. (310)

TOUCH CONTROL SWITCH Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J. Brochure describes touch control switch which operates from body capacity. (311)

VOLTAGE COMPARATOR North Hills Electronics, Inc., Alexander Place, Glen Cove, L. I., N. Y. Bulletin No. 862 is available describing a true rms voltage comparator. (312)

SUPERCONDUCTING SOLENOIDS Westinghouse Research Laboratories, Pittsburgh 35, Pa. Major characteristics of three commercially available superconducting solenoids are presented in bulletin SM5766. (313)

S-ELEMENT SPECIFICATIONS Dynamics Corp. of America, Cherry and North Sts., Carlisle, Pa. Two-page leaflet gives detailed technical specifications on the 200 to 800 Kc S element. (314)

D-C SUPPLIES Sorensen, a unit of Raytheon Co., Richards Ave., So. Norwalk, Conn., has issued a product data sheet on the QB series transistorized l-v d-c supplies. (315)

ALUMINUM HEAT SINKS Thermalloy Co., 4417 N. Central Expressway, Dallas 5, Texas. Condensed catalog features a complete line of more than 30 types of aluminum heat sinks. (316)

DIGITAL COMMAND SYSTEM Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J., offers a bulletin on a digital command system for use in the process control and aerospace industries, and for remote control in hazardous environments. (317)

DISK MEMORIES LFE Electronics, Boston, Mass. Technical data bulletin series 2200 describes specifications and applications of compact Bernoulli disk rotating magnetic storage devices. (318)

RFI GASKET Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J., has published a data sheet on a dual-purpose radio frequency interference gasket incorporating pressure sealing (319)

PANEL METERS Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill. Brochure features over 1300 stock panel meters of various sizes, styles, types and ranges. (320)

MICROWAVE DEVICES AND SUBSYSTEMS Hyletronics Corp., 185 Cambridge St., Burlington, Mass. Brochure describes a line of microwave diode devices, microwave ferrite components and strip line assemblies. (321)

WIRE MARKERS Stranco Products, Inc., 1534 W. Van Buren, Chicago 7, Ill. Data sheets describe Mylar-faced Lamicodes, wire markers which offer a permanent legend that will not rub off, yellow, or soak up oil and grease. (322)

CRYSTAL MICROWAVE POWER LIMITER Amercian Electronic Laboratories, Inc., 301 Richardson Road, Colmar, Pa. Bulletin covers a crystal microwave power limiter with low level insertion loss of 0.3 db. (323)

TOGGLE SWITCHES Controls Co. of America, Control Switch Div., 1420 Delmar Drive, Folcroft, Pa. Catalog No. 180 describes a line of toggle switches with actual size photos, specifications and dimension drawings. (324)

A-C MEASUREMENTS North Atlantic Industries, Inc., Terminal Drive, Plainview, N. Y. Technical bulletin, TB-101, presents a basic description of a-c signal measurement. (325)

MASS SPECTROMETER Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. A 16-page bulletin describes the type 21-103C mass spectrometer. (326)

TRAVELING-WAVE TUBE Warnecke Electron Tubes, Inc., 175 West Oakton St., Des Plaines, Ill. Catalog RW101 illustrates and describes a low noise, low voltage twt. (327)

MICROWAVE COMPONENTS Alpha Microwave, Inc., 381 Elliot St., Newton Upper Falls 64, Mass. A facility brochure is available giving a detailed picture of this recently formed microwave component manufacturer. (328)

MICA CAPACITORS General Instrument Corp., 65 Gouverneur St., Newark, N. J. Bulletin MC-1 covers the company's commercial mica capacitor line as well as the recently revised military specifications on mica capacitors, Mil-C-5B. (329)

PRINTER SYSTEM Anelex Corp., 150 Causeway St., Boston 14, Mass. A 4-page brochure describes the series 4-1000 high speed printer system that contains in a single housing, power electronics, buffers, logic and the print head. (330)

Genisco Moves Operations to New Plant

GENISCO, INCORPORATED, recently moved its operations to a 101,000-square-foot plant in the Dominguez Industrial Park of Compton, Calif.

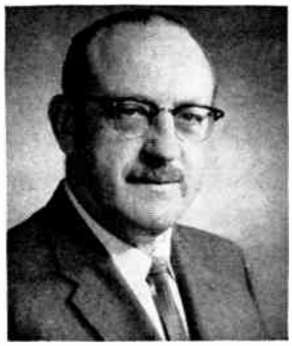
Genisco, a 15 year old company, was formerly located in West Los Angeles, where a total of seven separate buildings were utilized. Periodically, since 1947, the firm has acquired additional floor space, as the company grew, in buildings surrounding the original structure. Occupancy of the new plant places Genisco operations under one roof for the first time since the early months of the company's history.

E. C. Burkhart, chairman and president, said the move was necessitated by the company's increased business volume and continued diversification of product lines. New record high sales and earnings were reported by the company for the fiscal year ended September 30. In addition to Genisco's acceleration devices and environmental test equipment, the company's products include electronic data acquisition and processing systems and electronic conveyor control systems.

The Compton plant will house Genisco corporate offices and the operations of Genisco Systems, a division headed by vice president and general manager Paul Kuefler. Genisco has three subsidiaries all located in their own facilities: Genistron, Inc., Los Angeles; Genistron of Illinois, Inc., Bensenville, Ill.; and Eldema Corp., El Monte, Calif.

Titan III Production Team

WILLIAM G. PURDY *has been named general manager of the Titan III program for Martin Company's Denver division. Others on the management team (left to right): Larry J. Adams, systems engineering and technical direction; Clinton R. Spangler, materiel; Purdy; John P. Healey, assembly and test; Hugh P. Campbell, quality control; Robert E. Biddinger, logistics support and John Stap Jr., customer requirements. Robert B. Demoret, payload integration manager, is not pictured. A model of the new booster is in the foreground*

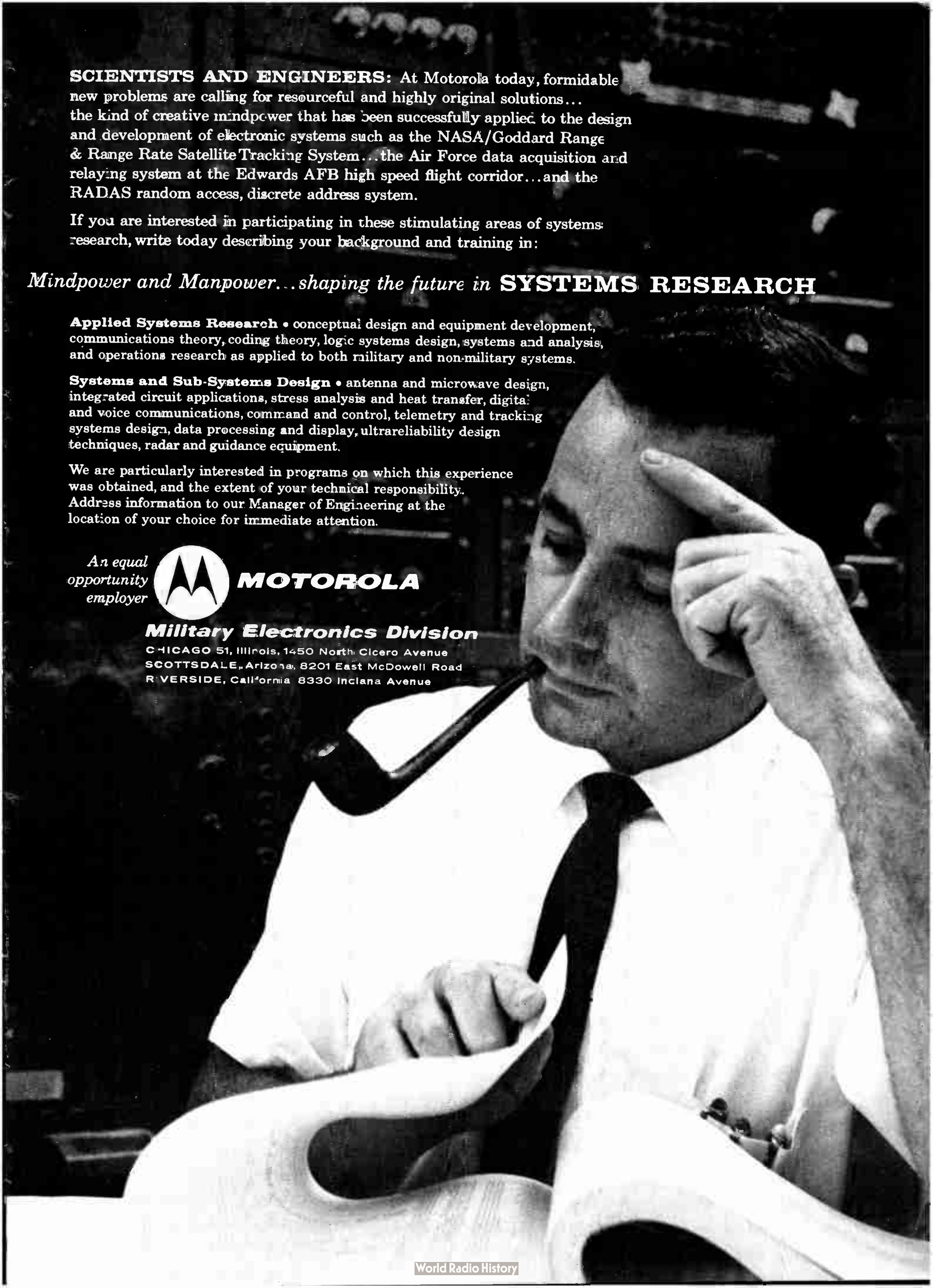


Van Atta Takes Lockheed Post

LESTER C. VAN ATTA has assumed duties as chief scientist of Lockheed Missiles and Space Co. He heads up a group of five scientists involved with long-range planning in such areas as the international situation and technological development, serves as chief scientific advisor to the company president, and will represent the company on government scientific boards and committees.

For the past two and one half months, Van Atta has been chief scientific consultant at Hughes Research Labs in Malibu, Calif. Prior to that time, he was director of the Hughes Research Labs. While with Hughes, he served for one year as special assistant for arms control for the director of defense research and engineering in the office of the Secretary of Defense.

Van Atta's tenure at Hughes began in 1950 when he was appointed head of the microwave laboratory. Before that, he was chief of the an-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tenna research branch at the Naval Research Laboratories.

Honeywell Appoints Top-Level Advisors

TWO major appointments to Minneapolis-Honeywell's Military and Space Sciences department in Washington, D. C., have been announced.

Richard G. Weber, formerly with Airborne Instruments Laboratory, has been named chief of command and technology.

John E. Gray, for the past year a senior planning engineer on Honeywell's Military Products Group advanced planning staff, has been appointed chief of support systems technology.

Atlantic Research Elects Three Officers

THE BOARD of directors of Atlantic Research Corp., Alexandria, Va., recently elected Arch C. Scurlock chairman of the board and Arthur W. Sloan vice chairman and chief executive officer of the company. M. Lee Rice was elected president of Atlantic Research and a director.

Previously Scurlock had been president; Sloan, chairman of the board and executive vice president; and Rice, a vice president.

Premier Microwave Names Maher

BAROUKH MAHER has been named engineering manager for ferrite devices at Premier Microwave Corp., Port Chester, N. Y. He is responsible for development of such components as ferrite isolators, circulators, phase shifters, modulators and switches.

Maher was previously employed

by FXR division of Amphenol Borg Electronics Corp. of Woodside, N.Y.

PEOPLE IN BRIEF

Francis J. Pallischeck, formerly with GE, joins Xerox Corp. as director of development and design engineering. **Frank E. Stoner,** Maj. Gen USA Ret., elected a director of American Microwave & Television Corp. **Robert W. Berg** promoted to mgr. of Granger Associates' Washington engineering office. **Joseph R. Feldmeier** moves up to director of Philco's Scientific Laboratory. **Frank H. Schrenk** advances to mgr. of custom products engineering for the Data Recorders div., Consolidated Electrodynamics Corp. **Donald Block,** previously with Packard Bell Computer Corp., now director of systems engineering at Redcor Corp. **Jordan Perlin,** ex-Airborne Instruments Laboratory, has formed the management consulting firm of Jordan Perlin Associates in New York City. Appointments at Microwave Electronics Corp.: **Harold Hogg,** formerly with General Electric Co., Ltd., named senior research engineer; **James Tangney,** recently with Sylvania, becomes senior development engineer. **Alexander P. Ramsa,** former faculty member at Monmouth College, appointed a scientific specialist in the R&D Laboratory of Erie Resistor Corp. **Joseph L. Flood** leaves GE to join Motorola's Semiconductor Products div. as mgr. of advanced reliability programs. **Leonard F. Cramer,** from Casco Products Corp. to Airtronics International Corp. as exec v-p. **Martin Rome,** ex-Machlett Laboratories, named mgr. of the Photoelectric dept. at Electro-Mechanical Research Princeton div. ITT Federal Laboratories promotes **Richard K. Orthuber** to director, Electro-Optical laboratory. **Thomas Nast,** president of the Kensico Tube Co. div. of Robinson Technical Products, Inc., elected exec v-p of the corporation.

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