electronics®

December 14, 1962

(photos at right)

NEW CONCEPT IN COLOR TV

sunflower plastic lens simplifies projection optics, p 33

KEY TO FAST COMPUTERS

amplifiers handle ten-nanosecond wide pulses, p 39

PASSING VENUS TODAY

circuit details of Mariner II instrumentation, p 42

GETTING THE JETS DOWN

all-weather landing systems have high priority, p 46

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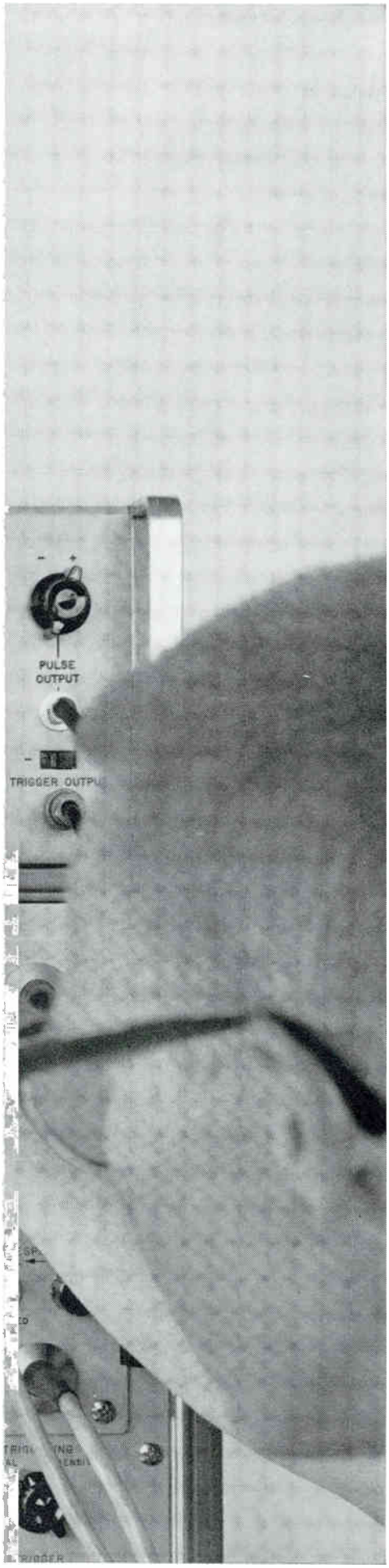

with these features:

Length, delay continuously adjustable! Constant 50 ohm output impedance! Rise, decay time less than 1 nsec!

New hp 215A Pulse Generator is the ideal instrument for measuring switching, recovery and storage time of diodes, transistors and thin film memory units. The 215A is useful for locating reflection sources in transmission and delay lines, measuring electrical length of cables, determining step response of circuits.

The 215A gives you clean pulses with 1 nanosecond rise and decay time. Constant 50 ohm output impedance, during all portions of pulse, allows operation into any load with freedom from multiple reflections. Calibrated front panel controls adjust pulse length from 2 to 100 nanoseconds, attenuation from 1 to 12 db, and delay, —10 to 140 nanoseconds after trigger output pulse. Positive and negative pulses are selectable from front panel.

Trains of pulses, either internally or externally triggered, can be generated by gating the pulser with a +1 volt signal. Internal repetition rate is 100 cps to 1 mc or pushbutton for single pulses. Pulses can be triggered by an external 10 cps to 1 mc source. Count down circuitry permits synchronization on external signals up to 100 mc. Solid state design makes the hp 215A compact, rugged and reliable.

Write or call your hp rep or Hewlett-Packard direct for a demonstration on your bench.

SPECIFICATIONS

Rise time:	Less than 1 nsec
Decay time:	Less than 1 nsec
Output:	At least 10 v peak into 50 ohms 20 v peak open circuit
Polarity:	Positive or negative, selectable
Attenuator:	1 to 12 db, calibrated
Pulse length:	Continuously adjustable, 2 to 100 nsec, calibrated dial
Pulse delay:	Continuously adjustable, —10 to 140 nsec after trigger output pulse, calibrated dial
Internal repetition rate:	100 cps to 1 mc or pushbutton for single pulses
External trigger:	Input voltage 1 v peak-to-peak; pulses 0 cps to 1 mc, 30 nsec min. duration; sine waves 10 cps to 1 mc; synchronizes to 100 mc. 1 μsec min. pulse spacing for random repetition rate
Output impedance:	50 ohms
Gate input:	+1 v to turn on
Trigger output:	Amplitude, at least 1 v peak into 50 ohms, either polarity; rise time, better than 5 ns; duration, approximately 50 nsec
Dimensions:	5½" high, 16¾" wide, 18⅜" deep. Converts to rack mount with furnished brackets. 33 lbs.
Price:	$1,875.00

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

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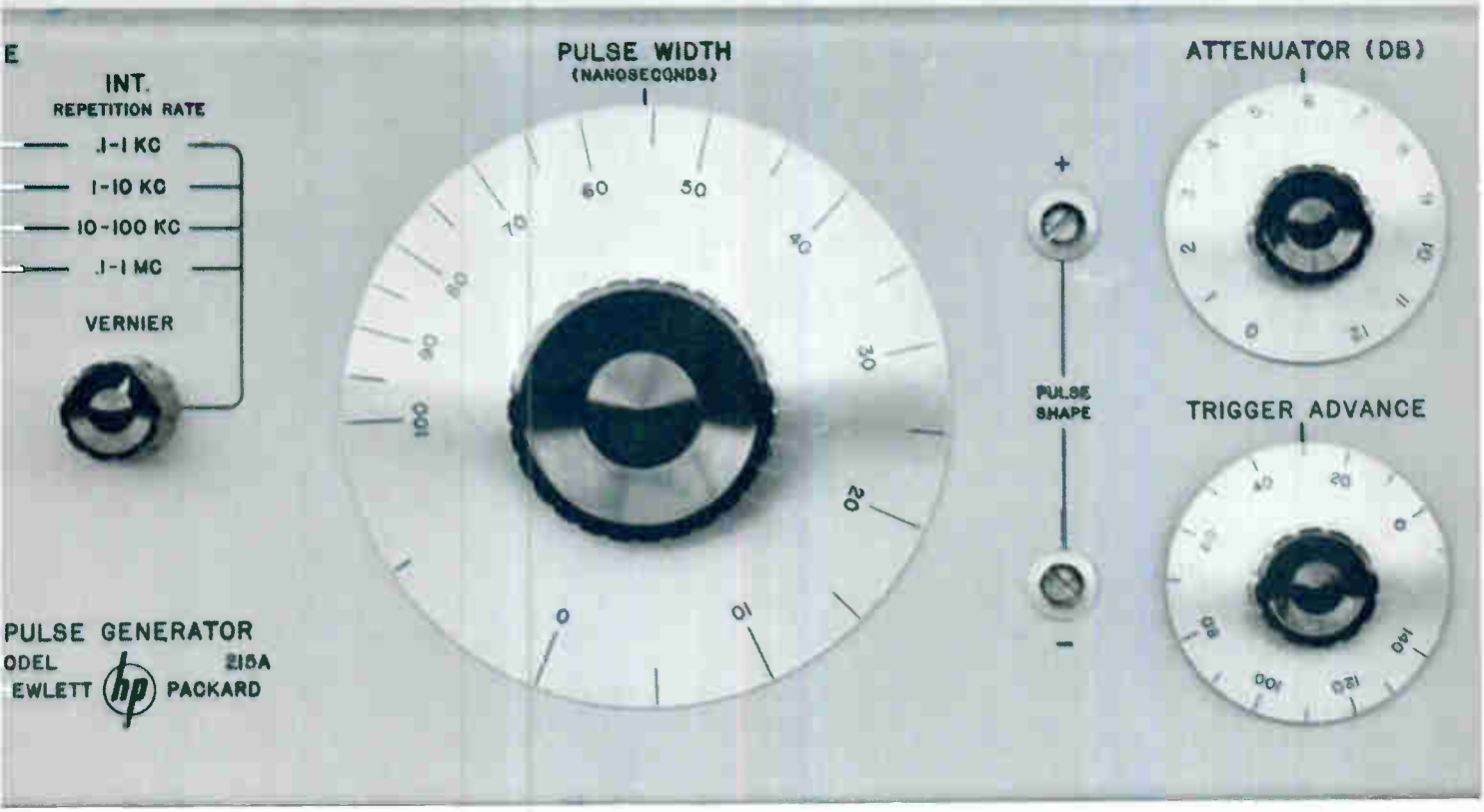
CIRCLE 900 ON READER SERVICE CARD

Nanosecond Pulses Custom Designed

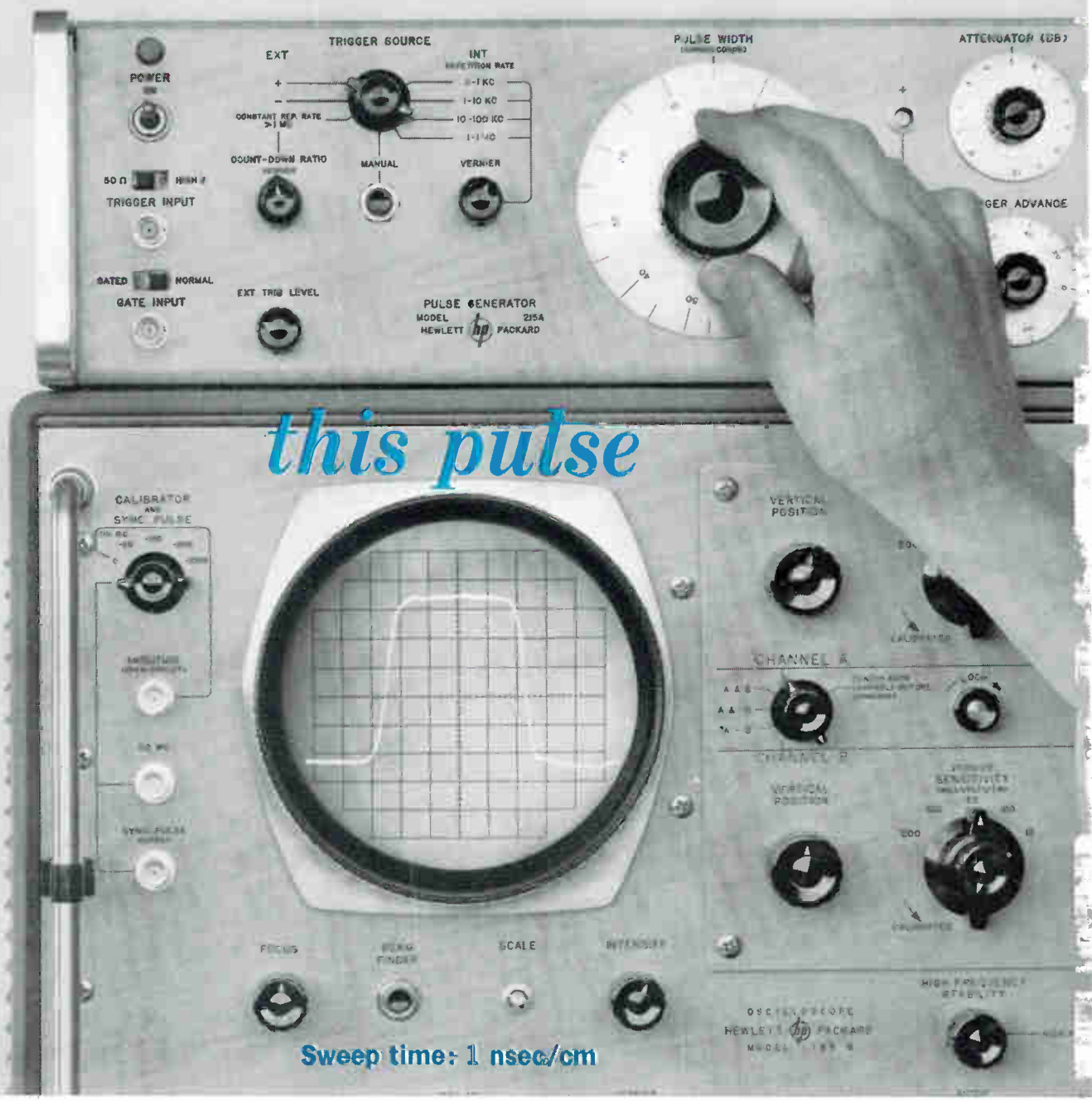


New hp 215A Pulse Generator

This pulse generator gives you 1 nsec rise, decay time . . . and lets you continuously control pulse length and delay!

Turn the page for details

From this new pulse generator...



this pulse

December 14, 1962

electronics

A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, Editor

W. W. GAREY, Publisher

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electronics

December 14, 1962 Volume 35 No. 50

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

Executive, editorial, circulation and advertising offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 212-640-4646. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

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CONTENTS continued

DEPARTMENTS

Five Years? Or a Better Four?

THE NEED for engineers continues to rise. Yet college enrollment of engineering students continues to decline. And many drop out. Primary reason is because engineering courses are tough.

Addition of new subjects to the already crowded curriculum is creating pressure for five year or even longer courses. Maybe this is the way to go, spread out the work load. But skyrocketing tuition and living expenses work against it for all except the wealthy and those who can get scholarships. This leaves a lot of good men in the middle.

Maybe we should first take a closer look at the present curriculum and see if it is possible to do better with the present four-year courses. And one of the first places to look is at so-called laboratory work.

Remember those long afternoons plotting the speed-torque curve of a compound motor, or measuring the characteristics of a type-80 electron tube, or watching the nodes in lecher wires and then staying up half the night writing reports while the liberal arts and business administration majors were resting? Lab work is probably the least popular part of an engineering education. Many bright young men drift off into the arts or sciences because of sheer boredom with it. Furthermore, the need to do lab work makes it difficult if not impossible for many who wish to complete or extend their education at night, even if they have great perseverance and an understanding boss.

To make matters worse, many college labs have equipment ranging from obsolete to downright antique. So even graduate assistants who teach lab often are not precisely enthusiastic about their subject, and there is very little class spirit that could lead to a real appreciation of the experimental method.

We think a budding engineer could learn more about using up-to-date instruments and components in a week with industry than by taking the average undergraduate lab course. So maybe such courses should be dropped and something else substituted for them. Such as a little sleep.

Or, how about industrial internship? Or apprenticeship in a research laboratory? Or summer programs that not only teach men how to use modern instruments and test techniques but also encourage them toward original research?

OBSOLETE LABS *like this have no place in engineering schools. This was New York University's electrical engineering lab before the university's modernization program*

If an engineering education has to be tough, let's make the time count.

Coming In Our December 21 Issue

READING WRITING. A prime problem in designing character recognition system is getting the system to read letters correctly no matter who writes them or what the type style is. It doesn't take much to ring the tilt bell. Next week, we'll have two reports on ways to solve this problem, one from RCA and the other from IBM.

Other featured articles next week include:

- A really simple square-wave generator
- How to use field-effect transistors in Wien-bridge oscillators
- A handy reference to 15 antenna designs and their characteristics
- New trend in ferrite limiters for microwave
- A pulse generator with a range variable down to 20 nanoseconds.

COMMENT

Engineering Shortage

It is impossible for me to remain silent in the face of the continuous moans and howls on the subject of the engineering shortage [*Crosstalk*, p 3, Nov. 2; *Comment*, p 4, Nov. 16 & Nov. 30].

The U.S. can at any time, allowing themselves a few short years for reeducation of the public and those concerned, tap a large supply of potential engineers. The Soviet Union and most other reasonably advanced countries have done this already—namely, with women.

As a woman with more than 20 years of experience in the engineering field, I cannot recommend it as an easy or pleasant way for a young girl to make a living under present circumstances, but as she grows older and toughens up to the discriminatory practices of most of her colleagues, she may, as I have, find it quite rewarding. She must, in addition to the usual technical abilities required of all engineers, have or develop iron nerves, perseverance in the face of almost unbelievably subtle persecution (*subtle because the people doing it are not conscious that they are being unfair*), and a steady and unrelenting determination to do a top job every time, as she cannot afford failures in the same proportion as her fellows, nor can she afford as much leisure, as she will be the first to be accused of lack of interest, etc.

If women of ability are willing to face these hazards, and if industry is willing to allow them to prove themselves in higher echelon jobs, as they have already in every other scientific field, then we will be tapping a new and fertile source of originality, progress and technical ability, which may do more than you think for the engineering profession.

(Mrs.) GRACE S. COLEMAN
Engineer

Logic vs "Crank-Out"

The solutions by Bruning and Lee (p 4, Nov. 23) to the Donald-plus-Gerald-equals-Robert problem require more IQ than the elementary algebraic methods and are, of course, very neat. However, we already pointed out (p 4, Nov. 2) that one of our lab men solved it in about 20 minutes, using logic and a couple of "OR" trials.

The main reason for presenting this bit of "AND-OR" modified elementary algebra, was that perhaps we have unwittingly bridged one gap between Arabic and Boolean algebra, and presented computer men with something to chew their pipe stems over.

Furthermore, the algebraic method allows a much simpler solution of more difficult three- or four-number addition solutions where pure logic would start to get pretty confusing. In addition to this, we have a *general* solution with the *alternate* possibilities of solving by means of negative and fractional numbers; note the possibilities of $(-1, 10, 9)$ and $(4\frac{1}{2}, 9\frac{1}{2}, -\frac{1}{4})$. This would be pretty rough to handle with straight logic. (As computer men are aware, computers will sometimes come up with unsuspected alternate solutions, or go about a solution in an unpredictable fashion.)

Incidently, there was an oversight goof in the original solution. We not only know that $L \geqq 5$, but is also *even* and is immediately 8, without the need for one of the equations.

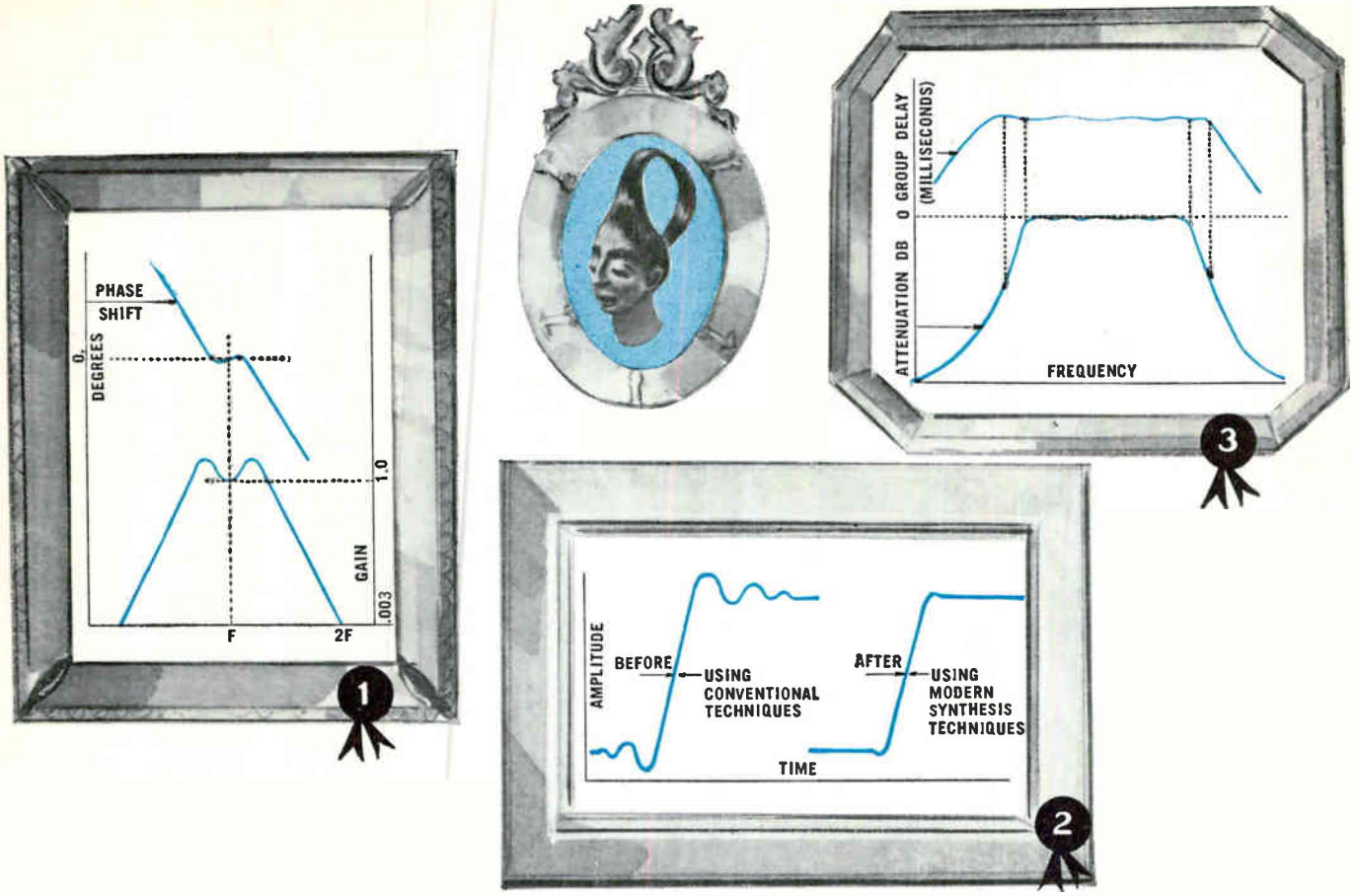
Anyway, it was a lot of fun—except for the Bell Labs man who has to prepare the next applicant quiz.

TED POWELL
Glen Oaks, New York

Alloy 404, Not 401

In the *Components and Materials* article, New Alloy Solves Brazing Problems (p 84, Nov. 9), the newly developed alloy that enables successive brazes in wet hydrogen is designated Monel alloy 404 (rather than Monel alloy 401 as shown) by the Huntington Alloy Products Division.

S. B. LASDAY
Huntington Alloy Products Division
The International Nickel Co., Inc.
Huntington, West Virginia



Burnell advances the state of the art with three new filter families

If you are concerned with new systems development, and would like to take advantage of advanced technology and the kind of sophistication that will improve transient response and eliminate obsolete circuitry . . . then here are three new filter families, that have advanced the state of the art, which you can immediately incorporate in your network designs – exclusive from Burnell. Call or write today for literature and technical assistance.

Burnell offers the most complete line of communications network components available to the electronics industry, with a versatility of experience unmatched in the production of filters, delay lines and toroids for interpretation of *complex signals*. Burnell will custom design filter networks to your specifications which may include special delay, attenuation, and transient response, involving precisely specified rise time, overshoot and ringing.

1 ZERO PHASE FILTERS

Impedance 1000 ohms/Grid 400 cps Center			
ATTENUATION & PHASE CHARACTERISTICS			
OP SERIES	OP400 L	OP400 M	OP400 H
Pass Band (3 DB)	±20 cps	±20 cps	±20 cps
Harmonic attenuation 2nd harmonic and all higher frequencies			50 DB
Harmonic attenuation (2nd)	>15 DB	>25 DB	
Harmonic attenuation (3rd)	>40 DB	>60 DB	
Max phase ±20 cps	±1°	±1°	±1°
Max. phase ±30 cps			±5°
Phase shift at Center Frequency	0°±½°	0°±½°	0°±½°
Gain =	UNITY	UNITY	UNITY
60 cps equivalent filters are also available having a pass band of ±5% with phase of ±1°.			

For the Servo Engineer . . .
By specifying Burnell's new line of Zero Phase Shift networks, it is possible to recover, without phase shift, the fundamental frequency from any periodic wave form without using complex squaring circuitry. This advancement in the state of the art is accomplished by combining zero phase shift in the vicinity of the center frequency — with high attenuation in the stop bands.

2 LOW PASS FILTERS WITHOUT DISTORTION

This family of filters is designed with modern synthesis techniques to have specified transient characteristics such as fast rise time, low overshoot and ringing.

60/3 DB Shape Factor	Ringing (over/undershoot)
2:1	< 5%
3:1	< 2%
4:1	<1%

3

This is part of a family of constant delay band pass filters of unusual characteristics, for example:

1—Group delay is constant well into the stop band!

2—Matched delay—as an example of delay matched band pass filters, we have produced a set of four filters having the same band widths of 500 cycles at 1½ DB with center frequencies ranging from 680 cycles to 2720 cycles; having a 20 DB band width of 710 cycles with group delay constancy of ±3½% over the pass band and between channels.

3—Constant flat delay band pass filter.

Frequency	Attenuation
5210 cps to 8336 cps	< .5 DB
1,000 cycles & below	> 20 DB
10,000 cycles & higher	> 20 DB
Delay: Group delay constant ±1% from 3,500 cps to 9,900 cps.	

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

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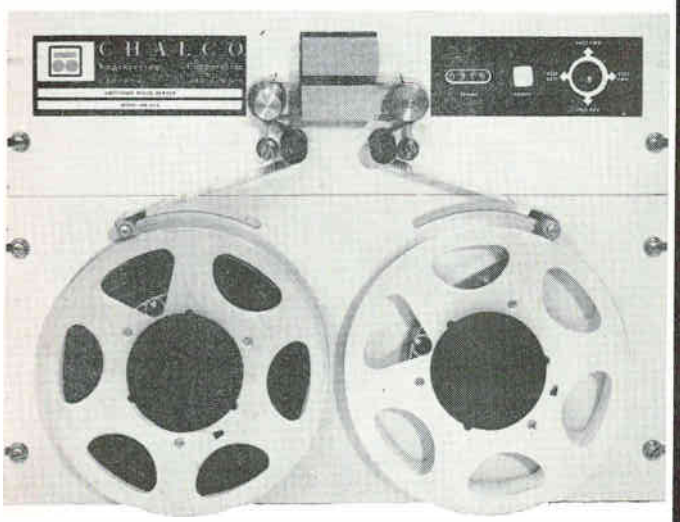

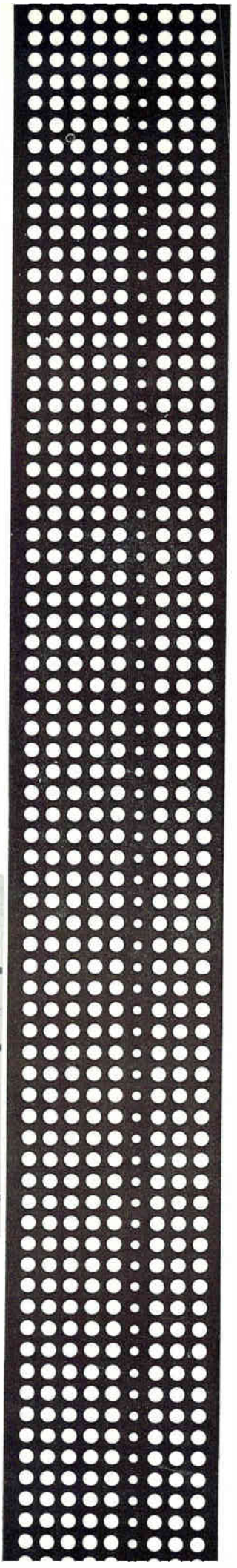

as reliable as you can get

Chalco's Switching Block Tape Reader never (or hardly ever) misses a bit . . . not one bit miss in 138 eight-hour days so far* . . . the highest degree of reliability available in mechanical block readers. Why? Because of the reading head (128 gold-plated form A isolated closures)—exclusive with Chalco. Storage and isolation circuits are unnecessary. The SBR-623 is bi-directional. $1695 with the tape handler. A program search accessory is available. Write to Chalco Engineering Corporation, 15126 South Broadway, Gardena, California, for complete (and quite amazing) specifications.

CHALCO

CIRCLE 6 ON READER SERVICE CARD

*as of Oct. 29, 1962

ELECTRONICS NEWSLETTER

Air Force Battling for Skybolt's Life

WASHINGTON—Skybolt, Air-Force's air-launched ballistic missile, is in trouble. Test firings have failed, the schedule is slipping badly and development costs are running way over budget estimates. Authoritative sources say the Pentagon's proposed 1964 budget contains no new funds for Skybolt.

The Pentagon is doing lots of soul-searching before cancelling the project. The missile could extend the life of manned bombers until 1970 or so, and has figured crucially in the Pentagon's long-range strategic planning. The British, too, have invested heavily in Skybolt. Coupled with latest RAF bombers, it would give Britain a deterrent force of her own.

Defense Department has apparently concluded on the basis of cost-effectiveness studies that Minuteman ICBM, a fixed-base missile, makes Skybolt a marginally useful strategic weapon system.

Air Force disagrees and is fighting for continuation of the project (while the betting in Washington is that the project will be killed, Air Force spokesmen told ELECTRONICS in New York that cancellation talk was based on rumor and that the program had not been killed). Douglas Aircraft is prime contractor and Northrop's Nortronics division has the guidance contract.

Rauland Corp., Zenith's tube-making subsidiary, is sticking with its earlier announcement that it hopes to make color tubes in its expanded facilities "early next year," but declined to specify tube size.

Sprint Antimissile Is Not a Threat to Zeus

DEVELOPMENT of the Sprint antimissile is not expected at this time to influence continuation of the Nike Zeus program. Army's interest in Zeus was strengthened by the successful test at Kwajalein.

With a solid-fueled booster, Sprint would probably be smaller and cheaper than Zeus. Army Missile Command, Huntsville, Ala., has not yet announced contractors.

Sprint is expected to carry an atomic warhead and kill directly overhead. This means it would guard only hardened weapons sites, not cities.

Nor would it guard a site against missiles from any direction. Its area of attack would probably be fixed in much the same way the Ballistic Missile Early Warning System fences is fixed. But like Bmews, several sprints could monitor several small segments. Theoretically, 18 or 20 could guard a complete circle.

New Device Resembles Pentode and Transistor

NEW YORK—RCA has made experimental microcircuit units that have the characteristics of a vacuum-tube pentode and a transistor. The device, made under an Air Force contract, was called a major advance in microcircuits, by Brig. Gen. B. G. Holzman, of Air Force Cambridge Research Labs. In his report last week to the American Ordnance Association, Holzman said RCA has been able to fabricate units with a "highly consistent uniformity and quality."

U. S., USSR to Cooperate On Peaceful Space Uses

WASHINGTON — First agreements for cooperative space programs have been reached by the U. S. and USSR. Success with three initial projects—weather, passive communications and geomagnetic survey satellites—will determine other

Production of 90-Degree Color-Tv Tubes Delayed

NEW YORK—RCA's Electron Tube division announced that commercial shipments of the new 90-degree, round, color-tv picture tube will be delayed for approximately 9 to 15 months. RCA blamed technical difficulties encountered during pilot production, stating that reliability goals were not fully realized.

RCA had hoped to introduce the new, shorter tubes next spring. It said it would continue to produce its 70-degree tube on an all-out basis.

Sylvania declined to comment last week on the RCA announcement. Sylvania had announced last May that it would have a 90-degree color tube ready in 1963.

Iced Protein Acts Like a Transistor

BERKELEY, CALIF.—Single-molecule circuits are among the possibilities raised by an Office of Naval Research-funded project at the University of California. The project, begun to determine microwave hazards, has branched into an investigation of semiconductor-like actions in proteins and protein-doped ice crystals.

P. O. Vogelhut, of the Electrical Engineering department, has measured changes in the dielectric constant of bulk solutions of proteins, primarily the enzyme pepsin. Protonic current flow on the molecule's surface, possibly due to tunneling, is indicated. Variations have been measured by Hall-effect techniques.

Vogelhut feels such research may explain enzyme kinetics and, possibly, transfer of energy in catalytic molecular reactions. Ultimately, he speculates, molecules may be designed to simulate on their surfaces the functions of such circuits as amplifiers and oscillators. These could be used as self-adaptive computer circuits.

On a microcomponents level, the use of protein-doped ice crystals exhibiting transistor-like characteristics, is being investigated. Early research indicates that both *p-n* and *pnp* junctions will be feasible

joint projects in the future.

For a world-wide meteorological satellite system, each country will continue separate experimental satellite programs until 1964 with free exchange of technical information. By 1965, a joint operational system is planned.

Joint experiments will be conducted in 1962-63 with passive Echo satellites, with the possibility of extending joint efforts to repeater-type satellites at a later time.

Both countries will launch satellites to measure the earth's magnetic forces during the International Year of the Quiet Sun, 1964-65. The satellites are to be in separate orbits and data is to be coordinated.

Portable Rangefinder Chops Laser's Beam

LASER RANGEFINDER with an accuracy of 5 feet regardless of distance measured is reported by Raytheon. The company says this accuracy is obtained by chopping the output beam into 20-foot segments with a modulator reacting in 20 picoseconds. Beams reflected from a target are detected by a multiplier phototube and a miniature computer calculates elapsed time. The system weighs 30 pounds, including power pack.

EIA Studies Navy's Microcircuit Proposals

NAVY'S PROPOSALS for functional microelectronics circuits (p 18, Dec. 7) will be studied by a working group of the EIA Advisory Committee on Microminiaturization. The group is expected to report on circuit parameter specification in about six months.

The idea of preferred microelectronic circuits appeals to potential users, but some predict circuits, except perhaps digital, will be difficult to standardize.

"We've been through this before in conventional circuits and there's always a reason why the standard can't be used," one engineer told ELECTRONICS.

Preferred microelectronic circuits is also an Army goal, but for now standardization is considered possible only for some circuits in specific equipment. Air Force feels the technology is insufficiently advanced to permit standardization for Air Force purposes.

The EIA committee adopted microelectronics nomenclature and definitions last week in Philadelphia. An engineering bulletin will be issued soon.

New Computers Get Hourly Rental Plan

WILLOW GROVE, PA.—A new series of computers was introduced last week by Philco's computer division. The 4000 is a family of stored-program systems that process both fixed and variable-length data. Philco says they can be used equally well in scientific or business applications. Binary or decimal arithmetic, or both, are available.

Philco also announced a new leasing plan called Pact, for "pay actual computer time." For example, one 4100 system would rent for a fixed $3,850 monthly, plus $22 for every hour the system is in use. Philco expects to extend the plan to their 2000 series soon.

Feasibility of Nuclear Gyro Is Demonstrated

GARDEN CITY, N. Y.—Berthold Zarwyn, director of Arma's basic research department, told ELECTRONICS last week that his scientists were able to sense the alignment of protons in an experimental solid-state directional gyro.

"Our present data as well as some extrapolations indicate we are on the road to obtaining a solid-state nuclear gyro having performance at least comparable to that of existing gyros," he said.

A report on the gyro was to be presented this week at the First Annual Symposium on Unconventional Inertial Sensors, at Republic Aviation Corp. General Precision and Republic were also to present papers at the symposium, cosponsored by Republic and Navy in cooperation with Air Force.

In Brief . . .

MOTOROLA plans to enter color-tv market in mid-1963, using an RCA tube, if necessary. The company is developing a 23-inch, 92-degree color tube. Motorola expects some 550,000 color-tv sets to be sold in 1963, almost double 1962.

AEC REPORTS the U.S. now has 286 nuclear reactors. Great Britain and USSR each have 39 and France 25. World total is 518.

AMPEX has introduced an all-transistor video tape recorder for closed circuit use. It weighs 130 lb, records 64 minutes of programming on an 8-inch reel of 2-inch tape.

NASA has awarded Link division of General Precision a contract to develop a video film converter that will enable stereo reconstruction of lunar views televised by Ranger probes.

AIR FORCE reportedly has now installed operational Titan II and Minuteman missiles at hardened sites.

HUGHES AIRCRAFT has a $27 million contract for missile launch control equipment at operational Minuteman sites.

EIA IS CONSIDERING establishment of a division for manufacturers who sell through distributors.

LEACH CORP. will furnish command receivers for Army Missile Command's Arpat, part of Project Defender for missile defense.

KOKUSAI DENSHIN DENWA, of Japan, has begun construction of its satellite communications station (p 23, March 23).

CANADA Meteorological Service will use a Bendix G-20 computer for weather analysis and prediction throughout the country.

SGS FAIRCHILD LTD. will produce silicon planar transistor and, in 1963, Micrologic units at a plant near London, England. A plant at Milan, Italy, will produce conventional components.

ADVERTISEMENT

New Pulse Transformer Assortment Facilitates "Bread-Board" Designs

The 100Z41 Pulse Transformer Assortment offers the circuit designer a versatile selection of miniature pre-molded pulse transformers. Developed by the Sprague Electric Company, this experimental assortment is suitable for a wide range of requirements and designs in either electron-tube or transistorized circuitry.

Provides 58 Combinations

This assortment contains 12 specially-selected type 32Z miniature pulse transformers which permit 58 turns-ratio and primary inductance combinations. With proper choice of terminal windings and connections, these transformers provide primary inductances ranging from 160 microhenries to 43 millihenries, and turns-ratios from 1:5 step-up to 6:1 step-down.

Permits Frequent Re-Use

The potted, pre-molded case construction of these pulse transformers facilitates bread-board wiring and permits frequent re-use.

The assortment is packaged in a clear, hinged-lid plastic case, complete with simple instructions. A printed table inside the lid indicates all turns-ratios, inductances, windings, and connections.

Specific Designs Available

When the required transformer characteristics are determined, production quantities to exact requirements can be easily obtained from Sprague's broad line of hermetically sealed or encapsulated pulse transformers.

For fast delivery or additional information on the 100Z41 Pulse Transformer Assortment, contact the nearest Sprague Products Co. Industrial Distributor, or write Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

45-470

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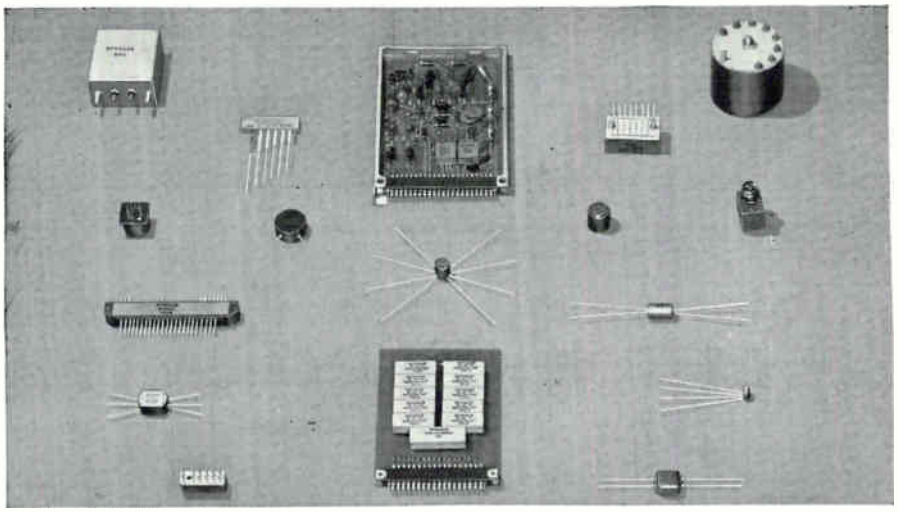


CUSTOM PACKAGING IS NO NOVELTY AT SPRAGUE'S SPECIAL PRODUCTS DIVISION

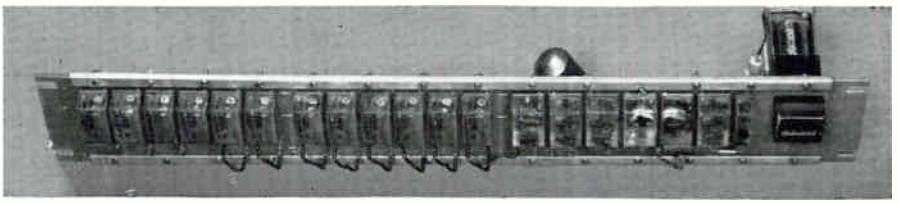
★ Sprague Electric Company's *SPECIAL PRODUCTS DIVISION* was founded originally to meet the electronic industry's needs for reliable packaged assemblies and subassemblies.

★ Sprague has developed and produced packages with countless variations in electrical characteristics and mechanical configurations, in all shapes and sizes, with and without semiconductors, as wiring boards, in encapsulated cases, in cast blocks, in hermetically-sealed packages.

★ In Sprague packaged assemblies, internal components are connected by soldering, welding, wire-wrapping, or printed wiring techniques.

★ Sprague versatility offers several basic types of construction, including molded cellular, high-density "cordwood", and molded multiple-circuit construction, permitting densities in excess of 200,000 standard components per cu. ft.

★ For application engineering assistance without obligation, write or call the Special Products Division, Sprague Electric Company, 35 Union Street, North Adams, Massachusetts.



SPRAGUE COMPONENTS

PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS
MAGNETIC COMPONENTS
PULSE TRANSFORMERS
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HIGH TEMPERATURE MAGNET WIRE
CAPACITORS
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THE MARK OF RELIABILITY

Kodak reports on:

the direct-writing electron pencil . . . how to cope with many, many, many oscillographs . . . KODAR—a name with a ring to it

The film in the bottle

We have something important to say about modulating an electron beam and writing with it directly on photographic film inside the bottle, skipping phosphor and lens: It is feasible and advantageous.

For a while now we have been tossing around the term "modulation transfer characteristic" with reference to photographic emulsions. We suspect that a few uncharitable souls in the gallery have snickered at such high-flown language issuing from people who brew one of the principal ingredients for their product from hides and old bones.

Let the snickers cease. With a modulated electron beam playing directly on this humble outcome of the efforts of cowboys and silver miners, stronger reasons begin to unfold for speaking of modulation transfer characteristics. The modulation, indeed, seems to get itself transferred a great deal better this way than the old way. In fact, the monkey now rides on the electronics to generate as much as the photography can take.

We peddle no hardware for this and can therefore talk freely with would-be hardware peddlers and their prospective customers. We wish to tell them we have looked into it deeply enough to know

- that when conventional medium-speed film records with electrons, it can resolve detail considerably smaller than 5μ;
- that we can make a film for which the modulation transfer level remains above 50% out to 355 cycles/mm, which corresponds to nearly 65 megacycles in TV 16mm format;
- that a high-resolution film (far too slow to consider for the light available from a phosphor screen), when exposed to an electron beam of low current at little more than half the accelerating potential customary in c-r tubes, gives far more resolution and far less graininess than can be expected of the medium or fast films that the phosphor screens need;
- that freedom from the graininess and other imperfections of the phosphor screens themselves is beautiful;
- that no harsh remarks should be uttered about the lenses that image phosphor screens on film because, until some practical equipment appears on the market for the new direct-electron technique, a lot of people will want to write to Eastman Kodak Company, Apparatus and Optical Division, Rochester 4, N. Y., for details and prices on what we believe to be the sharpest lenses for the purpose in the world.

For further information on the new technique, write Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y.

Feet, not inches

America's oscillographs are spewing out paper so fast that processing facilities are swamped.

To smash the bottleneck, we marketed last autumn what we called KODAK EKTALINE Paper and Chemicals. Instant success.

We were a little crafty. We advertised 180 inches/min processing speed and hoped that would sound fast. (You can't hang us, since available oscillogram processors couldn't operate much faster.)

How primitive that figure looks, now that the last link of the EKTALINE chain is in place!

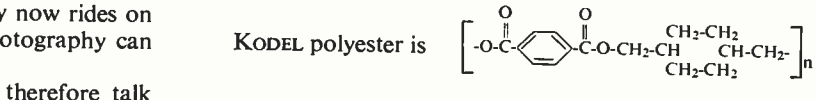
We hereby offer the new KODAK EKTALINE 200 Processor that processes KODAK EKTALINE 12, 16, or 18 Paper at 200 ft/min. (Feet, not inches!) With this machine in your darkroom, evaluation of a 475-foot roll of data can commence less than 3 minutes after the paper has been brought in from the oscillograph and placed on the supply spindle. You can operate the machine slower if you want to.

Quality of the result meets our ridiculously high standards. We are willing as of this writing to sell you the machine for $19,500. If people are standing around waiting for their data, you can't afford to go much longer without addressing an inquiry to Eastman Kodak Company, Professional Apparatus Division, Rochester 4, N. Y.

The improvement of capacitors

This is being written by a man wearing a suit and necktie of blended KODEL Polyester Fiber. Until we came out with "KODEL," the way to be chemically specific about polyester fiber, sheeting, and film without mentioning somebody's trademark was to say poly(ethylene terephthalate).

Whereas p(e t) is 

KODEL polyester is 

That large added ring preserves the bond between  and o- against moisture attack and raises the melting point substantially to as high as 290°C. We also put out the same polymer as biaxially oriented KODAR plastic film.

You cannot take pictures on KODAR, but you can roll it up with metal foil into capacitors.

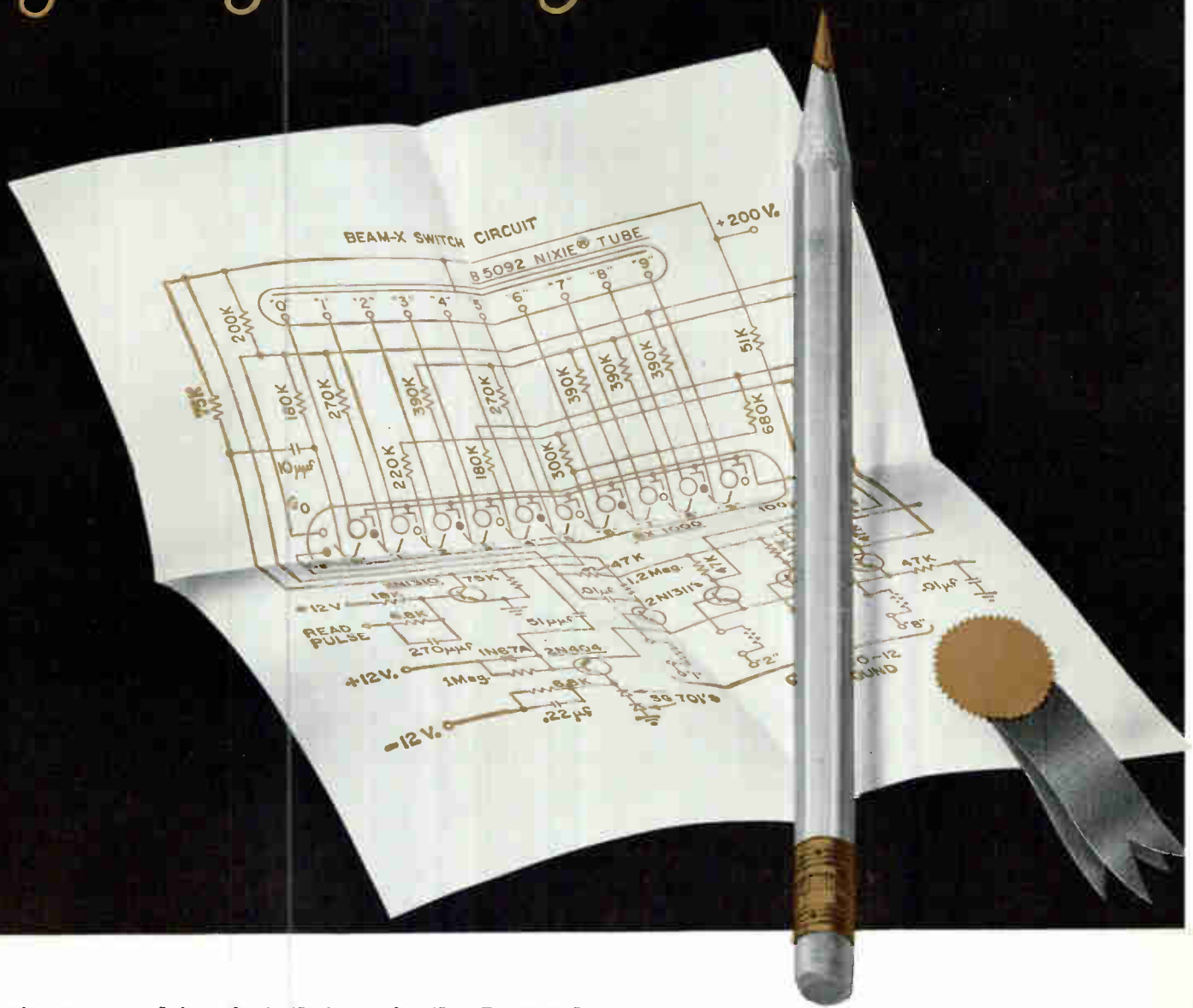
When the president of Kodak visited the laboratory where the many electrical advantages of KODAR were discovered, we set up ten .05-μfd 200-v capacitors for him, identical except that five of them had that cyclohexane ring in the polyester and five did not. We put them all in an oven at 185°C and applied 700 volts of dc across them. Within three minutes all five of the p(e t)'s had shorted out. This was the logical moment for the president to leave, but realism is company policy. The president wanted to watch the first of ours fail. It took 10 minutes. KODAR dielectric film has continued to improve.

On March 26, 1959, having replaced 15 of the regular capacitors in a TV set with our kind, we set it to running 9 hours a day, 7 days a week. All other components that failed (naturally, there were many) we replaced. For the Electrical Insulation Show in February this year we removed the set from the room where the lab manager hides it and took it to Washington. It was the hit of the show. The coincidence that it happened to be the only TV set in the hall on the day when the first American was orbiting the earth might have helped focus attention on it. It would not have been a good place to have one of our capacitors go.

The remarkable fact is that these capacitors can be cheaper than p(e t) ones because the inertness of KODAR to high temperature and humidity lets it act as its own monolithic case and survive conditions that crumble even the cased p(e t) variety into dust. Furthermore, without the variation introduced by measures necessary to protect the p(e t), capacitance can be held to ±2% at little added cost to pay for the rejects. The prominent capacitor manufacturers know all about this. If you want to be one yourself, you can find out a great deal more from Eastman Kodak Company, Plastic Sheeting Division, Rochester 4, N. Y.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

did you design a winning circuit?



Four engineers are doing just that — in the Burroughs BEAM-X® Switch Circuit Design Competition. They're using our new 40 page Circuits Brochure as their guide. Editors of Electronics, Electronic Design, EDN and Electronic Equipment Engineering will select four winning circuits. Each winner will receive a $1,000 U. S. Savings Bond . . . plus an all-expense paid trip for two to the 1963 IRE Show. Winners' names, and their winning circuits, will be published in March, 1963. Watch for announcement of the winning BEAM-X Switch circuits.

Even if you are not in the competition, be sure to get your copy of this new brochure. It may very well contain the key to your next successful electronic circuit design!

ANOTHER ELECTRONIC CONTRIBUTION BY
Burroughs Corporation
ELECTRONIC COMPONENTS DIVISION
PLAINFIELD NEW JERSEY

CIRCLE 11 ON READER SERVICE CARD

WASHINGTON OUTLOOK

DOD SAYS FEE PLAN WOULD REWARD "GOOD" CONTRACTORS...

CONTROVERSIAL PLAN to establish, by formula, the target profits in negotiated, noncompetitive military contracts goes to the Pentagon this month. The aim is to give high-performance contractors more profit and inefficient contractors less. The plan is being proposed by the Logistics Management Institute, a Defense Department advisor.

LMI's formula involves a dozen different contractor cost elements, each weighted mathematically and assigned a percentage of the profit allowance. Profit rating for each depends on contractor performance. The composite profit rating is adjusted by such factors as the contractor's risk, investment and type of contract.

LMI complains that target profits are now established by "habit" and are too frequently based on a contractor's previous profit allowances and industry averages. An LMI Survey shows target profits now average 11 percent in fixed-price contracts and 7 percent in cost-reimbursement contracts.

...THE HECK IT WOULD, SAYS EIA

ELECTRONICS INDUSTRIES ASSOCIATION will oppose the LMI plan, arguing that it won't give a wider range of profits. Theoretical application of the plan to representative recent contracts resulted in lower profit rates than are now allowed, EIA officials say.

The proposal has been in the works since May. DOD has discussed a preliminary draft with EIA and other industry groups and plans detailed discussions with the Defense Industry Advisory Council.

POST OFFICE ZIP CODE: PRELUDE TO AUTOMATION

POST OFFICE isn't waiting for electronic mail-sorting equipment to speed up mail delivery by the numbers. Its new five-digit (three for major geographical areas, two for local areas) mail-routing code will work well without reading machines, postal officials say. They expect it to work even better when readers become available. Bulk mailers—25,000 firms account for 75 percent of the mail—with computers will program them to presort addresses by the code. This will eliminate four of the customary six sortings in post offices.

ANYBODY NEED A NIKE AJAX?

PENTAGON IS PUSHING new uses for the Army's Nike Ajax anti-aircraft missile, now being phased out at operational sites. Some $39-million worth of equipment—mostly tracking and acquisition radar gear—has already been transferred from the North American Air Defense Command to other military agencies.

Among the new uses: Cape Canaveral is modifying units for use as infrared measurement systems, Naval Ordnance Test Station at China Lake is using the equipment for test purposes and data acquisition, and Navy's Patuxent River Test Center is also using radar equipment for testing.

BROADCASTERS OPPOSE UHF-TV REALLOCATION

ANOTHER PROTEST to the proposal to give land mobile radio services the frequencies now assigned tv channels 14 and 15 (see p 26) has been filed with FCC. National Association of Broadcasters said reallocation "would be a crippling blow" to uhf-tv development. NAB suggested land mobile services be improved through common carriers or coordinated systems.

6 REASONS TO LOOK AGAIN

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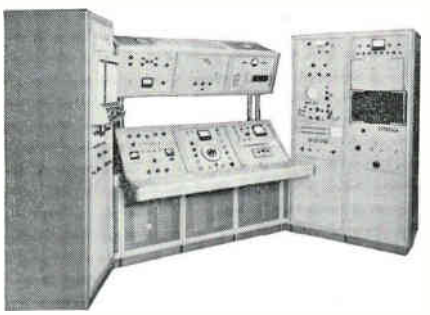
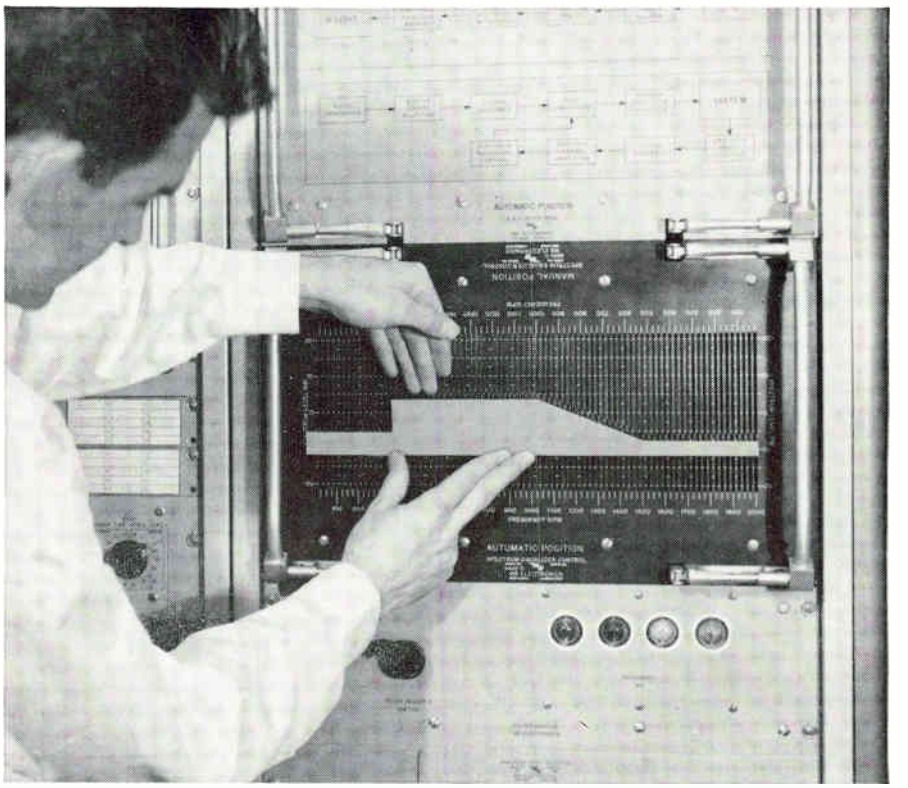
MB's T-388 Automatic Equalizer cuts equalization time to 5 seconds...

Production random vibration is now practical with MB's completely automatic spectrum equalizer. Set up time is eliminated and equalization realized within 5 seconds. Savings in test time and labor for missile and aircraft manufacturing can easily reach many thousands of dollars per missile tested.

Operation of the T-388 automatic equalizer is extremely simple and can be readily handled by non-technical personnel. A flat or shaped spectrum is easily programmed on the spectrum control panel by setting the slide wires. A template of the spectrum can be used for the setting as shown above. The equipment does the rest.





Templates of your test spectrum can be used for rapid set-up of the T-388 Automatic Equalizer.

The T-388 also provides higher test accuracy and versatility. Equalization to $\pm 1\frac{1}{2}$ db is obtained and equipment automatically compensates shifts in resonant frequencies and changes in amplitudes. Normal frequency range is 15 to 2000 cps in 25 cps bandwidths; any 2000 cps bandwidth can be obtained between 15 and 10,000 cps by simple front panel selection.

Other unique features of the T-388 Automatic Equalizer include:

- Spectrum analyzer has 3 types of readout: 1) precision, direct reading in g^2/cps; 2) visual display on scope for continuous monitoring; 3) permanent record of test using X-Y plotter.
- Highly accurate equalization through the use of 80 distinct channels of narrow bandwidth (25 cps) covering a 2000 cps band.

A test laboratory equipped with the T-388 unit will not only save many hours of valuable test time, but will also be prepared for present and future test requirements.

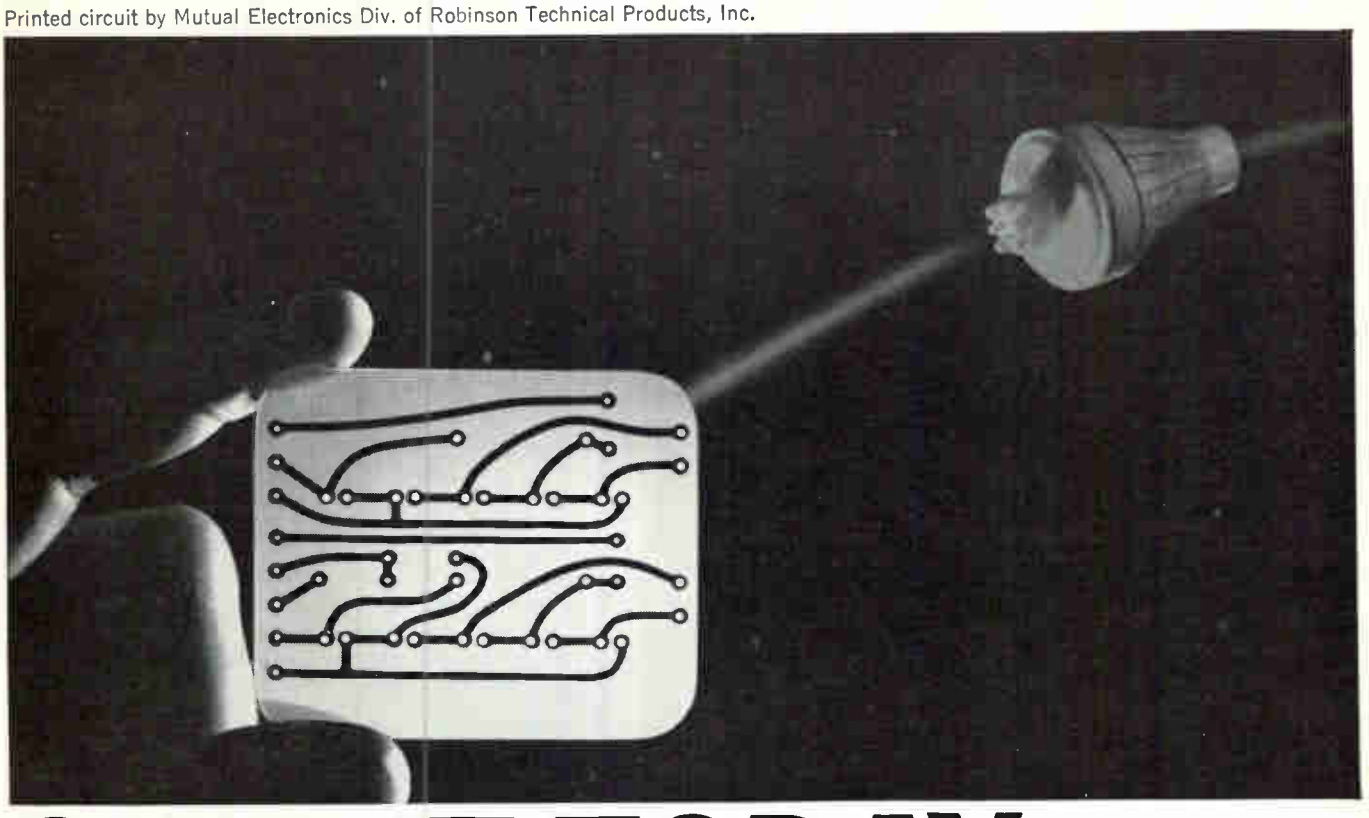
For detailed information on the T-388 Automatic Equalizer write to MB Electronics, 781 Whalley Ave., New Haven 15, Conn.

Over 50 Multi-Filter Equalization Systems purchased by leading test laboratories

The important contribution which the MB Multi-Filter Equalization System makes to the field of vibration testing has been recognized by leading environmental testing laboratories. To date over 50 units have been purchased...a remarkable record for equipment of this type.

MB engineers will gladly consult with you on how to apply the unique advantages and savings of the Multi-Filter Equalization System to your test programs.

Printed circuit by Mutual Electronics Div. of Robinson Technical Products, Inc.



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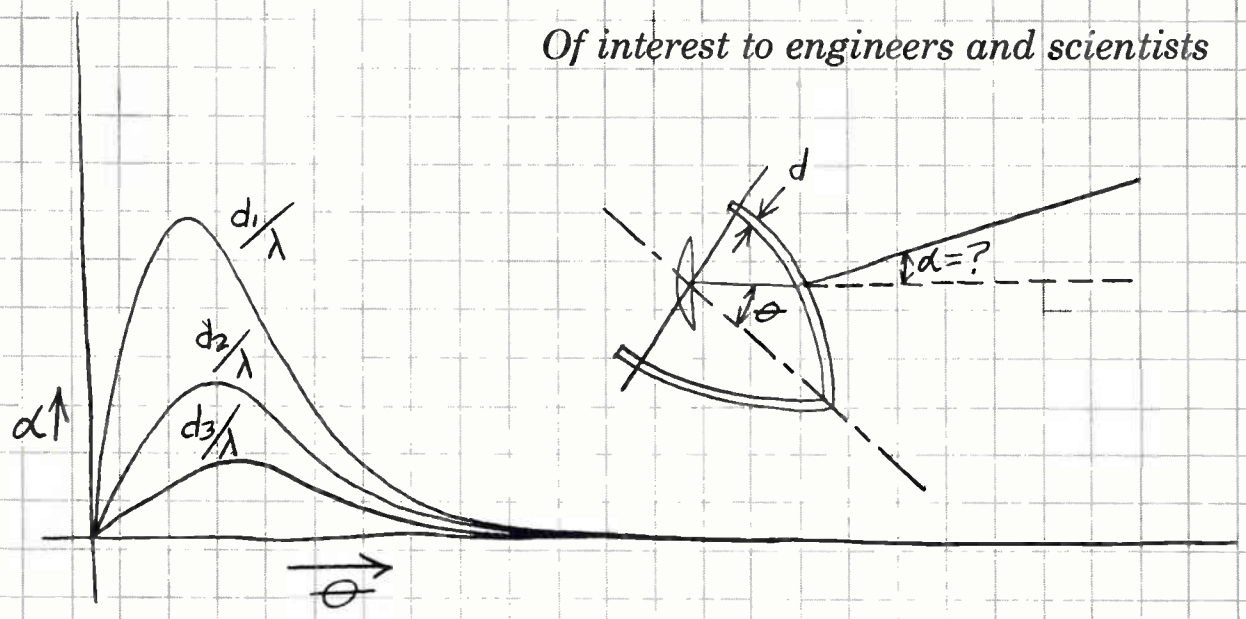
Of interest to engineers and scientists



ELECTROMAGNETIC WINDOWS

...one of more than 500 R & D programs under way at Douglas

Douglas is engaged in an intensive program to further development of radomes and antennas that will operate with precision in high performance missile and re-entry vehicle applications.

The following are a few of the areas under investigation: methods of radome construction to extend the usefulness of presently known materials to temperatures beyond present state of the art limits; new materials that will provide "see through" capabilities at temperatures all the way up to 6000°F; methods of measuring electrical properties of dielectric materials at elevated temperatures.

Urgency of this research is emphasized by the mechanical and electrical inadequacy of fibre-laminates at the temperature levels of high-speed technology.

Of career interest to engineers and scientists

Douglas is seeking electronics specialists and others with disciplines related to aerospace at all degree and experience levels. Applicants can be assured of stimulating work assignments and wide professional growth opportunities as they participate in vital defense, space, research and commercial programs. Some of these undertakings extend 10 years into the future.

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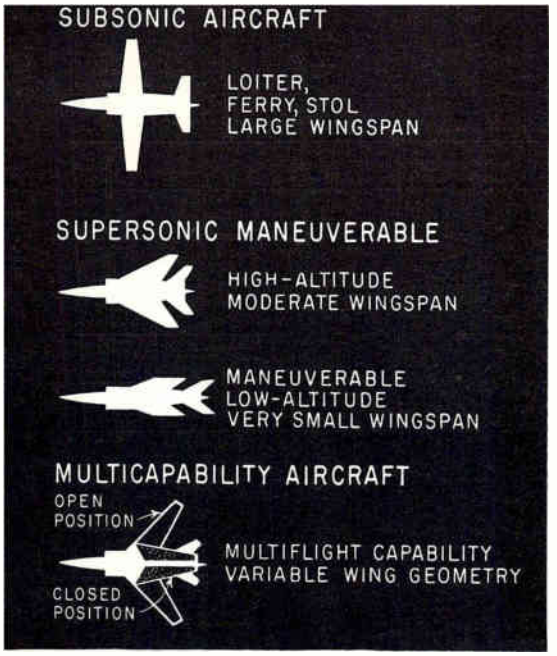


OPTIMUM WING *configurations for various military missions (top 3 sketches) and concept used in TFX fighter to achieve desired range of flight capabilities (bottom sketch). Variable wing geometry employs pivots on wings*

TFX Aircraft Will Use

Electronics for weapons systems will be like that planned for RS-70

By LEON H. DULBERGER
Associate Editor

TFX TACTICAL FIGHTER aircraft contract awarded to industry by DOD will lead to extensive electronics subcontracting not only for the usual airborne electronics, but for special radar, intelligence and missile guidance systems.

The two-man aircraft, will be developed jointly by General Dynamics, in Fort Worth, and Grumman Aircraft Engineering Corp. The initial phase of the contract calls for an expenditure of $1.1 billion for development.

The joint Air Force-Navy fighter will provide an air-to-air missile weapon system for all-weather maintenance of air superiority.

TWO VERSIONS — TFX, which will have a maximum speed of Mach 2.5 or over 1,500 mph under certain conditions, will be built in two versions. One will go to Air Force, the other with modifications for aircraft carrier service, to Navy.

Variable geometry wing, to allow optimum flight performance at various altitudes and under different missions will be used. This is a basic design departure from previous fighter aircraft. The fighter can take off and land on a 3,000 foot runway.

Because of the unusual wing geometry, the TFX, which will become the F-111 when it is operational, will have a ferrying range exceeding 3,500 miles.

Initially, 22 of the fighters will be built for test and evaluation. Successful evaluation will call for

Will Japan Close the Door

Five companies making small and medium types to compete with imports

By CHARLES COHEN
McGraw-Hill World News

TOKYO — Japan's seven digital computer manufacturers say they can now meet domestic requirements for medium and small computers. This declaration is expected to influence sales of American computers in Japan.

The Ministry of International Trade and Industry is restricting the imports of computers. But MITI cannot very well prevent imports of a specific class of computer unless there is an equivalent domestic machine. Otherwise, it can only control imports by varying overall computer imports.

Five of the computers shown at the first Japanese computer show late last month are reported to be directly competitive with IBM's 1401, a best-seller here. Of the 502 computers installed or on order in Japan by the end of July, about 100 are 1401's.

The five Japanese contenders are the Nippon Electric 2230, Toshiba 4200, Fujitsu 241, Oki Electric 5090 and the Hitachi 3010.

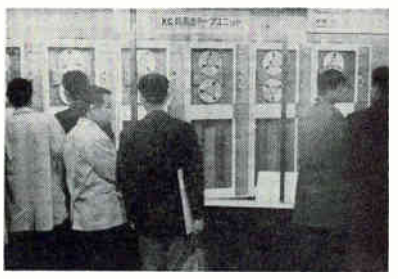
Hitachi's is similar to the RCA 301, but the others are said to be original Japanese designs.

COMPUTER IMPORTS—Attendance at the show was almost 20,000—double pre-show estimates.

Officials of Japan Electronic Computer Co. (JECC, a government-aided company financing computer rentals) said this means that a large number of potential customers realize domestic computers are now competitive with imported ones.

JECC predicts that future sales of imported computers will taper off while domestic computer sales

OKI ELECTRIC'S *5090 computer was one of crowd-pleasers at the show*



TAPE-HANDLING *units of Nippon Electric's 2230 computer. Speed is 90 Kc*

High-Power Radar

1,500 of the aircraft to be built at expenditures totaling roughly $6 billion.

SUBCONTRACTS — Subcontracting on the project will be heavy, some 50 percent of the first billion dollars to be spent will go to firms other than the two prime contractors.

Hughes Aircraft Co., has been chosen to develop an air-to-air TFX missile and fire-control system for Navy use. To date, Air Force is expected to require development of its own missile system for its version of the TFX aircraft. The missiles designed for the TFX will be capable of nuclear-warhead service.

Pratt and Whitney will build the turbofan jet engines for the fighter. Two will be used in the TFX. Other firms which may win subcontracts from the General Dynamics — Grumman team, include: General Electric, Litton Industries and McDonnell Aircraft.

ELECTRONICS—Details of the fighter aircraft's electronics have not been made public, but it will probably carry sophisticated systems similar to those under study for the RS-70, reconnaissance-strike bomber.

Systems for detection, location and identification of targets, and for calculating guidance data will be carried.

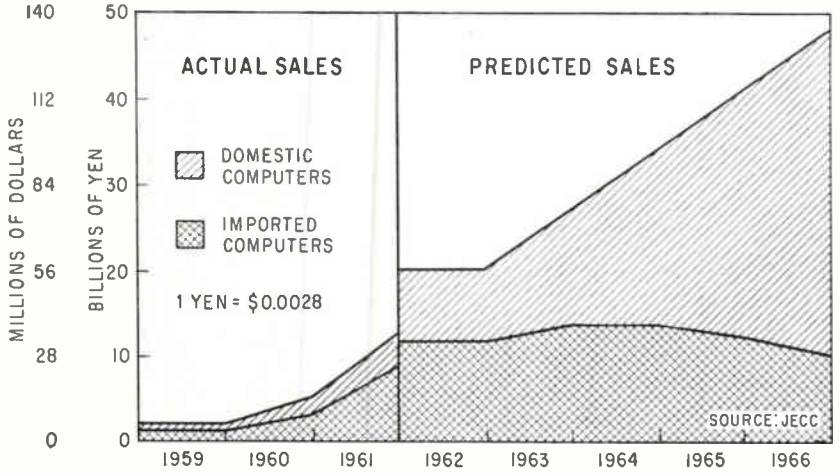
Included will be radar, electro-optical and infrared sensors, and electronic intelligence systems. In-flight computer processing of information, and central display will be provided.

In addition to the advanced design long range missile being developed for primary armament, the TFX will use the now operational Sparrow 3 as secondary armament. The missile control system for the fighter will use a high-power airborne intercept radar.

to Computer Imports?

rise (see graph). Japan's digital computer industry didn't start until four years ago. Even with foreign currency restrictions, American manufacturers have over half the market.

The show was sponsored by the Japan Electronic Industry Development Association and JECC, and was supported by MITI.



JAPANESE PREDICTION *of future computer market: fewer sales of imported systems, greatly increasing sales of domestic computers*

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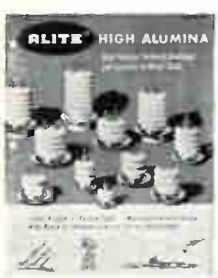

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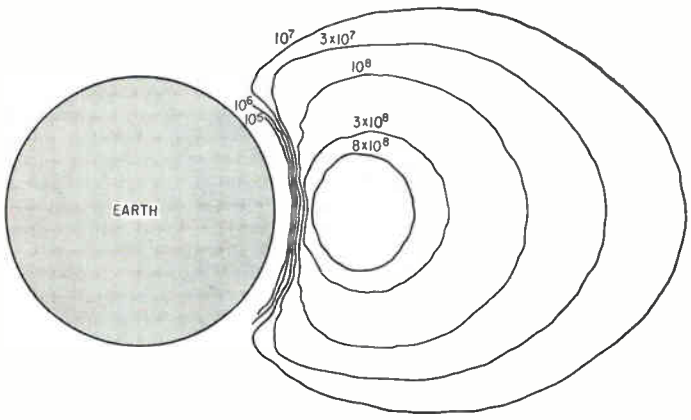
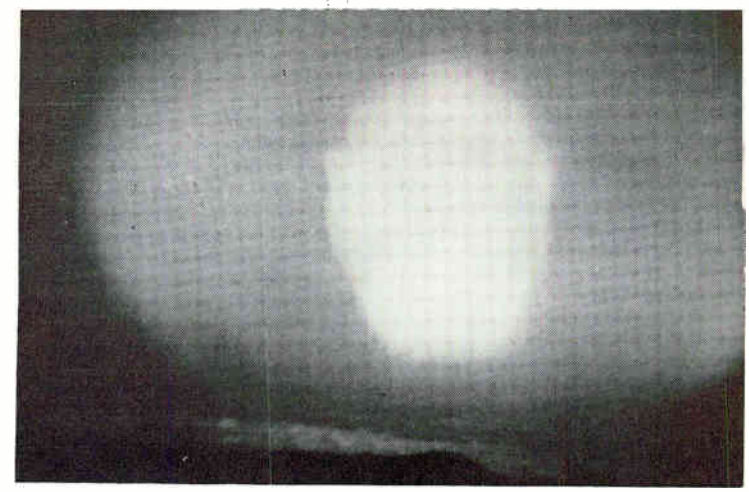


RADIATION BELT *plot indicates flux contours in electrons/cm² in the week after July 9, 1962 explosion*



VIEW FROM HAWAII, *780 miles away, of a high-altitude explosion in 1958*

Is That Radiation Belt Going Away Next Summer, or Isn't It?

Van Allen says it will, but astronomers and others are skeptical

By WARREN KORNBERG
McGraw-Hill World News

THOMAS MAGUIRE
New England Editor

MICHAEL F. WOLFF
Senior Associate Editor

WASHINGTON—Is the artificial radiation belt produced by last July's high-altitude nuclear test disappearing quickly?

James A. Van Allen says it is. Other satellite experimenters and radio astronomers say it isn't. The President's Scientific Advisory Committee (PSAC) is uncertain.

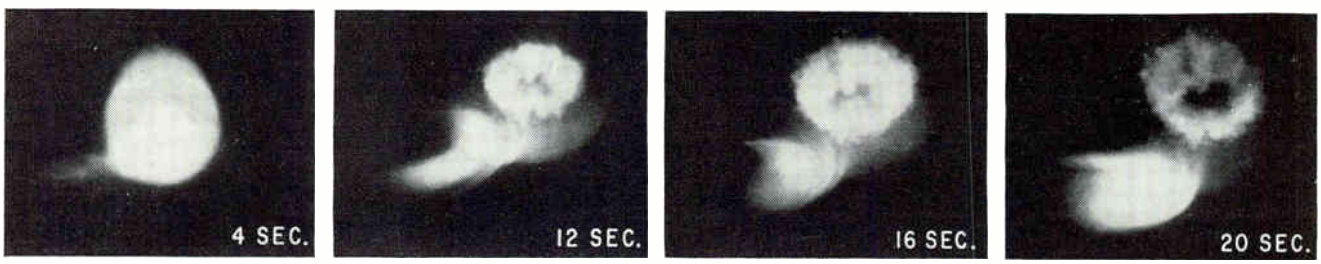
Atomic Energy Commission and Department of Defense had reported that the U. S. nuclear test last summer (ELECTRONICS, p 20, July 20) produced a greater increase in radiation intensity than was anticipated and that it might persist for years. Solar cells on several satellites were damaged (p 27, Sept. 14), halting transmission.

ASTRONOMERS SAY—National Bureau of Standards' radio astronomers at Jicamarca, Peru, initially estimated the life of the belt at 100 months and have seen no reason since to revise the estimate downward.

Their highly sensitive equipment is one of the few radio astronomy operations in the equatorial regions covered by the belt. This area is affected because of the latitude of the July 9 explosion.

To avoid further contamination, the U. S. subsequently reduced the power and altitude of high-altitude tests. Later U. S. and Soviet tests added some contamination, but its geometry is not as well known.

Radio astronomers in the equatorial regions say their searches for weak radio sources in space will be affected by the belt during 40 of the 100 months the belt will be detectable. Increasingly important studies of the polarization of radio star energies will be most radically affected.



ANATOMY OF A NUCLEAR BLAST. *Photos of the July 9, 1962 explosion are not yet available. These show the fireball from 4 through 28 seconds after the blast. Note formation of aurora. Photos were made from plane by Edger-*

HAWAIIAN *night sky glows during the high-altitude explosion July 9*

Effects on radio astronomy are subtle. Strong radio sources will generally come through the noise, which, although reduced, is still a nuisance to some experiments.

Overall, astronomers say no more than 5 to 10 percent of radio astronomy will be troubled, virtually none will be destroyed. All effect is dependent on latitude and a critical band of frequencies between 50 and 100 Mc.

VAN ALLEN SAYS—Recently, Van Allen said the belt was gradually being whittled away (p 7, Nov. 23).

"Within a year from the date of the burst it will be hard to tell that there ever was a belt—it will be undectable by anything we know of," he said.

Characterizing as "complete nonsense" claims reportedly made that the belt would ruin radio astronomy for years, he referred to the "near hysteria" resulting from such reports as "the preliminary and—I think—ill-considered report put out by PSAC."

Van Allen said the Johnston Is-

development of the 1958 Teak ton, Germeshausen & Grier

land tests were planned to explore the military significance of high-altitude tests in jamming communications.

In May 1961, he said, "A group of us were asked by the government to determine if there were any towering objections" from the viewpoint of prejudicing the observation and measurement of natural phenomena, or hazards to life, and so forth."

He wrote in his report about the expected production of artificial belts and perturbation of the natural belt. "I was not wrong by very much in the predictions," he said.

Data on the artificial belt has been received from the Injun satellite, which provided "before and after" data, and Telstar, Explorer XIV, and now Mariner. While there are disagreements over the interpretation of data, Van Allen expressed confidence in that yielded by Injun and summarized: "The actual effects were in accordance with the predicted effects by a factor of two."

PSAC'S OPINION—Neither Van Allen's estimate nor the conflicting one by the ionospheric probers is being bought by PSAC yet. A recent meeting failed to turn up a clear picture.

ELECTRONICS was told the belt is not behaving as expected, but that the basis for expectation was limited. There was almost no thorough study of the natural lower radiation bands and none at all in low sunspot activity periods like the present one.

Phenomena that is not understood includes the uneven decay of both natural and man-made electrons in the lower regions. However, this is not of the kind to cause revisions in the evaluations. It is considered that Van Allen's estimates are more sophisticated since he has time-linked data.

DATA GATHERING—Data are still being gathered from Jicamarca, from an equatorial radio astronomy station operated in Hawaii by the High Altitude Observatory, and from Telstar, Anna, Explorer XV (the experimental satellite launched to probe the belt), Injun, the Defense Atomic Support Agency and other monitoring operations.

Although the data may not be read out for a month or two, indications so far are that the initial estimates were not far off.

NASA SCIENTIST—At an MIT symposium last week, Wilmot Hess, of Goddard Space Flight Center, declined to call Van Allen's statement premature. He said data from Injun, Telstar, Traac and Ariel indicate the number of particles in equatorial regions will only have halved after one year.

"If the particles are gone within a year (after the blast), then something other than atmospheric scattering is going on," he said.

Atmospheric collision can account for loss at low altitudes, but there may be other mechanisms at higher altitudes. There are fission-spectrum electrons near earth, but beyond 1,000 Km particles could be fission or natural.

Air Force has declined to reveal data from an unnamed satellite launched within two months after the blast to measure radiation-belt effects. But some data was privately presented to Hess at the seminar by AF Cambridge Research Labs scientists. Publicly, they said only that the data indicates a high-altitude particle spectrum softer than would be expected from fission particles.

AND FROM ENGLAND . . .

British radio astronomers are standing by their early opinions until data supporting Van Allen's thesis are published.

Sir Bernard Lovell and Martin Ryle told ELECTRONICS they were astounded by Van Allen's statement, claiming they had seen nothing published that would alter their views—expressed before the test—that the nature and life of the Van Allen belt is unpredictable.

They deplore the lack of American data before and after the test, but refuse to take a definite stand until they see Van Allen's data.

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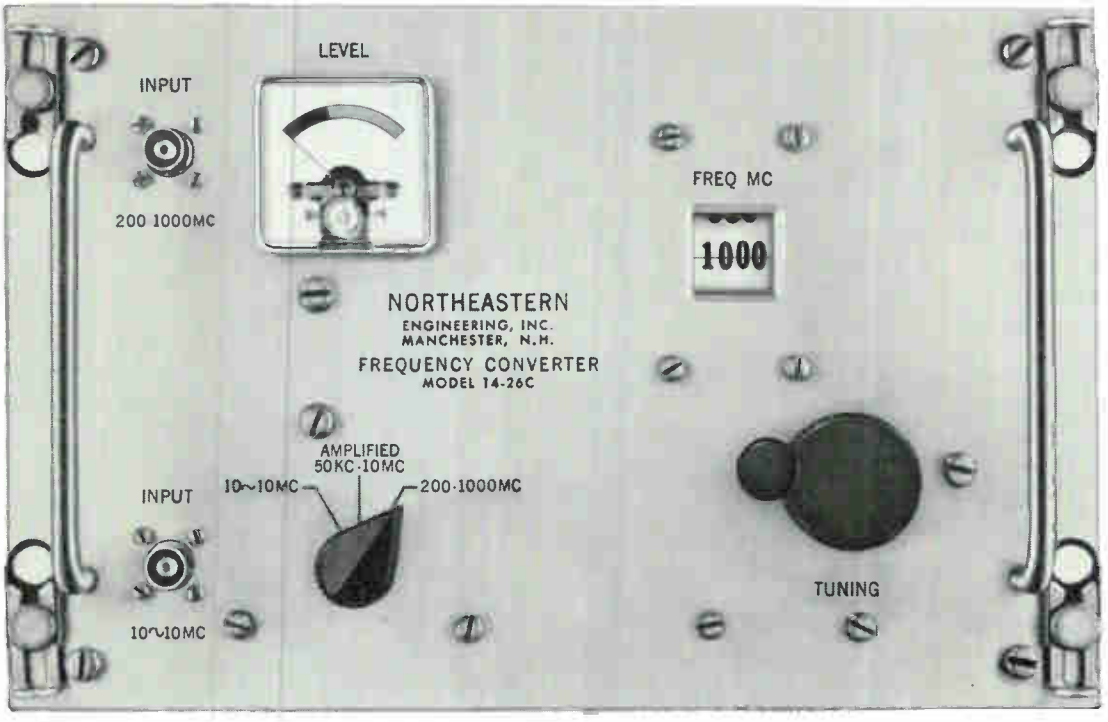

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FAMILY DISPUTE

Executive Committee of the EIA's Consumer Products Division decided at the EIA conference that it will formally oppose a petition by another EIA group.

The Land Mobile Communications Section is asking FCC to reallocate to land-mobile use the frequencies now allocated to uhf-tv channels 14 and 15 (ELECTRONICS, p 7, Oct. 12 and p 18, Nov. 30).

Consumer products people feel there will be more need for those channels for general viewing in years to come and are so informing the FCC

By the time a weapons system is perfected, it could be obsolete

By ED ADDEO
McGraw-Hill World News

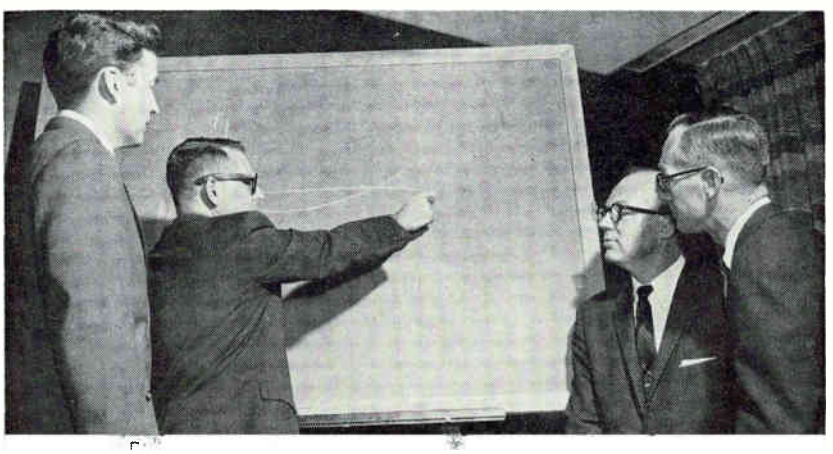
SAN FRANCISCO—When is a good weapons system a bad weapons system?

When it doesn't get built in time, because the developers strive too long for perfection, or when it doesn't do the job for which it was intended.

These are a few of the problems spotlighted at an all-day symposium on "Methodology of Weapons Systems" that kicked off the Electronic Industries Association's Winter Conference here. The panel was the first step in an effort by the EIA Systems Requirements Committee to aid defense electronics producers in improving proficiencies in weapons-system decisions.

WEAPONS SYSTEM *panelists Bernard Sobin, Ernest Mosbaek, E. S. Quade and T. G. Pearson, moderator*

COST-TIME ASPECTS *of weapons system analysis being discussed by T. G. Pearson, Herbert Spiro, Stahrl Edmunds (symposium chairman) and Peter Holman*



TOO MUCH TOO LATE—The panelists indicated agreement that perfection in weapons-system selection is all but impossible, owing to dynamic criteria and constantly shifting emphases and objectives.

Peter Holman, of Systems Development Corp. urged his colleagues to avoid trying to "optimize" or "maximize" military values in selecting weapons systems and to start "satisfizing"—fulfilling minimum needs to "get off the ground" and concentrating later on improvement to an optimum degree.

Bernard Sobin, of the Institute for Defense Analysis, said the world "isn't as simple as analysts would like it to be," adding that only "real-world" problems and considerations could lead to an effective weapons system analysis. He said the usual case is that analysts always try to fit the world to their problems, rather than conversely.

Ernest Mosbaek, Tempo Division, General Electric, agreed with Sobin and added that analytical problem models are essential to accurate weapons systems analyses.

He said the tendency to consolidate important factors often leads to incorrect systems decisions. His example: a water-land weapon system route being consolidated into "mud" for ease of evaluation, and a tank selected as the best weapon. What happens when the tank tries to cross the water, the "real-world" factor the analysts consolidated?

ANALYSIS STEPS—Herbert Spiro, Douglas Aircraft Co., outlined five steps in analyzing a weapons system decision:

- Threat determination
- Description of environment
- Definition of objectives
- Outline of operational concepts
- Specification of tools with

Planners

which the system will operate.

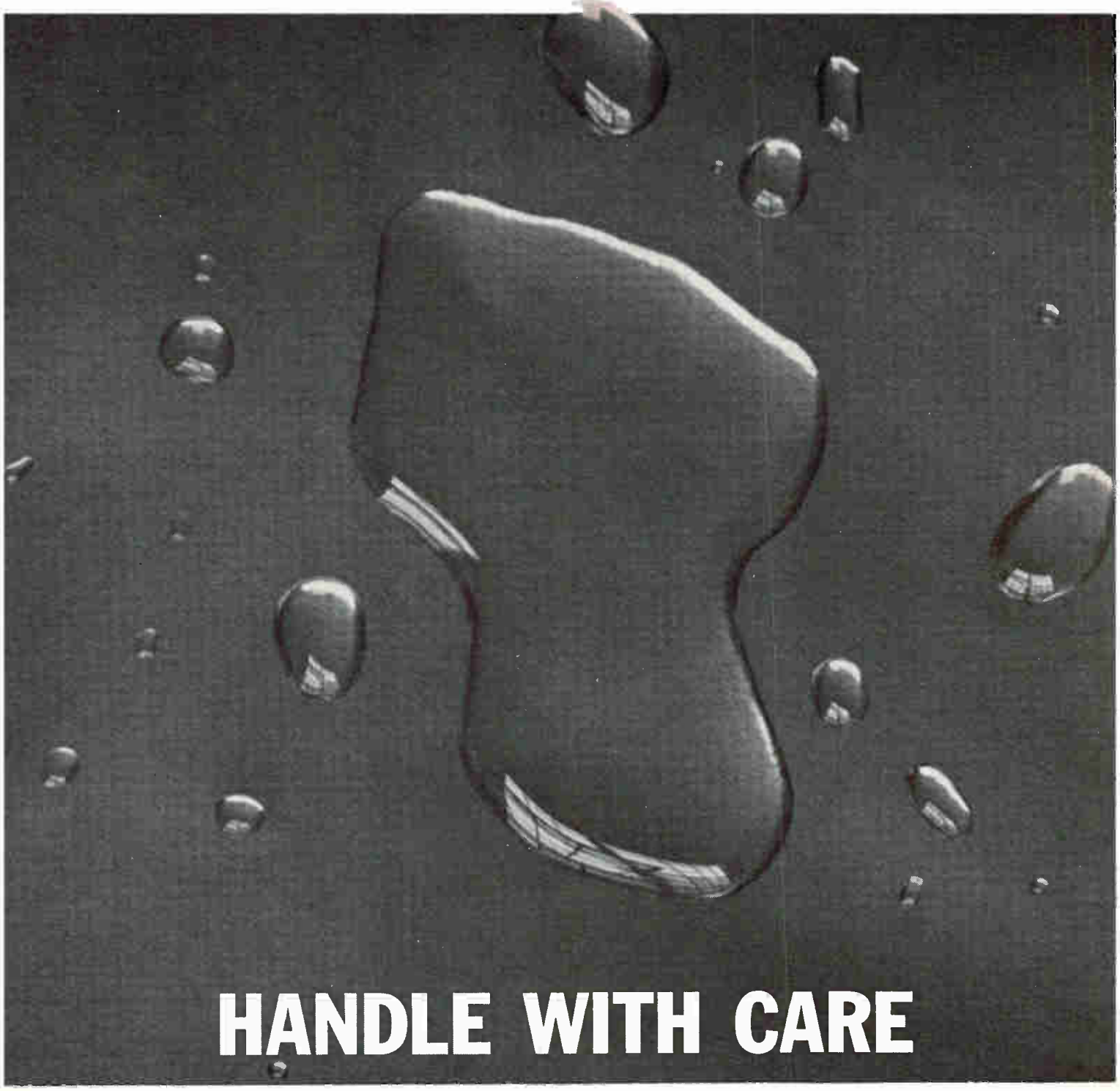
E. S. Quade, of the Rand Corp., noted some pitfalls of the analysis approach to deciding on a weapons system, saying that no analyst should assume what the enemy will do. Instead, he should consider every possible alternative even before the analysis begins. He said erroneous or inefficient objectives often cost time and money.

Security restrictions prevented the panelists from citing specific examples of the analysis approach, but Quade recalled a World War II bomber gunnery problem. By the time it was solved, the problem was obsolete because the enemy was no longer shooting back with conventional weapons.

Significance of the symposium was stressed by T. G. Pearson, Marquardt Corp. He said weapons-system predictions have been about 37 percent off in the past. That figure could be drastically reduced with more proficient decision-making.

OTHER EVENTS—Other news at the three-day conference:

- Unofficial talk at receptions and lunches that prices of conventional semiconductor devices still have a slight way to go before they bottom out. Most officials were reticent on the price subject, but some offered opinions that prices were on a momentary plateau after the steady decline of past years.
- Proposal by the EIA Parts Division to protest publication, by the Defense Department's Interservice Data Exchange Program, of manufacturers' failure to meet DOD testing standards. Many manufacturers feel that their own testing standards and procedures are more efficient than DOD's. They apparently fear some potential customers will be scared off by IDEP, when actually the parts may pass vendor's higher standards with flying colors.
- Talk on the DOD's program for stimulation of overseas sale of U. S. defense electronics products, by James Dunlap. Sales to foreign countries by 1965 are expected to be more than $10 billion.



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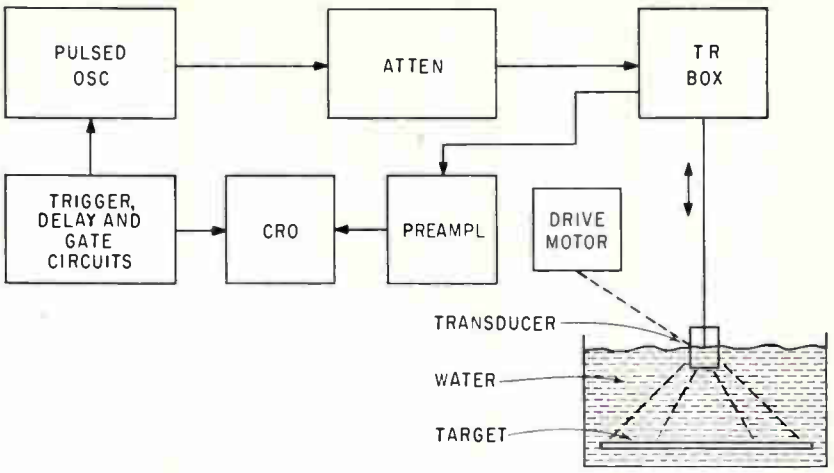


ACOUSTIC SYSTEM *is a small-scale simulator of radar altimeter*

Garnet Simplifies Preselector

Ferrite in cavity electronically tunes L-band receiver

KANSAS CITY—There's a simpler way to tune up the front end of small, multichannel receivers—use ferrite preselectors, said one speaker at the Mid America Electronics Conference here.

Building the preselector around a garnet bead, as illustrated, makes it electronically tunable, reported Guy Gooch, of Wilcox Electric. The device is tuned by varying the strength of a magnetic field coupled to the bead by orthogonal loop coax cable terminals. Insertion losses are 4 to 9 db.

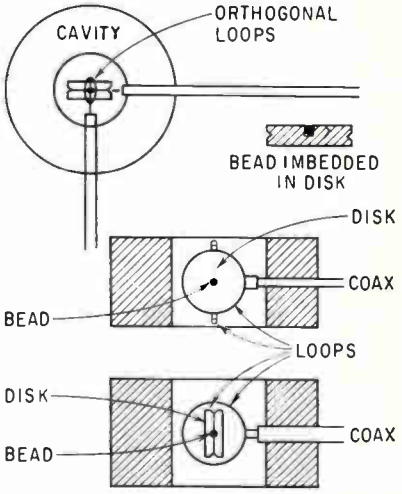
Beads are polished 0.02 to 0.05-inch spheres of single-crystal, yttrium-gallium-iron garnet. During a feasibility study at the University of Kansas, it was found that substituting 15 percent gallium for yttrium in garnet lowered its resonant frequency from S-band to L-band.

The preselector operates at L-band. Gooch suggested substituting other materials to produce spheres resonating at other frequency ranges.

The bead's resonant frequency shifts 4½ Mc/deg C—a range of 850 to 1,200 Mc over 20 C to 60 C. A crystal oven would probably be the best control over this, he said. Feedback sensors would probably distort the magnetic field.

RADAR SIMULATOR—A shortcut for radar altimeter designers was described by R. K. Moore, University of Kansas. He put a 1-Mc acoustic transducer in a tank of water, then scaled down system parameters to correspond to the frequency change.

For example, returns from a 400-Mc radar at 20-Km altitude can be simulated by acoustic propagation through 6 feet of water. At this scale, plywood looks like ocean or desert, sand is like farmland or a forest depending on sand density, and wrinkle paint the moon.



RESONANT *frequency is varied in preselector by varying strength of magnetic field*

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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.

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

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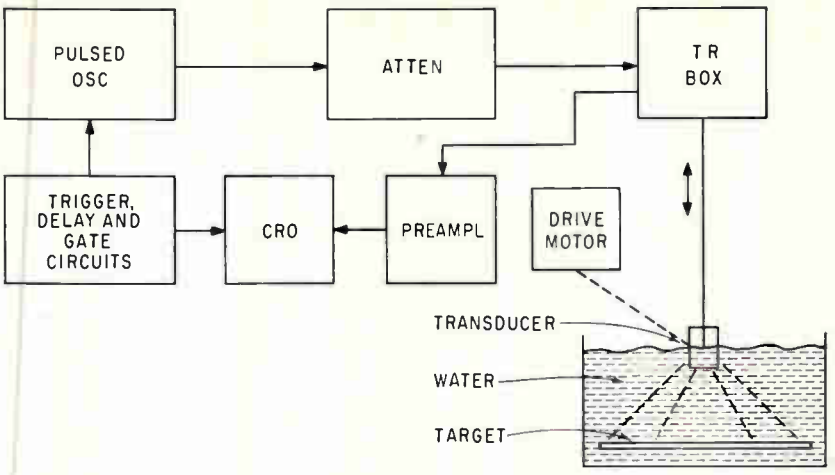
OHIO VALLEY INSTRUMENT-AUTOMATION SYMPOSIUM, ISA, et al; Cincinnati Gardens, Cincinnati, Ohio, April 16-17.

ADVANCE REPORT

NATIONAL TELEMETERING CONFERENCE, IRE-PGSET, AIEE, *et al; Hilton Hotel, Albuquerque, N. M., May 20-23, 1963. Feb. 1 is the deadline for submitting papers to: T. J. Hoban, NTC Program Chairman, Sandia Corp., P. O. Box 5800, Albuquerque, N. M. Papers are being sought jointly for the International Telemetering Symposium to be held in London, England from Sept. 24-27. The conference will stress telemetering achievements in four fields: industry, biomedicine, aerospace and oceanography.*



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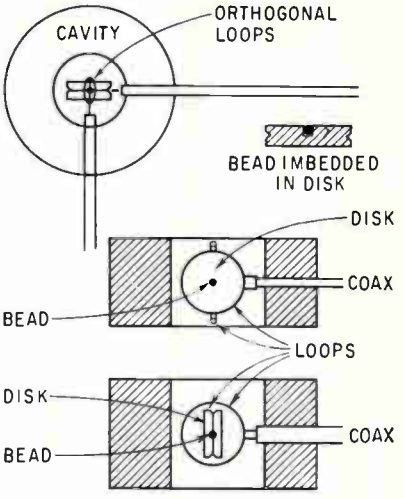

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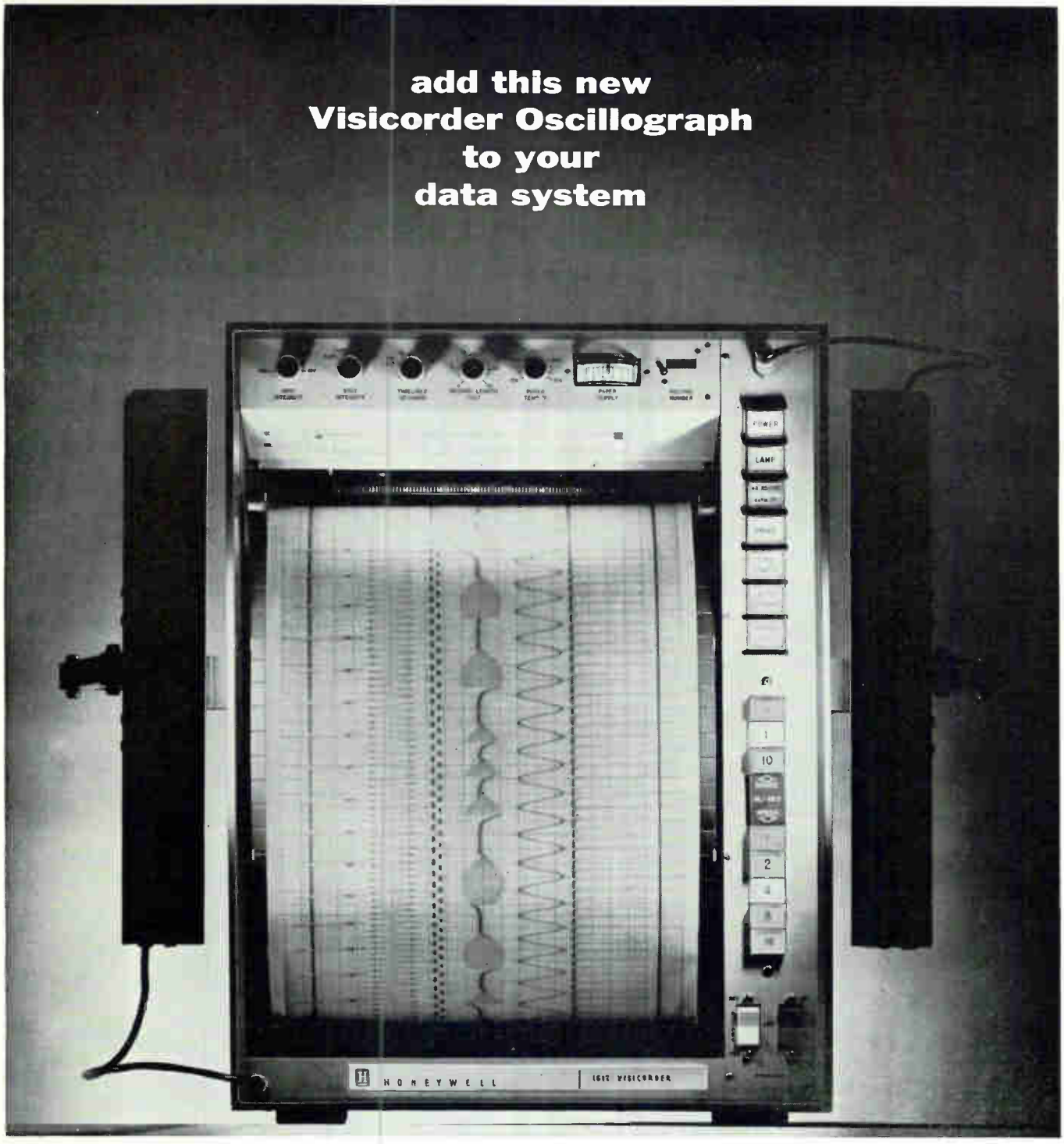

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ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

electronics

December 14, 1962

Sunflower Optics:

A New Concept in Color TV Display

Projection system uses inexpensive components to achieve low-cost home receiver with high luminance output. Plastic corrector plate minimizes keystone and pincushion distortion

By J. H. OWEN HARRIES, Harries Electronics Corp. Ltd., Bermuda

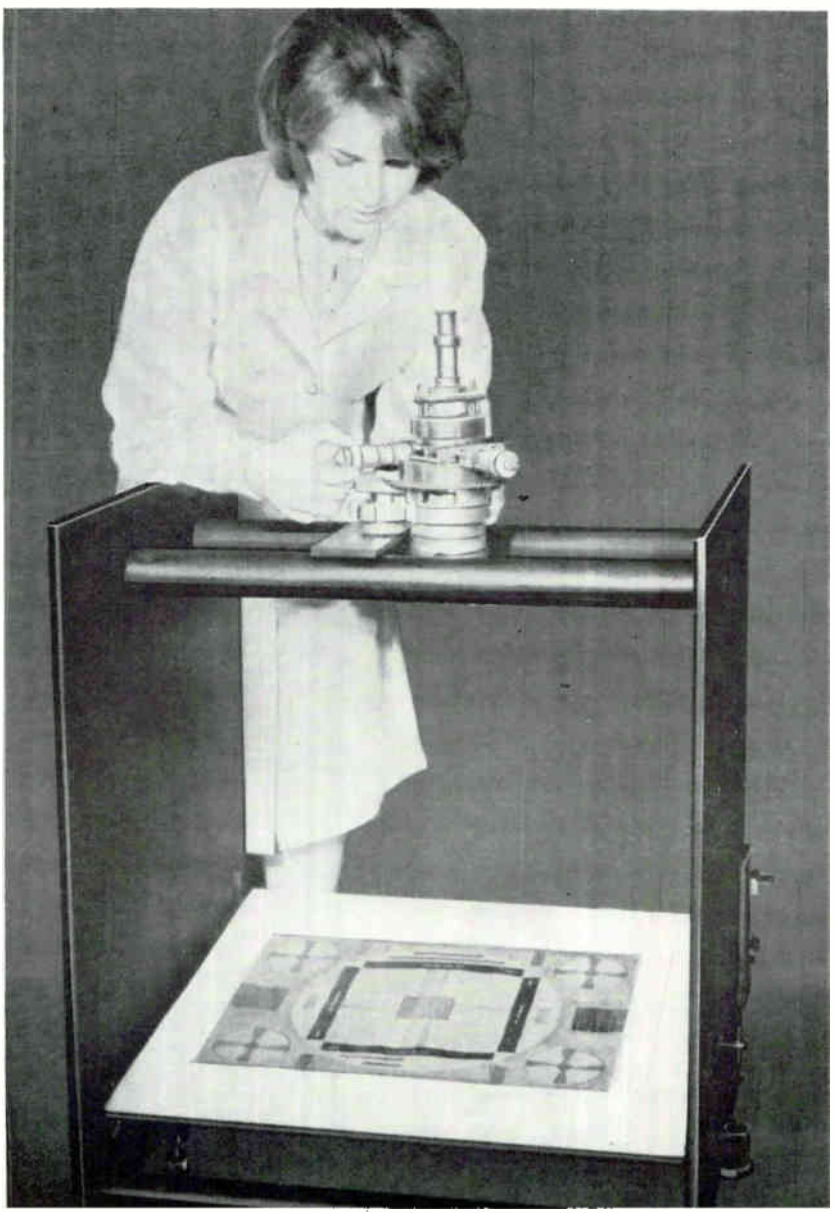
ALTHOUGH THE AMERICAN color television system is a technological triumph, present-day color television receivers are relatively expensive and technically complex.

There is a need for a color receiver of good performance that can be produced at a lower price for the mass market. The problem cannot be solved by lowering the cost at the expense of picture quality.

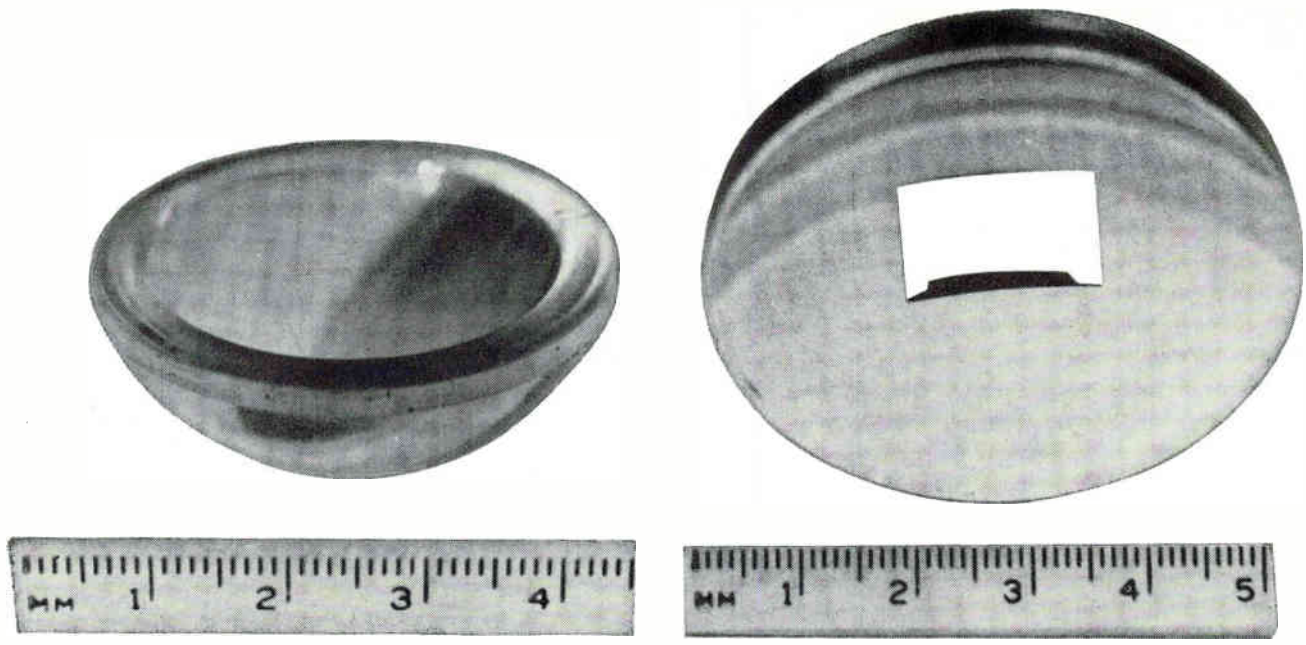
This article describes key features of a new color television receiver design that fully utilizes the capability of the National Television Systems Committee color transmission system, and one that can attain the low-cost objective if produced in large quantities.

CHOICE OF DISPLAY—A basic question in tv receiver design is whether to use a direct-viewed or projection-type display.

During the past ten years, much development effort has been expended on direct-viewed color tube displays. The aperture mask and "Apple" displays are among these.[1, 2, 3, 4] High cost appears to be inherent to direct-viewing in color because the synchronous selec-



OPTICAL BENCH SETUP *tests registration capability of a sunflower lens corrector*



ADDITIONAL KEY COMPONENTS *in the optical system of the receiver are the injection-molded acrylic plastic meniscus (left), and a glass aluminized spherical mirror*

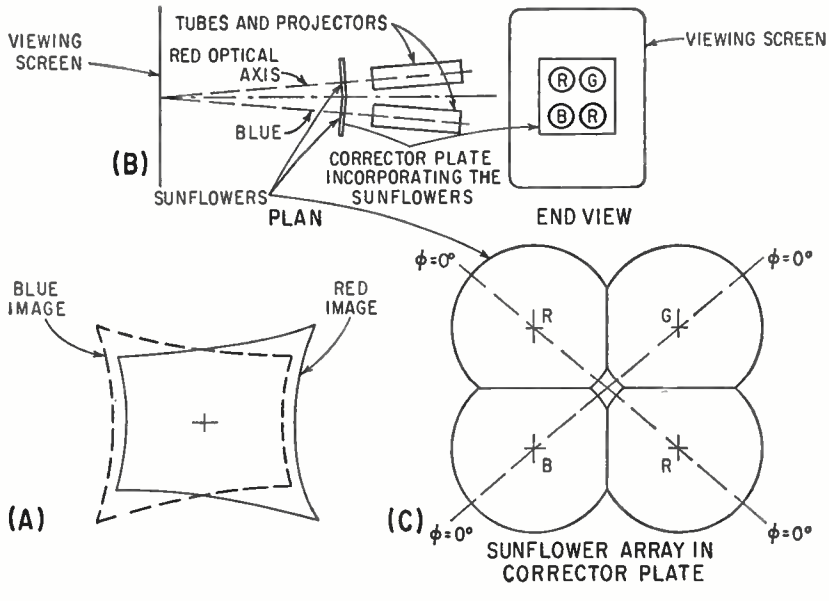
CAN COLOR TV COST BE HALVED?

Author Harries believes that the manufacturing cost of his new color projection receiver should be no more than $31 higher than for monochrome sets. His hope for a potential retail market price of $300 for a four-projection-tube-color receiver, and $200 for an economy design using only three such tubes, is based in part on the following estimates:

1. The sunflower corrector, heart of the receiver design, 50 cents.
2. Total cost of the optical system, about $6.00.
3. Manufacturing cost of all four color tubes, $20.

The above estimates assume mass production quantities.

Author Harries has been a pioneer in television since 1928. Among his accomplishments were a published analysis of the bandwidth requirements of commercial television, and a patent on a beam power output tetrode tube first produced in 1932.

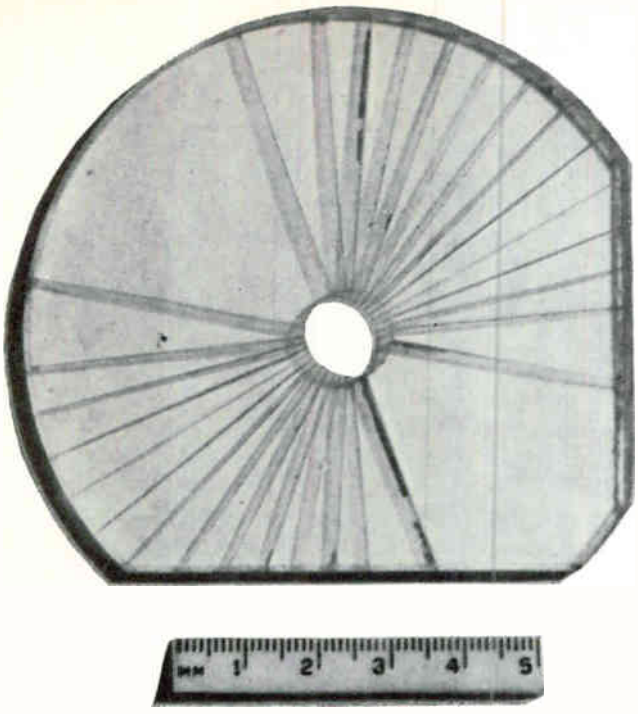


tion of nearly 10^6 red, blue and green phosphor dots or strips per picture (nearly 30×10^6 dots or strips per second) requires elaborate equipment.

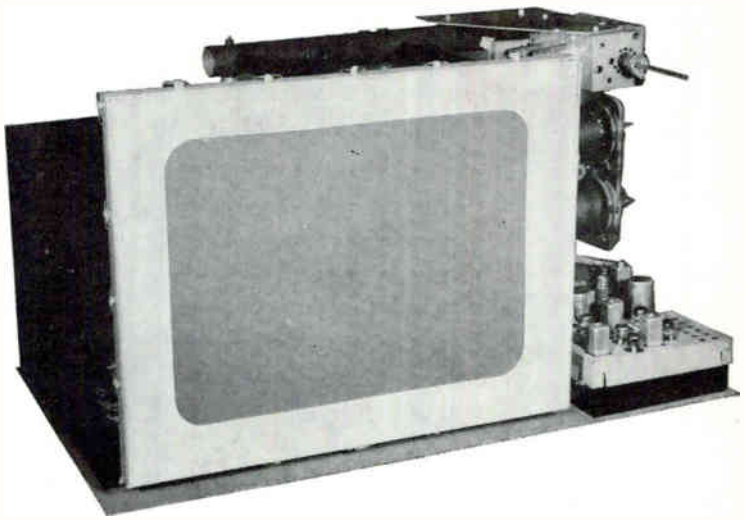
On the other hand, projection color displays have so far been even more costly than direct-viewed displays.[5, 6, 7] Also, because the phosphor is conventionally viewed by an optical system on the opposite side of that scanned by the electron beam within the color tube, a typical loss in luminance of about a third occurs, with attendant loss of contrast. Furthermore, a commercial quality faceplate is usually positioned near the focal plane of the optical system, resulting in optical errors of registration. A glass faceplate is a poor heat sink, and a further luminance loss accurs (sometimes as much as 50 percent) from phosphor over-heating. In c nventional projection displays, a Schmidt mirror optical system is commonly used. The bulky projection tube itself obscures much of the illumination.[5]

A major problem of color projec-

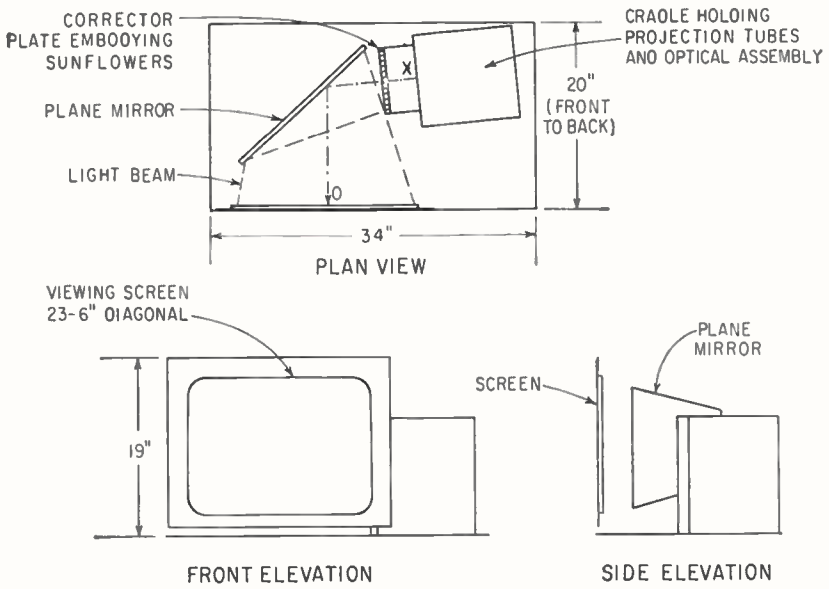
EXAGGERATED FOR CLARITY, *sketch (A) shows keystone and pincushion effects on color registration in early projection system. Schematic diagram of new optical system (B) indicates how sunflower corrector plate (C) removes keystone pincushion and other geometrical distortion, positioning the red, blue and green images in registration—FIG. 1*



A SUNFLOWER *distortion corrector. Unit is injection molded from acrylic plastic*



LAYOUT AND DIMENSIONS *of the prototype receiver (below). The photo above is of the prototype model— FIG. 2*



tion has been the registration of the red, blue and green images. It was almost impossible to make the throw of the projector short enough for the home receiver to fit into an acceptably small cabinet space. Even moderate viewing screen luminance (typically 15 foot-lamberts or less) could only be obtained by using a high "gain" viewing screen with an objectionably narrow viewing angle. Early viewing screens often exhibited a hot spot where unfocused light from the projectors was visible.

Recent investigation shows that the high cost, low picture luminance, unreliability and other defects of old projection displays are not inherent to the principle of projection. Picture quality can approach the limits imposed on the transmission system, and this fact alone justifies careful reexamination of the basic projection display characteristics.

If improvements in the areas of luminance and color registration could be made, competitive technical performance at low price might be achieved with projection type displays. Thus, a projection system was chosen as the basis of the new color receiver design.

REGISTRATION PROBLEMS— Projection displays use superimposition of the red, blue and green images in registration at the viewing screen. The color images must be projected along axes which are not normal to the viewing screen. This produces keystone distortion. The projectors must have large numerical apertures (NA) and this tends additionally to produce a type of distortion known as the "pincushion" effect. The red, blue and green images will not superimpose in register (Fig. 1A) unless these distortions are corrected.

In some color projectors the distance (throw) between the projectors and screen is relatively large compared with the screen diagonal dimension. This minimizes keystone distortion, and what remains is cancelled by pre-distorting the scanning waveforms. A typical pre-distorting circuit requires vacuum tube or transistor amplifiers in a network interconnecting the line and frame scans.[7] Operating adjustments are complicated and subject to drift. The pre-distorted, scanning wave shape is non-linear. It needs to be stable and accurate within about 0.1 percent in amplitude/time relationships. The cost of cancelling the keystone distortion in this way is considerable.

A home receiver must be in a cabinet of moderate size. This calls for a throw of the projectors which

COMPARING LUMINANCE IN PROJECTION AND DIRECT-VIEW DISPLAYS

The effective luminance at the screen of a monochrome projection display is

$$L'_p = \frac{\pi \eta P_b T G S}{4 F^2 A'} \left(\frac{m}{m+1}\right)^2 \quad (1)$$

where A' is the area of the screen, P_b is the power input to the phosphor, η is the phosphor efficiency, G is the screen gain, F is the F-number of the lens, m is the optical magnification of the projector, T is the transmission of the optical system, and S is the saturation of the phosphors. S is less than unity, typically 0.7 to 0.8 at full luminance.

The bracketed term in m tends to unity as m tends to infinity. When $m = 5$ (as in old home projection receivers), the bracketed term is 0.694; when $m = 30$, this term is 0.937.

The corresponding expression for the luminance of a direct-viewed display is

$$L_d = \frac{\eta P_b T_N}{A_d} \quad (2)$$

where A_d is the picture area and T_N is the transmission of the neutral density filter.

In a projection display F^2 can readily have a value approaching unity. If m is about 30 (as in the new projection display), the bracketed term is nearly unity. S can be taken conservatively as 0.8. T_N tends to equal T. Using equal picture areas $A' = A_d$, and equal power inputs P_b to the same phosphor, the ratio between the screen luminances of both type displays is then approximately

$$\frac{L'_p}{L_d} = \frac{\pi G S}{4} \quad (3)$$

A satisfactory viewing screen (60-deg viewing angle) has G = 2.4. The ratio of luminances is thus 1.5 in favor of projection.

The same result is obtained for color displays by substituting the combined "white" luminance efficiency η_w for η in equation (1).

$$\eta_w = \frac{KS}{\frac{f_R}{\eta_R} + \frac{f_B}{\eta_B} + \frac{f_G}{\eta_G}} \quad (4)$$

where f_i denotes the lumen contribution of each color, and the lumen efficiency of each color phosphor is denoted by η_i (i = R,G,B). K is about 0.9 and represents the loss of phosphor efficiency in tube manufacture. The sum P_{bw} of the power inputs to each color phosphor is substituted for P_b in Eq. (1)

---

is about equal to the diagonal dimension of the screen (23 inches). The angle between the normal to the screen and the axes of the red, blue and green projectors is then so great that keystone and pin-cushion distortion become accentuated.

SUNFLOWER CORRECTOR—An essential feature of the new color receiver design is an optical distortion corrector. The corrector developed for this receiver is an injection molded, faceted, plastic plate called a "sunflower". It is an element new to the optical art. The sunflower corrects keystone, pincushion, and all other geometrical distortions of the red, blue and green images, and positions them in register at the screen.

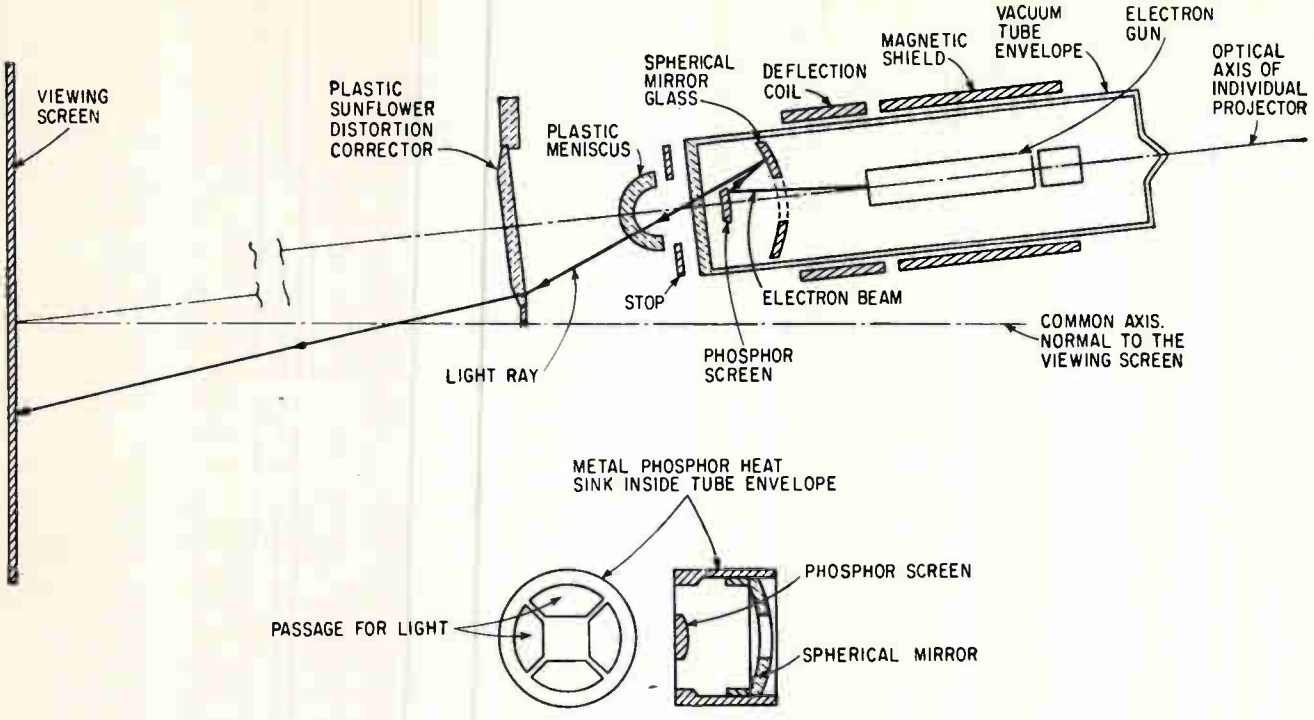
As shown schematically in Fig. 1B, the sunflower is positioned between the viewing screen and the projector. It is mounted as an integral unit with the projection tubes, projection optics and viewing screen. These components are locked in position mechanically so that drift is avoided.

The sunflower concept depends on the fact that any principal ray (travelling from the projection tube and projection optics to the viewing screen) can be bent, and its point of contact with the screen corrected, by passing through an appropriately angular, lens-like, refracting surface. The NTSC system requires in theory that the point of contact of each ray at the viewing screen be positioned within a 0.3 mm diameter circle for a 23.6-in. diagonal viewing screen. This tolerance is probably unduly severe at normal viewing distances, but was used in prototype sunflower design nevertheless. From the optical engineering stand-point, it is an easy tolerance to meet; however, although a single principal ray can be corrected in this way, a fundamental problem arises when the positions of all possible rays must be corrected over the entire picture area. It can be shown that the slope $f(x,y,z)$ of the entire refractive corrector surface must satisfy a differential equation of the form $\partial z/\partial x = Cy^2$ and $\partial z/\partial y = Cxy$, where C = constant.

This equation is a mathematical proof that no continuous corrector or lens-like surface can exist with the property of correcting keystone distortion. On the other hand a discontinuous or faceted surface would be rejected for conventional optics owing to its unacceptable degradation of picture definition. But the definition of an NTSC picture is low when compared with conventional optics and the required NTSC bandwidth is narrow. After an extended experimental and mathematical program, it has been found possible to satisfactorily minimize the image degradation of a faceted surface by using proper shapes and positions of the facets. The refracting angle of each facet is chosen to correct the position of the bundle of rays which passes through it. The degradation of the picture though too severe for conventional optics, can be made to fit the bandwidth of NTSC color television.

The definition of an NTSC color television picture is about 350 lines vertically and 280 lines horizontally[6]. A sunflower optical projection system, including the spherical mirror and meniscus, has a measured definition over the greater part of the 23.6 inches diagonal picture area in excess of 500 lines, falling to around 300 in the extreme corners. This is a prototype result, which can be adjusted as required.

A typical receiver layout is shown in Fig. 2; a prototype model is also shown photographically. The space needed inside the cabinet is



COMPONENT PARTS *of an individual color projector. The path of a light ray is shown from the phosphor to the viewing screen. The ray is refracted at the sunflower to correct distortion. The phosphor screen is on a metal mount in a cup which acts as a heat sink—FIG. 3*

20 inches front to back, 34 inches wide, and 19 inches high. The weight of the prototype sunflower display itself is 38 lbs. As a comparison, the cabinet space required by a typical aperture mask receiver is 26.5 inches front to back, 26 inches wide and 26 inches high. The display weight alone is 51 lbs.

Figure 3 shows schematically the components of a projection tube, optical projector, sunflower and screen. A low-cost, injection molded plastics meniscus corrects aberrations of the spherical mirror. It takes the place of a costly Schmidt corrector plate. The meniscus has sufficient definition to fit the bandwidth of the NTSC color system.

Registration is no longer a problem because the correction of keystone and pincushion distortion is done optically by bending the light rays at the sunflower surface. It is then only necessary to hold the viewing screen, sunflower, meniscus and tube faceplate (to which the internal phosphor and spherical mirror are fastened), in their correct relative positions in a rigid cradle. A typical positional tolerance is an easily attained ± 0.015 inch. To adjust raster size and rotary alignment, the deflection coils are rotated and moved along the optical axis. The coils are then locked mechanically in position. Electronic shifts are provided for final adjustments of the rasters.

LUMINANCE—It can be shown that, for the same picture size and same power input to the phosphor, the ratio between the inherent picture luminance of a projection display and the luminance of a direct-viewed display can typically be as much as 1.5 in favor of the projection display (see box). A viewing screen gain $G = 2.4$ is assumed. The low luminance of old projection color displays is not inherent in the projection principle. The equations show that the magnification m of the projectors should not be low; that is, the phosphors should be small.

The diagonal dimension of the viewing screen in the new receiver is 23.6 inches. Optical magnification m is about 28.4, and this leads to a 0.5 × 0.7 inch phosphor screen in each of the new color projection tubes developed for the receiver.

The light from each phosphor screen is collected by a spherical mirror and projected towards the viewing screen (Fig. 3). The cost of spherical projection mirrors was one of the major causes of the objectionably high cost of the old projection displays. In the new receiver, however, the small phosphor screen areas enable correspondingly small spherical mirrors (2 inches diameter) to be used, with a resultant cost reduction. The definition (bandwidth) produced by various manufacturing methods was compared with that required by the NTSC system. The final choice from a study of many samples is an aluminized glass mirror of considerably higher definition than is required for the NTSC picture.

The spherical mirror and the phosphor screen are pre-focused, and positioned inside the vacuum envelope of the new tube. The electron gun is of fairly conventional design. The tubes are electrostaticaly focused and magnetically deflected. They are approximately 12 inches long by 2.5 inches at maximum diameter. These tubes are small enough to be sealed, exhausted and processed on compact high-speed rotary machinery.

The potentially low unit cost of each of the projection tubes enables two red tubes to be used economically in the receiver as well as a green and a blue tube. The use of two red tubes approximately doubles the available luminance.

The spherical mirror and phos-

phor screen are positioned (Fig. 3) so that the optical system views the phosphor screen at the same side as is scanned by the electron beam. Special phosphor techniques have been developed to produce a luminance efficiency of the phosphor layer of 90 percent of the intrinsic luminance efficiency of the phosphor.

A rear-projection viewing screen, recently made available, is used. Experiments with several observers have established that an on-axis "white" luminance of around 60 to 70 foot-lamberts yields satisfactory viewing positions up to at least 60 degrees from the normal. Unlike the faceplate of a direct-viewed tube, this screen does not reflect room lights and windows.

For a theoretically perfectly diffusing screen (G = 1.0), the ratio between phosphor and screen luminance is about 2,000 for the optical system used in the prototype receiver. The on-axis luminance for the actual screen (G = 2.4) can thus be expressed as

$$L' = \frac{\eta_w P_{bw} G}{2{,}000\, A} \text{ (foot-lamberts)}$$

where G, η_w and P_{bw} have the meanings given in the box and A is the phosphor area in square feet.

In a typical prototype display, a total full drive power input P_{bw} of 18.5 watts was used for full drive "white", with this full drive power distributed almost equally between the four color phosphors (R,R,G,B). $G = 2.4$. Several combinations of phosphors are possible, but a typical combination has a "white" luminance efficiency η_w of about 8 lumens/watt at full drive.

Substitution of these values in the above equation shows that the required full drive "white" on-axis luminance of about 70 foot-lamberts is obtained. This is confirmed by measurements.

The mean input wattage to each of the most heavily loaded of the four phosphors can be taken as about one third to one half of the full drive value; namely, about 1.5 to 2.5 mean watts to each phosphor. The 0.5 × 0.7 inch phosphors are each mounted on a metal backing which is connected to a radiating surface of about 9½ square inches. The metal backing has only a very small temperature rise above ambient at the power dissipations specified. No over-heating of the phosphors occurs.

CIRCUITS—The receiver circuitry is essentially the same as a conventional black and white receiver plus chrominance channels. A protected 50-Kv high voltage supply design has been produced. Commonly used television rectifier tubes have too low a peak inverse rating to be economic at this voltage. Therefore a new rectifier diode 1029G was made. Partly by using electrode surfaces subjected to super-clean processes, this tube has a higher rated peak inverse voltage.[9] It is operated in the power supply at less than 40 Kv peak inverse.

If only one red projection tube is used instead of two, the resulting three-projector-tube receiver has an on-axis picture luminance of about 24 foot-lamberts with a 19-in. diagonal picture. A 25-Kv power supply is used instead of a 50-Kv supply. The on-axis luminance of 24 foot-lamberts is adequate if the receiver is not operated in a strong ambient illumination.

If larger projection tubes are used, with phosphor screens of twice the area of those described earlier, and using an appropriate sunflower array, it is possible to design a receiver with either about 120 foot-lamberts with 23.6 inches diagonal picture, or 60 foot-lamberts with a 33 inches diagonal picture.

The inherent ruggedness, light weight, compactness, and economy also justify further exploration of the application of sunflower displays for multi-color radar and navigational equipment.

W. T. Welford of Imperial College, London, was consultant on the optical problems and design. Acknowledgements are due to A. F. Amos, F. J. Amos, D. F. Fetigan, C. M. Munford, A. J. Payton and A. R. Seymour, who contributed in their respective departments to vacuum tubes, mathematical computation, optical parts, instruments and tool-making, and circuit and system engineering.

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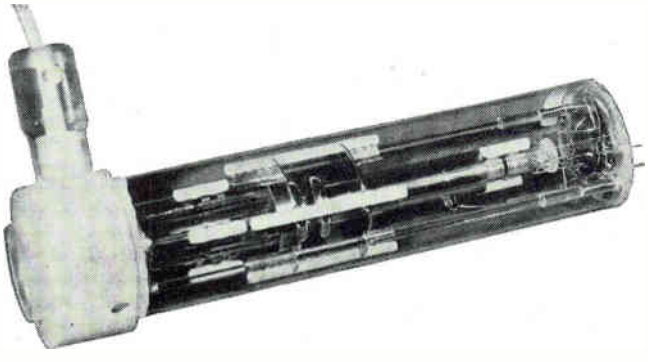
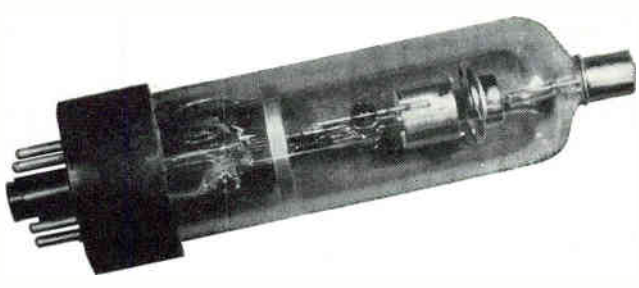


PROTOTYPE PICTURE TUBE *is 12 inches long, is intended for production using high-speed rotary machinery. Four are required for high luminance, although a three-tube model has been satisfactory in low ambient light*



HIGH VOLTAGE DIODE (1029G) *developed for new receiver. Principally because of super-clean electrode surfaces, this diode is rated at peak inverse voltages higher than conventional television high-voltage types*

KEY TO FASTER COMPUTERS:

TEN-NANOSECOND AMPLIFIER

This broadband amplifier can be used as a pulse reshaper with only three-nanosecond delay, as a gate or as a driver for eight 75-ohm lines. Input impedance is 75 ohms

By KENNETH H. KONKLE and JOHN E. LAYNOR
Lincoln Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

THIS AMPLIFIER, used as a building block in MIT's 50-megapulse computer—handles pulses of 10-nanosecond duration and combines the independent output typical of saturated circuits, with the fast turn-on time typical of non-saturated circuits.

The amplifier output impedance is matched to 75-ohm strip or coaxial transmission line to avoid crosstalk and mismatch losses; thus, transit time between amplifiers can be accurately predicted.

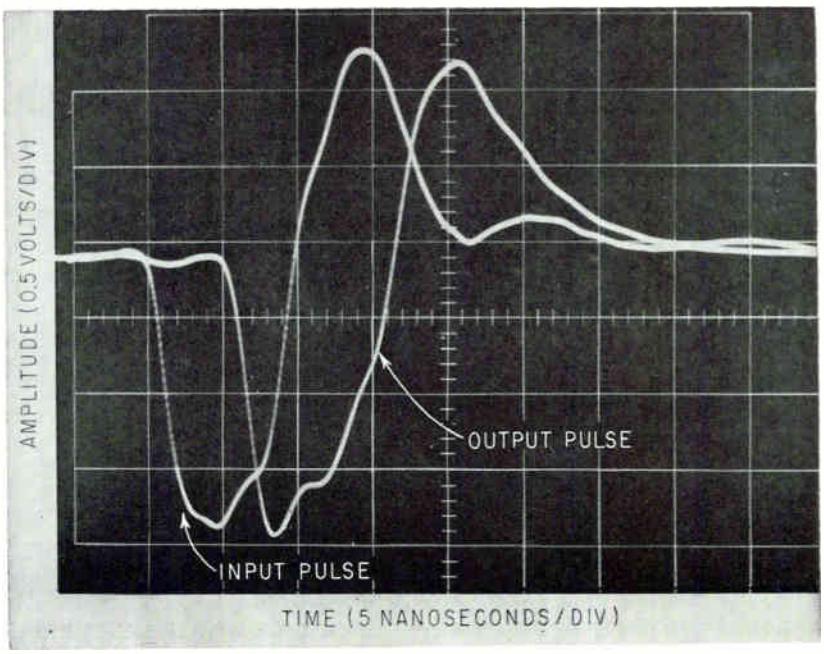
Modified versions of the basic pulse amplifier operate either as logic gates or drivers. Typical set-up time for the gates is 7 nanosec-

COMPUTER SECRETS

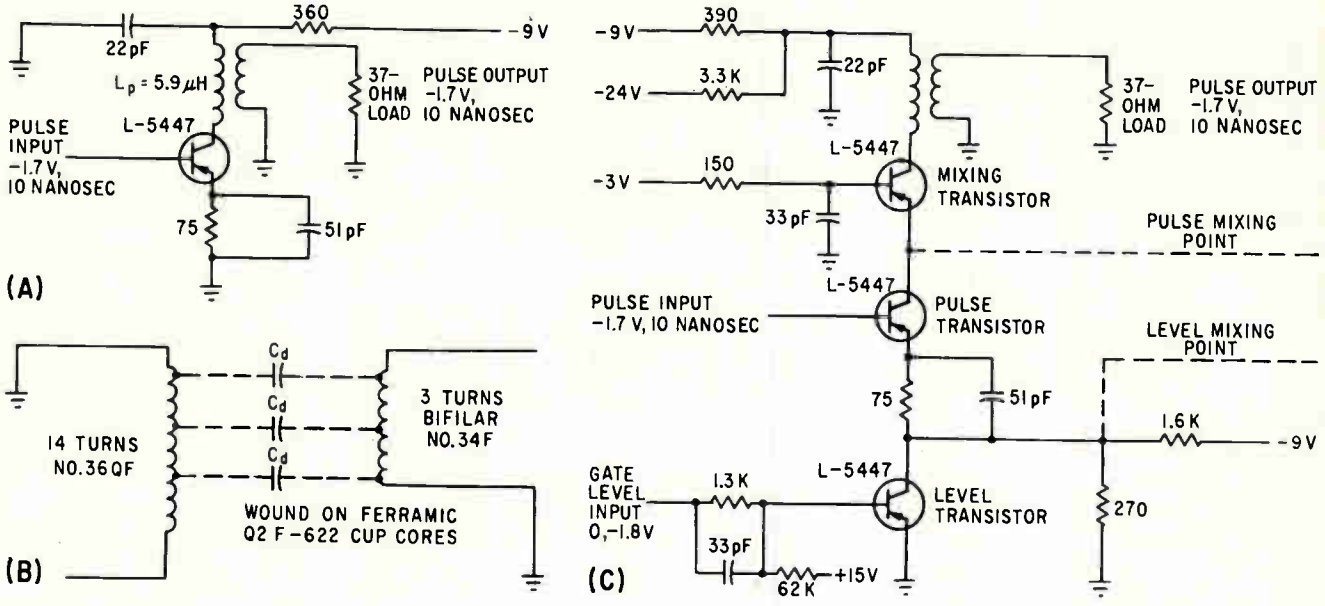
Faster digital computers require high-speed circuits and shorter distances between circuits because the time a pulse travels two gates is now comparable to the delay time of the gates.

MIT's Lincoln Laboratory's 50-megapulse computer, the FX-1, uses a basic pulse amplifier with matched input and output impedances; interconnections are made with 75-ohm strip or coaxial transmission line.

Matching all impedances minimizes crosstalk and losses and makes transit time between amplifiers predictable. Amplifier modifications are used as gates and drivers



INPUT AND OUTPUT *pulses to the amplifier. Notice the six-nanosecond delay of the output pulse*



BASIC AMPLIFIER *circuit diagram (A) and special transformer employed (B); diagram of the amplifier with a gating and mixing stage. Commercial versions of transistor L-5447 are the 2N769 and 2N976 (C)—Fig. 1*

onds. The power driver can feed up to eight 75-ohm lines.

DESCRIPTION—The pulse amplifier (see Fig. 1A) consists of a pulse-inverting transistor, a pulse transformer, resistors and capacitors. The transistor, a Philco MADT L-5447, has high gain-bandwidth product and low base resistance, collector capacitance, hole storage and saturation voltage.

The pulse amplifier operates when a −1.7 volt pulse from a terminated 75-ohm line is applied to the base of the transistor; the input voltage and the emitter resistor determine the maximum value of collector current in the transistor—approximately 17 ma. This current brings the transistor into saturation, thus applying the supply voltage to the collector R-C network, loaded pulse transformer and emitter R-C network. The current in the transformer magnetizing inductance increases until the collector current is exceeded. The transistor then comes out of saturation and terminates the output pulse. If the pulse is then applied to the base of a second amplifier, an output pulse is produced (see photo on p 39) with the following characteristics: rise time, 2 nanoseconds; pulse width, 10 nanoseconds; fall time, 3.5 nanoseconds; peak pulse amplitude, 1.7 volts.

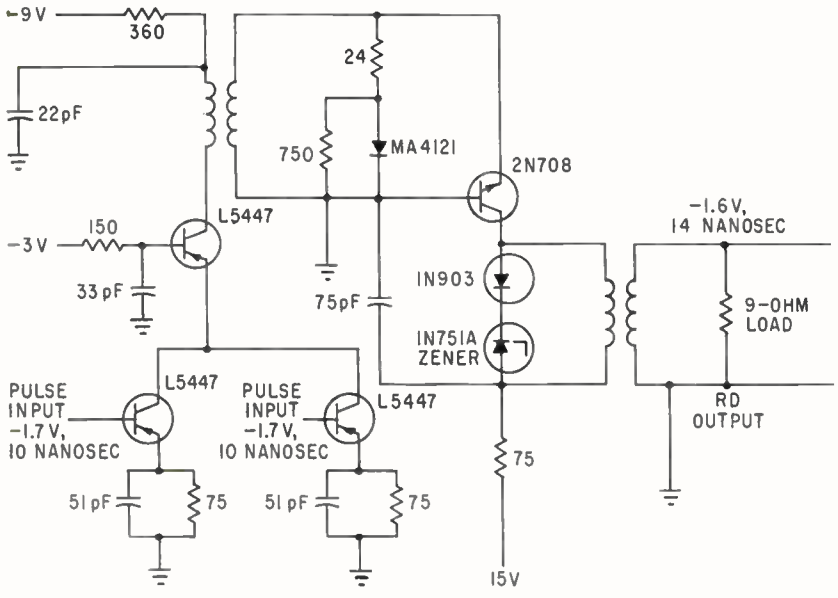
The pulse width is controlled principally by the supply voltage, peak emitter current, load resistance, and magnetizing inductance of the transformer—5.9 μh. Pulse amplitude is fixed by saturating the transistor. The emitter capacitor speeds up the output pulse rise time. Narrow pulses are lengthened by hole storage in the transistor, while broad pulses are shortened by shaping action.

The collector R-C lowers the peak voltage applied to the collector during transformer overshoot. Overshoot voltage is determined by the magnetizing inductance of the transformer and the load resistance, which is always 37 ohms, hence no clamping is required to limit the back voltage at the transistor collector. The collector R-C network causes some droop in the output pulse, but this has not been found objectionable.

PULSE TRANSFORMER — The pulse transformer, Fig. 1B, consists of primary and secondary windings mounted on a nylon bobbin and enclosed in two Ferramic Q2 F-622 cup cores. It must be constructed accurately, with the distributed capacitance and inductance controlled to assure the proper characteristic impedance and resonant frequency. The secondary turns are close-wound over the end of the primary which is a-c ground, thus creating unsymmetrical distributed capacitance. At these circuit speeds, the transformer operates as a conventional inverting transformer and as a transmission-line inverting transformer. Because of the unsymmetric distributed capacitance, the transmission-line mode is not immediately excited during the initial collector swing. Thus the transformer cannot be reversed in the circuit without appreciable degeneration.

A 75-ohm transmission line terminator at the input to the pulse amplifier compensates for the capacitive, nonlinear input impedance. A 100-ohm resistor can be used with some increase in rise time and propagation delay time and decrease in stage gain.

The pulse amplifier has greater than unity gain for input pulse amplitudes over 0.8 volt and attenuates pulses of lower amplitude. It thus



REGISTER *and driver has additional power stage (2N708); output pulse is slower and wider than 10 nsec pulse (see text p 41)—Fig. 2*

has a noise rejection capability. Since the pulse amplifier exhibits gain and pulse shaping abilities, weak or distorted pulses are re-standardized as they pass through a chain of these amplifiers.

The pulse amplifier is designed to drive two 75-ohm transmission lines. Each terminated 75-ohm line driven by the pulse amplifier can drive two pulse inverter bases not more than five inches apart, hence the basic amplifier has a fan-out of four, with the specified geometric limitation. The propagation delay time of the basic amplifier circuit is 3 nsec. The maximum pulse repetition frequency is 25 megapulses per second, due to relatively long recovery time in the pulse transformer.

GATING CIRCUIT—The pulse amplifier is converted into a logic building block in the FX-1 computer by adding gates and mixing points. The gating circuit is shown in the lower part of Fig. 1C. The gate or level transistor, an L-5447, is in series with the pulse inverter transistor. Application of a 1.8-volt negative level to its base circuit causes the gate transistor to conduct and grounds the lower end of the pulse inverter transistor emitter R-C. A ground input level cuts off the gate transistor and the bias network returns the emitter R-C to −1.3 volts, sufficient to keep the pulse inverter transistor from conducting when a pulse is applied to its base. The gate set-up time is 7 nsec. With an increase in gate set-up time, up to four inverters may be conditioned by the same gate but no two inverters may be pulsed simultaneously. Three gates may be connected to a pulse inverter at the level mixing point with a corresponding increase in gate set-up time. Paralleling the gate transistors provides an OR function for negative input levels.

In the mixing pulse amplifier (Fig. 1C) a grounded base transistor, again an L-5447, is inserted between the pulse inverter collector and the pulse transformer primary. The impedance level at the mixing transistor emitter is lowered to 100 ohms, thus up to five pulse inverters can be paralleled at the pulse mixing point. Input pulses are mixed at a common point with no two pulses occurring simultaneously. The propagation delay time of a gated-mixing pulse-amplifier circuit is 4.5 nsec.

Another variation of the pulse amplifier is the register driver, Fig. 2. It has an additional high-power 2N708 output stage following the mixing pulse amplifier. This circuit can drive eight 75-ohm lines. Its output pulse has a slower rise time (4.5 to 5.5 nsec) and is wider (13 to 14 nsec) than a standard 10-nsec pulse.

The authors thank Leopold Neumann, formerly with MIT Lincoln Laboratory, who was responsible for the early development of the circuits, and the U. S. Army, Navy and Air Force with whose support the Lincoln Laboratory is operated.

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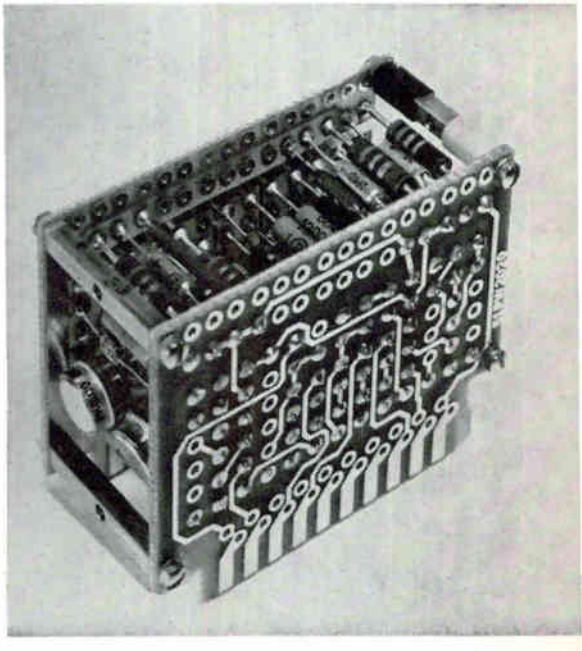
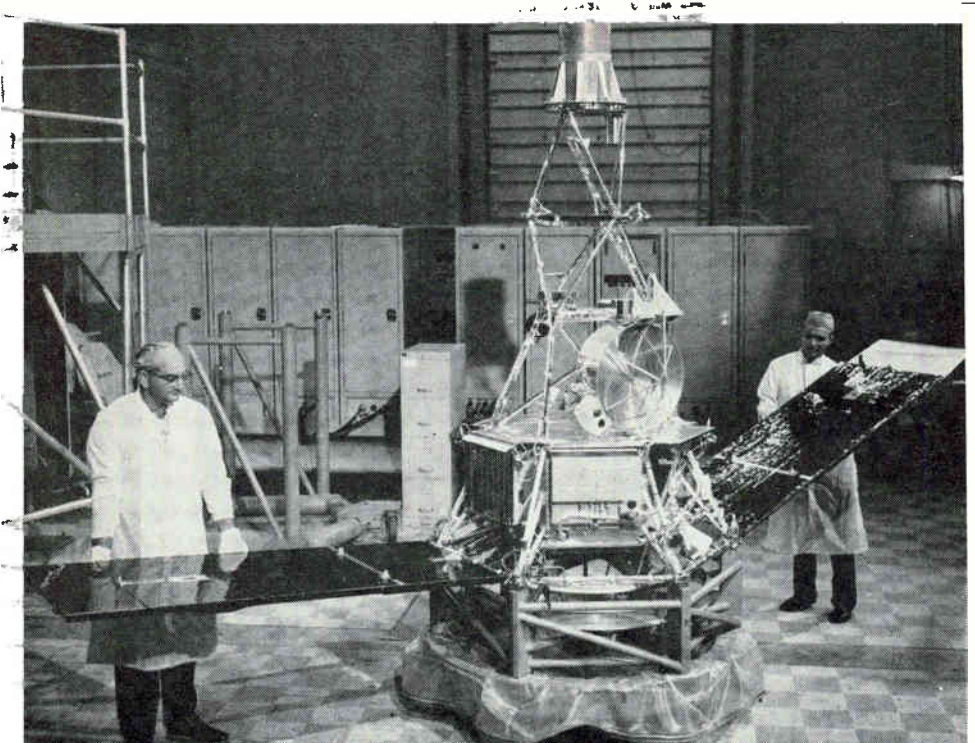


TYPICAL PLUG-IN *unit of FX-1 digital computer; this unit has three gate circuits, five pulse inverters and two mixing amplifiers. Leads are brought out to contacts to obtain any combination of logic gates*

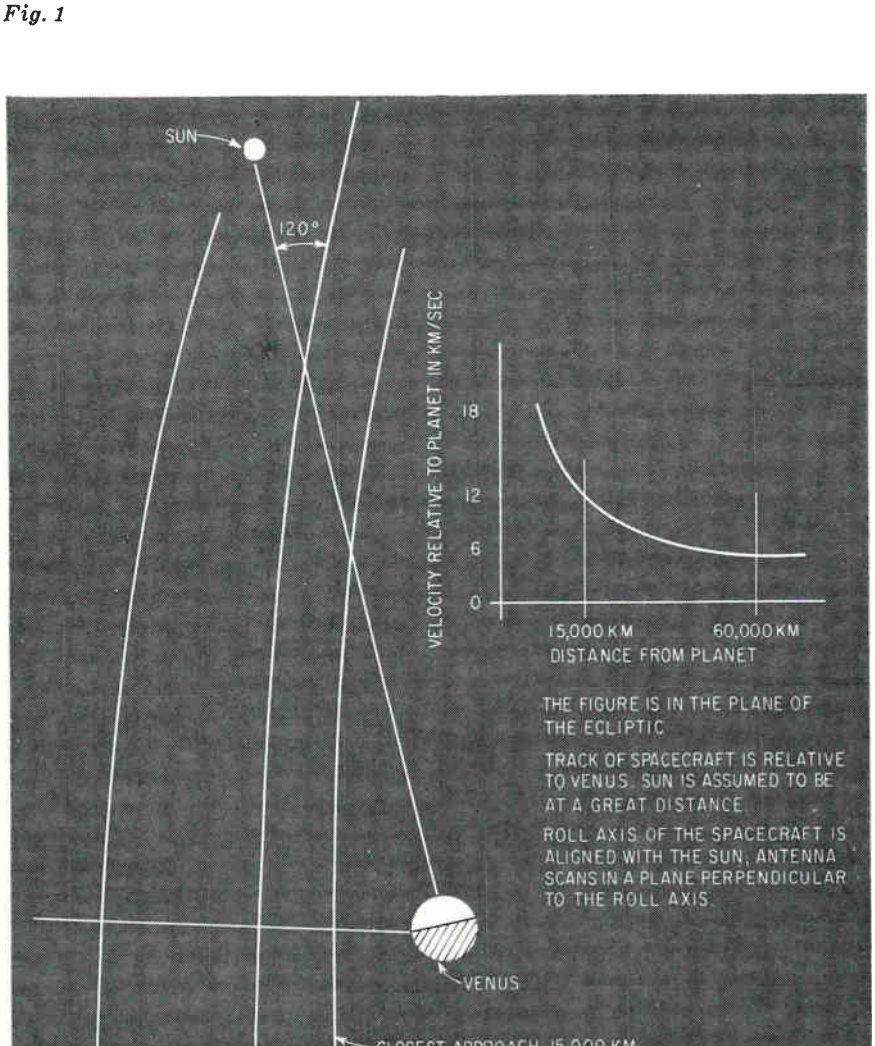
MARINER II

By S. CHASE, JR.,
Jet Propulsion Lab, Pasadena. Calif.

F. SCHWARZ,
Barnes Engineering Co., Stamford, Conn.



INTERNAL VIEW *of Mariner II showing radiometer temperature plate Fig. 1*



VEHICLE *trajectory and alignment axes—Fig. 2*

SEVERAL OF TODAY'S most scientifically important experiments are being carried out by the Mariner II Venus spacecraft.

Four of the six instruments on board are taking data: the solar plasma spectrometer, cosmic dust detector, ion chamber and particle flux detector and the magnetometer.

The spacecraft will pass the planet Venus at a nominal miss-distance of 20,900 miles. Then, the microwave and infrared radiometers will be activated so that measurements of the radiation coming from both planetary surface and cloud tops can be made. The radiometers are shown in Fig. 1.

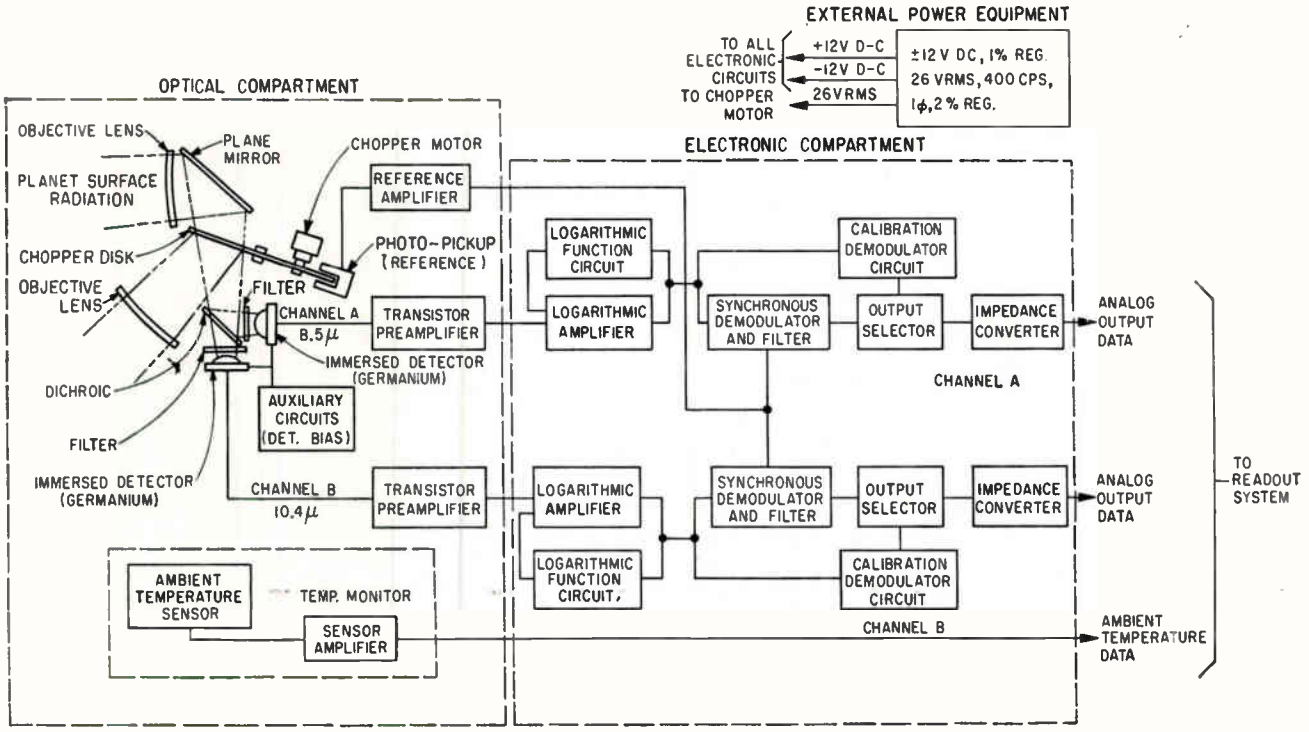
The ir radiometer experiment will map the temperature pattern of the planet's cloud tops and measure the extent of cloud breaks if they exist. This data will help to establish a correct model for the atmosphere on Venus. This experiment was carried out under the scientific direction of L. D. Kaplan of JPL and U. of Nevada, G. Neugebauer of CIT, and C. Sagan of U. of Calif., Berkeley.

OPTICAL DESIGN—A thermistor detector will receive radiation alternately through two lenses that view regions 45 degrees apart as shown in Fig. 3. As the chopper rotates, open and closed segments of the chopper wheel appear alternately in front of the detector. When the chopper is in the open position, the radiation from lens *B*

INSTRUMENTATION:

What Will It See On Venus?

Our Mariner II space probe contains a variety of instruments to perform scientific evaluations of the planet Venus. Here is a discussion of the microwave and infrared radiation detectors that will examine the planet's cloud cover and surface radiations



TWO-CHANNEL *infrared radiometer is a major part of instrumentation—Fig. 3*

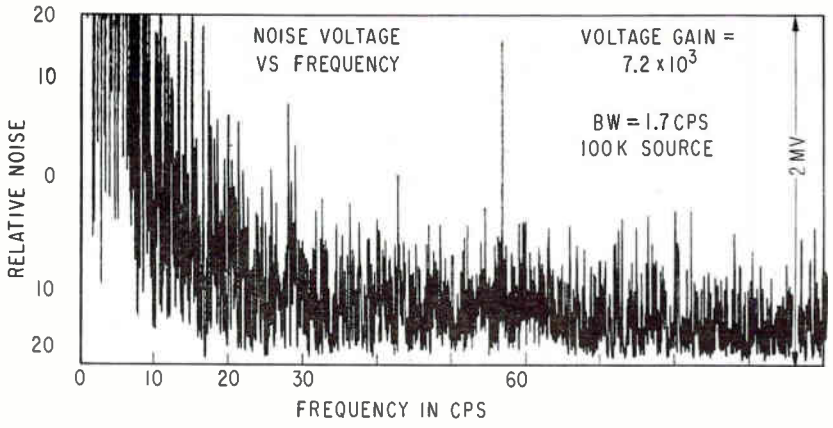
WHAT'S ON VENUS?

It may be some time before the first earthman sets foot on the planet Venus. However, we now see more than meets the eye, even through a 200-inch telescope.

Our Mariner II Venus probe is equipped to radio a wealth of scientific data back to earth

is collected by the stationary mirror. Radiation from lens *A* is gathered by the mirrored-back surface of the chopper when in the closed position. Thus, in its fly-by mission, the detector receives essentially zero radiation from lens *B* that views cold outer space and planetary radiation from Venus with lens *A*. Outer space is the reference and the measured absolute radiation from the planet will permit determination of temperature. The chopper provides modulation at 20 cps and the amplitude of energy, converted by the voltage-biased thermistor to an a-c voltage, is proportional to radiant power received. If the planet surface more than fills the field of view of the instrument, as it would at the fly-by distance of 20,900 miles, and if target emissivity is unity, the signal output can be related directly to target temperature by Planck's equation.

ELECTRONICS — The require ments for signal processing include:



LOW-FREQUENCY *noise spectrum of preamplifier—Fig. 4*

a low frequency, high input-impedance preamplifier that does not measurably contribute low-frequency noise to the Johnson-noise-limited detector input; a logarithmic amplifier to compress the range of input signals representing 600 K to 200 K to the lower dynamic range output of 1 to 6 volts required for the digital converter; a synchronous demodulator, filter and low impedance driver; an ambient temperature monitoring circuit and an auxiliary circuit, including calibration output driver, synchronizing signal generator as the reference signal for the demodulators and detector bias supplies.

PREAMPLIFIER—The preamplifier is of repackaged conventional design, the characteristics of which were described in an earlier article[1]. A low-frequency noise spectrum curve for this preamplifier is shown in Fig. 4.

LOGARITHMIC AMPLIFIER — The log amplifier uses the operational amplifier-function generator principle, and compresses the potentially wide range of detector signal levels to a set of values within the range capability of the telemetering system. The output impedance of the amplifier is less than 500 ohms. The gain at the low end of the transfer function, below the compression, is adjustable by a trimming potentiometer to within the range 2,000-5,000. The logarithmic amplifier, including demodulator, can be considered logarithmically linear for outputs in the range 0.5 to 6.0 v d-c.

To meet the requirements of radiometer readout, a function was devised of the form $y = k \log x - c$, where $k \approx 2.07$, $c = 0.5$ v, y = dc output volts and x = radiance input = $w \times 10^{-7}/\text{cm}^2\omega\Delta\lambda$. The calculated values fall within 5 percent of this expression.

An operational amplifier was designed, in which voltage gain is dynamically adjusted depending on the magnitude of the signals at the output. A transfer function characterized by this relation was obtained. This is accomplished by providing a group of feedback paths, each with a different resistance ratio. Each path is connected through a pair of inverted parallel diodes. These diodes are actuated when their saturation voltages are exceeded.

In an operational amplifier with high open-loop gain, the voltage gain is solely a function of the feedback-resistance ratio, as in Fig. 5A, where $i_1 = (e_i - e_1)/R_i$, $i_2 = (e_i - e_o)/R_{f1}$ and $e_o = -Ae_1$. If the gain is high, all the input current can be assumed to equal the output current $\therefore i_1 = i_2$; then, $(e_i - e_1)/R_i = (e_1 - e_o)/R_{f1}$ or

$$\frac{e_i + e_o/A}{R_i} = -\frac{e_o/A + e_o}{R_{f1}}$$

Since $e_o/A \rightarrow 0$ when A is large $e_o/e_i \cong -R_{f1}/R_i$.

If the voltage is large enough to exceed the saturation potential of the first diode pair, a new feedback resistor, R_{f2} is shunted across R_{f1}, changing the gain to a new, lower value as in Fig. 5B. The new voltage gain

$$G_2 = \frac{R_{f1}R_{f2}}{R_{f1} + R_{f2}}/R_i$$

When voltage e_o rises to a value that exceeds the saturation potentials of both diode pairs in series (> 1 volt), the gain decreases further as the effective feedback resistance becomes the parallel combination of R_{f1}, R_{f2} and R_{f3} the process continues until the last diode pair lowers the gain once more.

Since the diodes are soft at the knee of their conduction curve, the transition from nonconduction to conduction is smooth. A straight line plotted on semilog paper indicates that a good approximation of a logarithmic curve can be obtained. The complete schematic of the logarithmic amplifier is shown in Fig. 6.

IMPROVED S/N RATIO — To obtain improved signal-to-noise ratio with attendant reduction in noise bandwidth, synchronous rectification was used.

It gives better signal-to-noise ratio with a simple reduction in noise bandwidth and improves system detectivity over a conventional detector. Since weight and size limitations precluded the use of large optics, the amount of energy available from the two narrow spectral bands would otherwise be too small to detect; furthermore the rectification transfer characteristic is linear and no d-c output term is obtained for nonsynchronous input frequencies including noise or motor pickup. Also, the noise bandwidth may be limited by a simple low-pass r-c output filter. (For an equivalent noise bandwidth, an elaborate bandpass filter would be needed ahead of a conventional rectifier.) Finally, narrow band filtering and noise bandwidth reduction is possible with the simple R-C filter without regard to stability of the chopper frequency.

A 0.05-cps bandwidth would be almost impossible to achieve with a band-pass filter and would be impractical because of possible chopper frequency variations.

The demodulator with associated filter is followed by a complementary emitter-follower to supply a low-impedance analog output signal to the digital converter.

MONITOR CIRCUIT — The temperature monitor senses variations in ambient temperature near the

detector. The monitor circuit is necessary because variations in ambient temperature change detector response and transfer of energy to the electronic system.

Since it is impractical to apply large voltages and currents to a temperature sensing element to obtain large output voltage swings, an active element measurement is desirable because it results in some voltage gain. If too much power were dissipated in the sensing element, self-heating would take place and reduce the accuracy of temperature measurements.

In the circuit of Fig. 7 the zener diode maintains a constant operating potential on the base of the transistor. The emitter potential, which follows the base bias potential, will also be maintained at a constant level. Since the potential across the sensing element in parallel with the 22,000-ohm resistor remains constant, a variation in total emitter resistance will be linearly related to variations in emitter current. An increase in thermistor resistance, caused by a drop in temperature, would result in a reduction of emitter current. Since the base current is a small portion of the emitter current, nearly all emitter current flows through the collector and can be measured as a voltage drop across the fixed collector load resistor. This determines the readout. A curve of output voltage against temperature is shown in Fig. 7B.

CALIBRATION — Since an absolute measurement of thermal radiation is needed to determine effective temperatures, the calibration of the radiometer must be checked for drift before and after the pass by. A small calibration plate is mounted on the spacecraft so that it can be seen by the radiometer at the end of each scan. A circuit similar to that in Fig. 7A develops a voltage proportional to plate temperature. Comparison can be made between radiometer output and plate temperature to check calibration.

The authors thank G. Neugebauer of JPL and A. Ziolkowski of Barnes Engineering.

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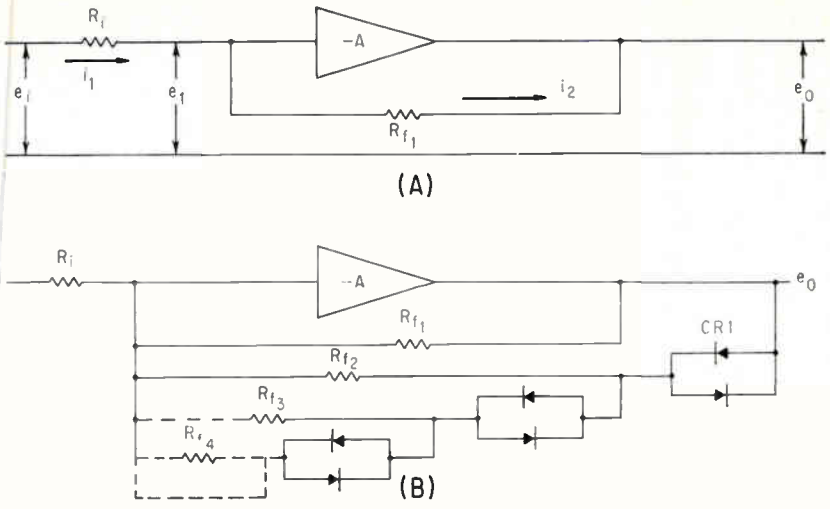
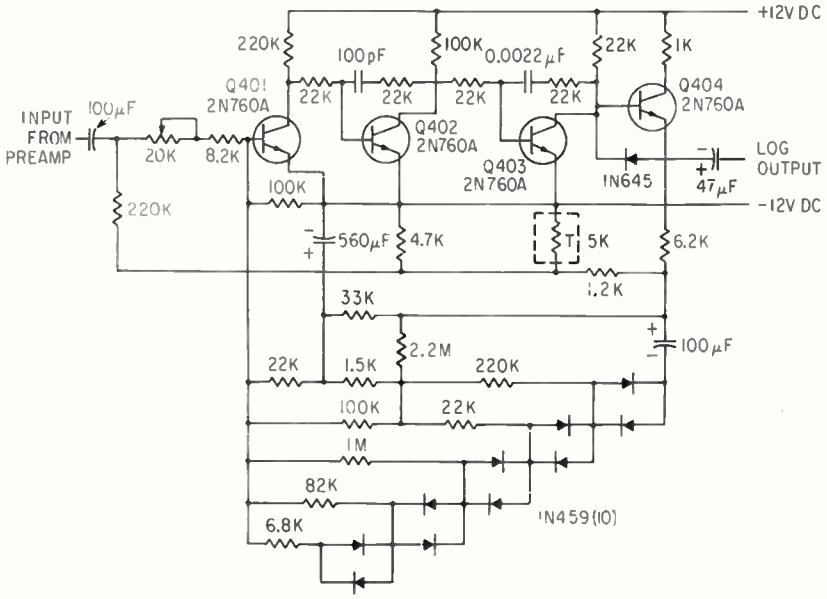
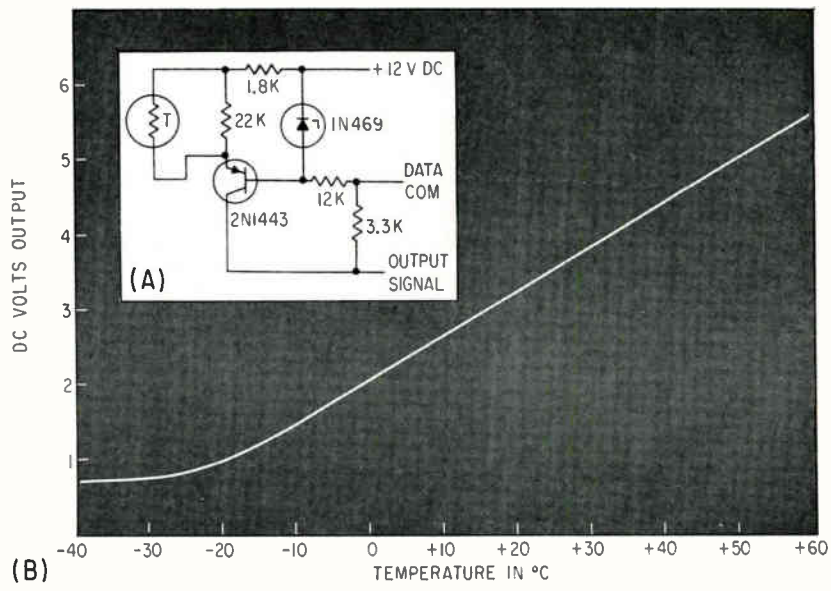


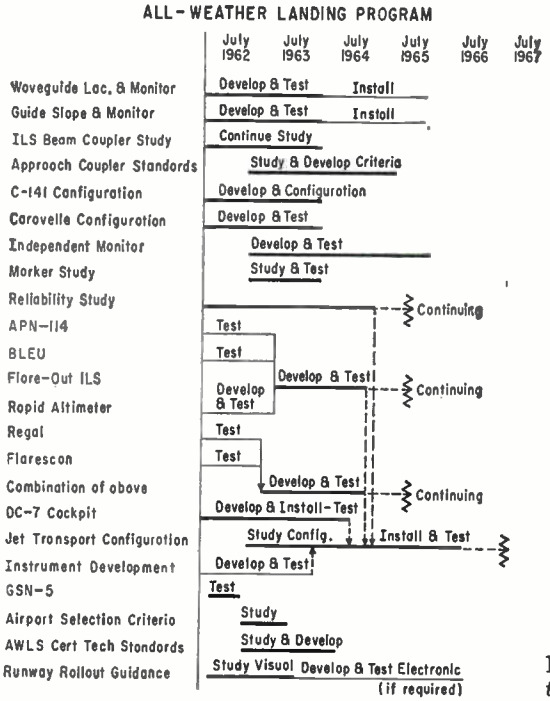
EQUIVALENT CIRCUIT *of log amplifier (A) and that of the operational amplifier including functional generator feedback (B)—Fig. 5*



LOGARITHMIC AMPLIFIER *and function circuit—Fig. 6*



TEMPERATURE MONITOR *circuit (A) and electrical transfer characteristics of radiometer (B)—Fig. 7*



FAA's ALL-WEATHER *landing program calls for system testing for at least two years before a decision is made*

PICTORIAL *Displays use Vortac to provide pilot with aircraft's moving position over changeable map (ITT)*

IMPROVED NAVIGATION AIDS

Inability to land in poor weather costs airlines millions of dollars a year. This

PART OF ALMOST every airline flight is spent in a totally sightless void. Often the plane enters it immediately after takeoff, only to emerge hours later above the runway at destination. Hurtling blind through the increasingly congested airspace, even the staunchest traveler wonders from time to time, as he sips the steaming dark water the stewardess gave him for coffee, what lies beyond the wingtip. Fortunately, there's usually nothing out there but more fog. Sometimes, of course, there is.

Prevention of disaster depends largely on the ground controller who is monitoring the flight sector by radar plus, eventually, a beacon transponder (ELECTRONICS, p 37, Dec. 7, first article in this series). But also important is the pilot's ability to know where he is, and to stay where the controller tells him to stay. This depends on navigation gear.

To provide safety in the existing air traffic control system, each plane under positive control is given an enormous block of air in which it alone has the right to be. Because of the size of the air territory surrounding each plane, there are often more planes ready to take off than blocks in which to accommodate them. Solution is to improve both the ground controller's position acquisition system, and the pilot's navigational equipment. This would make room for more planes by reducing each plane's air volume.

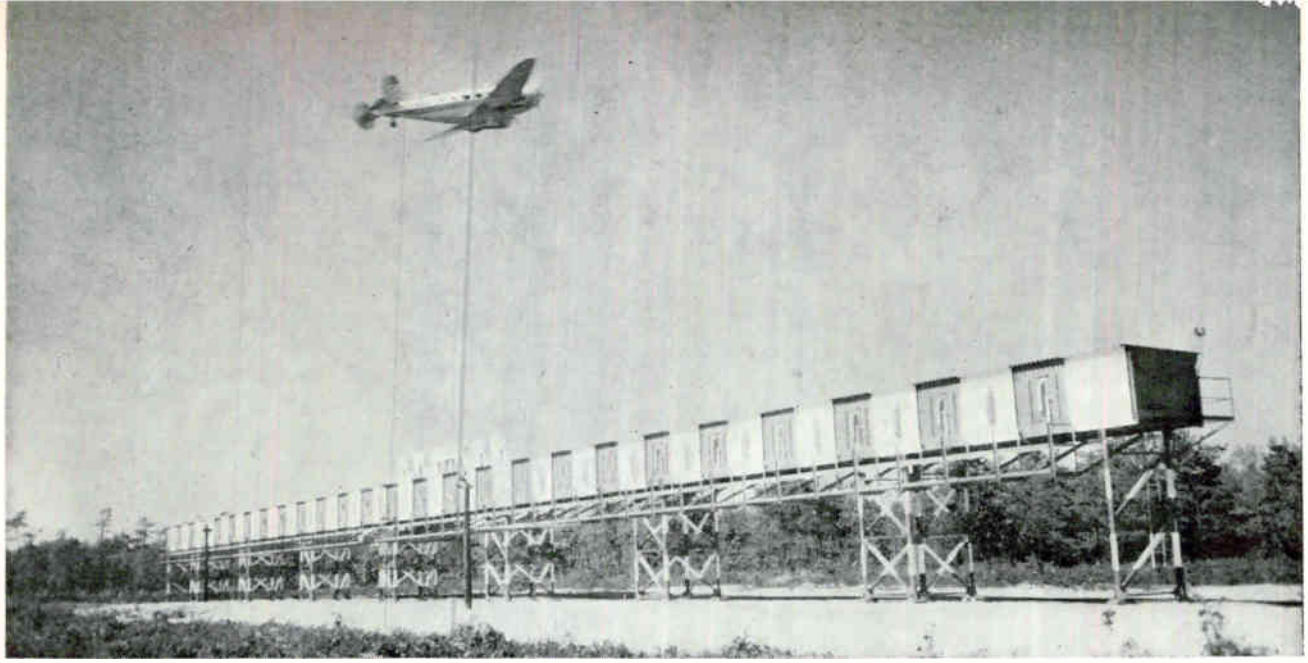
Although a number of devices are being developed, the major electronic navigation element of the air traffic control system through 1975 will be Vortac (vhf omnirange and Tacan), according to the Federal Aviation Agency's system design team. Other ground-based systems that could come into limited use in the distant future, FAA says, are loran C, vlf, Omega or perhaps satellite navigation. Although answering the extended range need, loran C and Omega require full-time navigators as part of the flight crew. A satellite system will be costly and is a long way off.

Because of complexity and cost, FAA rules out, for the immediate future, the HARCO (Hyperbolic Area

SECOND OF THREE ARTICLES. See: Air Traffic Control Today and Tommorow, p 37, Dec. 7

WHAT THE INITIALS MEAN

AWLS—All-Weather Landing System
BLEU—Blind Landing Experimental Unit
CAS—Collision Avoidance System
DME—Distance Measuring Equipment
GCA—Ground Controlled Approach
HARCO—Hyperbolic Area Control
ILS—Instrument Landing System
NAFEC—National Aviation Facilities Experimental Center
PAR—Precision Approach Radar
PWI—Pilot Warning Indicator
REGAL—Range and Elevation Guidance for Approach & Landing
TACAN—Tactical Air Navigation
VLF—Very Low Frequency
VORTAC—VHF Omnidirectional Range collocated with TACAN



EXPERIMENTAL *waveguide localizer, 304 ft. long, at NAFEC, near Atlantic City, N. J., will help to solve design problems for localizers to be used in all-weather landing systems*

Needed to Tighten Wasted Airspace

30-year-old problem may be near solution

By JOHN F. MASON Senior Associate Editor

Control) system, being developed and evaluated under the sponsorship of the Eurocontrol organization. Based on the Decca Navigator, HARCO includes a two-way data link, hyperbolic to x-y coordinate conversion, linear pictorial display, self-setting display, autopilot coupling, adjacent chain synchronization and distance-heading output data.

One drawback FAA sees in HARCO is the cost and complexity of programming the Omnitrac computer.

SELF-CONTAINED AIDS—Doppler navigators are now under evaluation by NAFEC. Although the study is not completed, FAA says the equipment will undoubtedly become a useful navigating aid—first on transatlantic routes and later in the U. S.

Inertial navigation equipment used as a complete navigation system is still too expensive and unproven to be considered economically practical for civil use, FAA says. This spring, however, Pan American World Airways will begin a six-month evaluation for FAA of a Litton Systems inertial navigation system. Another self-contained device, a photoelectric sextant called the automatic star tracker, is also complex and expensive, FAA says. It might, however, come into civil use by the end of this decade.

Since Vortac is here to stay and traffic is bound to get worse, a method for expanding the Vortac channel (implemented on a 100-Kc channeling basis) as a companion to 50-Kc communication is needed. The next step is to explore methods for introducing an expanded channel capability into the existing environment, while maintaining the 100-Kc basis.

Varian Associates has proposed a method for improving the position-fixing accuracy of the present Vortac system by using high-accuracy atomic frequency standards to control Vortac transmitters. In the aircraft a position-generating computer and readout device would be necessary.

The controlled pulse signals would be transmitted at a moment in time precise to approximately five parts in 10^{-11} stability of such standards. A calibrated standard at the plane's receiver would measure propagation delay, and give aircraft range from the station. Three such signals would give a triple-rho, unambiguous position fix.

Pictorial displays will not be mandatory in aircraft before 1975. NAFEC tests, however, reveal their usefulness, and terminal area configurations are being planned to include them in the ATC system.

LOW APPROACH—The standard instrument low-approach system (ILS) will, like Vortac, be used for many years to come. Not only does it have growth potential for lowering the operating minimum altitude or landing approach, but it also appears to be a suitable source of azimuth guidance for all-weather landing systems of the future. ILS is now going into some airports to satisfy a Category II operation—minimum altitude of 100 ft with ¼-mile visibility. (Category I—now in effect—is 200-ft altitude, ½-mile

visibility; Category III is all-weather landing). The improved ILS directional localizer uses a 117-ft waveguide. NAFEC is now experimenting on other apertures using a new waveguide 304 ft long.

Development now underway on building ILS equipment for all terrain is technically promising. What is needed is a low-cost, high-quality system.

GCA/PAR—The radar systems with which a ground operator talks the pilot down to a low approach for landing continue to be favored more by the military than by civil pilots. Ground controlled approach, as it is called by the military, and precision approach radar, its civilian name, are located at many major airports. At FAA airports, it is used to monitor the ILS. Justification for this limited role is being questioned by FAA and will be explored more thoroughly.

CATEGORY II DEVELOPMENT—While no further development work is needed for the ILS 117-ft localizer waveguide, work on the ILS glide slope has not been so satisfactory. Partial solution may lie in the modified M-array glide-slope configuration that cancels out low-angle radiation and, therefore, makes the installation less susceptible to irregularities in the forward-area ground plane. A flush-mounted glide slope, also under test at NAFEC, shows promise, although the effect of snow and ice on the equipment is still unknown. A new approach, also with problems unresolved, utilizes the waveguide principle for the construction of the glide-slope antenna.

The use of distance measuring equipment (DME) with ILS is recommended with improved ground equipment and new cockpit presentation.

CATEGORY III DEVELOPMENT — The design team has attempted to abandon the 30-year-old wish for a system that would magically take over and get a plane out of the soup and safely on the runway. Such a nebulous objective does not lend itself to step-by-step engineering progress. The team concluded that the system need not be completely automatic, and that the pilot should have a contributive role in the operation; the term all-weather should be changed to all-visibility since the former implies landing in hurricanes; and, it is unlikely that a universal system will be possible: instead, systems will probably emerge for one type of aircraft at one specific airport.

In line with these more realistic requirements, techniques have been narrowed down and objectives are firmer. Based on the common civil-military nature of the all-weather landing operation, there are two major approaches: (1) a ground radar acquisition technique, and (2) a pilot-derived method.

An example of the ground-based type is Bell Aircraft's GSN-5. The design team says "the basic philosophy inherent in the GSN-5 approach is not considered satisfactory to the civil air carriers. This stems not so much from the technical factors involved, as from the operational nature of this type system." Civil pilots like to have responsibility for landing. In spite of this, NAFEC will begin testing a refined version of the GSN-5 this month.

Pilot-derived systems fall into two categories: those using airborne radio altimeters for height finding, and those using data from ground-based angular or angular distance-measuring gear transmitted to a display in the cockpit.

Four pilot-derived systems are being tested. A combination of these systems may eventually be used to take over from the ILS at an altitude of 100 ft.

The Blind Landing Experimental Unit (BLEU) is a radio altimeter type system, made in England. It uses the normal ILS localizer and glide slope, radio altimeter and an automatic throttle control to bring the aircraft to the touchdown point. The British have made thousands of successful landings with Bleu, and FAA has now made more than 200.

Another radio-altimeter system being tested is North American Aviation's AN/APN-114, similar in some respects to Bleu.

Instead of using radio altimeters for determining flare-out altitude, two systems use ground-based vertical scanning guidance equipment. Gilfillan's Regal system uses vertical angle and DME measurements which provide computed height and permits a flare-out computation for landing. Airborne Instrument Laboratory's Flarescan uses vertical angular information only which it couples with the fixed existing glide slope to provide a means of displaying flare-out guidance to touchdown. The best features of these two systems could be combined, FAA says.

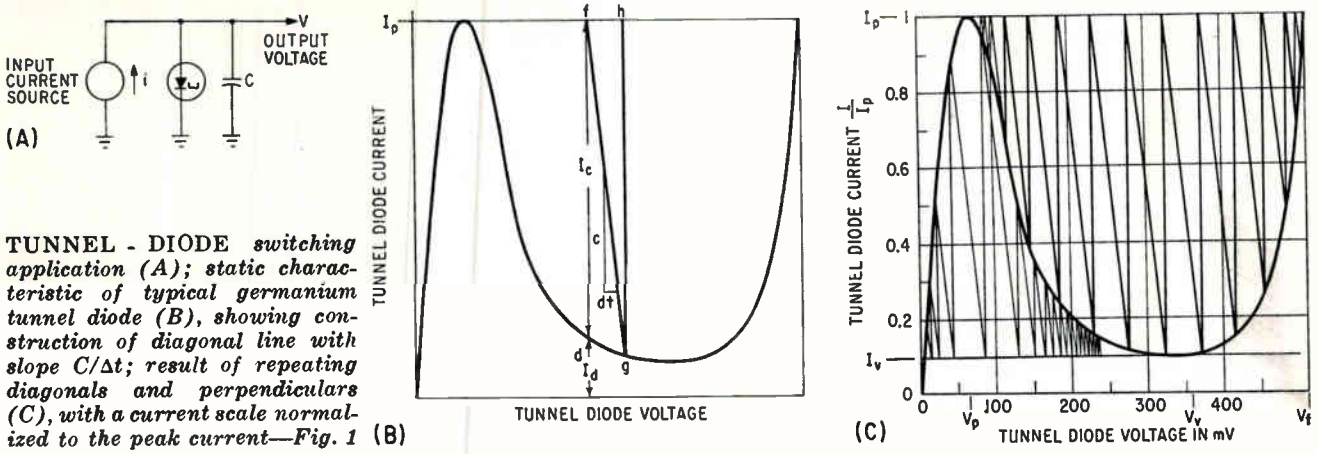
There are advantages and disadvantages to the two basic means of achieving flare-out guidance: radio altimeters are familiar to pilots, they don't require new ground-based guidance units, and they have been proved out in the United Kingdom. On the other hand, they can only be used over smooth terrain, which often means the pilot gets accurate information very late in the landing procedure.

Ground-scanning systems are newer, and knowledge of their performance is limited. They provide signals out to 10 miles and are unaffected by rough terrain. Ground gear, however, will be costly.

One problem of concern to pilots is that of quick transition from instrument to visual flight.

One solution to this problem is provided by Sperry in a device that projects a display of the ground and aircraft position on the windshield. This is a synthetic display derived from the instrument landing system being used, the airborne instrumentation, a computer and collimating-projection techniques. The pilot sees the IFR-situation information identical in form to selected outside-world cues. The aircraft is an orange dot, the runway and horizon are green. When the real runway becomes visible, the perspective is the same as that already on the windshield.

COLLISION AVOIDANCE—Development of airborne equipment that will recognize a collision situation and warn the pilot and tell him what to do, has not yet reached a stage that warrants its inclusion in the system design. Work financed to date by FAA has produced cooperative systems, warning the pilot only of aircraft similarly equipped. Because of the lack of promise of existing developmental projects and the pressing need for spending money elsewhere, FAA is cutting down on its collision avoidance program. The tide could quickly be changed, of course, should a new technique appear promising.



TUNNEL - DIODE *switching application (A); static characteristic of typical germanium tunnel diode (B), showing construction of diagonal line with slope C/Δt; result of repeating diagonals and perpendiculars (C), with a current scale normalized to the peak current—Fig. 1*

Simple Method for Plotting TUNNEL-DIODE Switching Waveforms

Rise and fall times can readily be plotted using manufacturer's data for capacitance and peak current. Step-by-step procedure is given for deriving a general curve applicable to most germanium diodes

By JAMES K. SKILLING General Radio Company, West Concord, Mass.

SOMETHING NEW HAS BEEN ADDED

Tunnel diodes are widely used as trigger generators, pulse generators and amplitude detectors, and so their switching characteristics (rise and fall times) are of increasing interest, although not generally given in manufacturer's data. These characteristics can easily be plotted using no more data than diode peak current I_p and capacitance C

TUNNEL-DIODE switching application is shown in Fig. 1A. Source and load resistances are considered to be large, the capacitor represents load and stray capacitances, as well as junction capacitance, and any small inductances are neglected. If the source current is slightly larger than diode peak current I_p the diode switches regeneratively from its low to its high-voltage state. In most cases, the source current does not change appreciably during the switching times, and may be considered constant.

Diode current I_d at some time during switching might be as shown in Fig. 1B at point d, where capacitor current I_c is the difference between source current and diode current. During a small increment of time, Δt, the change in capacitor voltage, Δv (hence diode and output voltage), may be calculated assuming I_c is constant during the interval

$$\Delta v = I_c \frac{\Delta t}{C} \qquad (1)$$

$$\text{or } \frac{\Delta v}{I_c} = \frac{\Delta t}{C}$$

CONSTRUCTION — Graphically, this is equivalent to constructing a line from point g with slope $C/\Delta t$, as line fg in Fig. 1B. Voltage change Δv_c is then the change fh. If the process is repeated (that is, a vertical line is dropped from h to the curve and a line of slope $C/\Delta t$ constructed, and so on), the voltage change during the next interval Δt is obtained. Figure 1C is such a construction for a germanium tunnel diode, with a current scale normalized to the peak current. The construction is for both the low-to-high and high-to-low switching transitions (rise and fall times, respectively). The latter occurs when the source current drops just below diode valley current I_v.

Once Fig. 1C is constructed, voltage can easily be plotted against time, as shown in Fig. 2. The procedure for translating Fig. 1C to Fig. 2 is as follows: Equation 1 can be rewritten as

$$\Delta t = C \frac{\Delta v}{I_c}$$

where the function Δ_v/I_c is the slope of the lines of Fig. 1C, which was made $50\text{mv}/I_p$. Therefore

$$\Delta t = C \frac{50mv}{I_p)} = 0.05 \frac{C(pf)}{I_p(ma)} \text{ nsec}$$

This means that all the diagonal lines in Fig. 1C are spaced by the same amount of time. $0.05\ C(\text{pf})/I_p(\text{ma})$ nsec, and each successive intersection of diagonal line and, say, horizontal I_p line is spaced by the amount of voltage change in that constant time interval.

The first step in constructing Fig. 2 is to lay out the horizontal axis in major units of $0.1\ C(\text{pf})/I_p(\text{ma})$ nsec. For example, consider a tunnel diode having an I_p of 5 ma and junction, stray and load capacitances totaling 50 pf. The time scale for such a diode would be 0.1 (50 pf/5ma) = 1 nsec per major division.

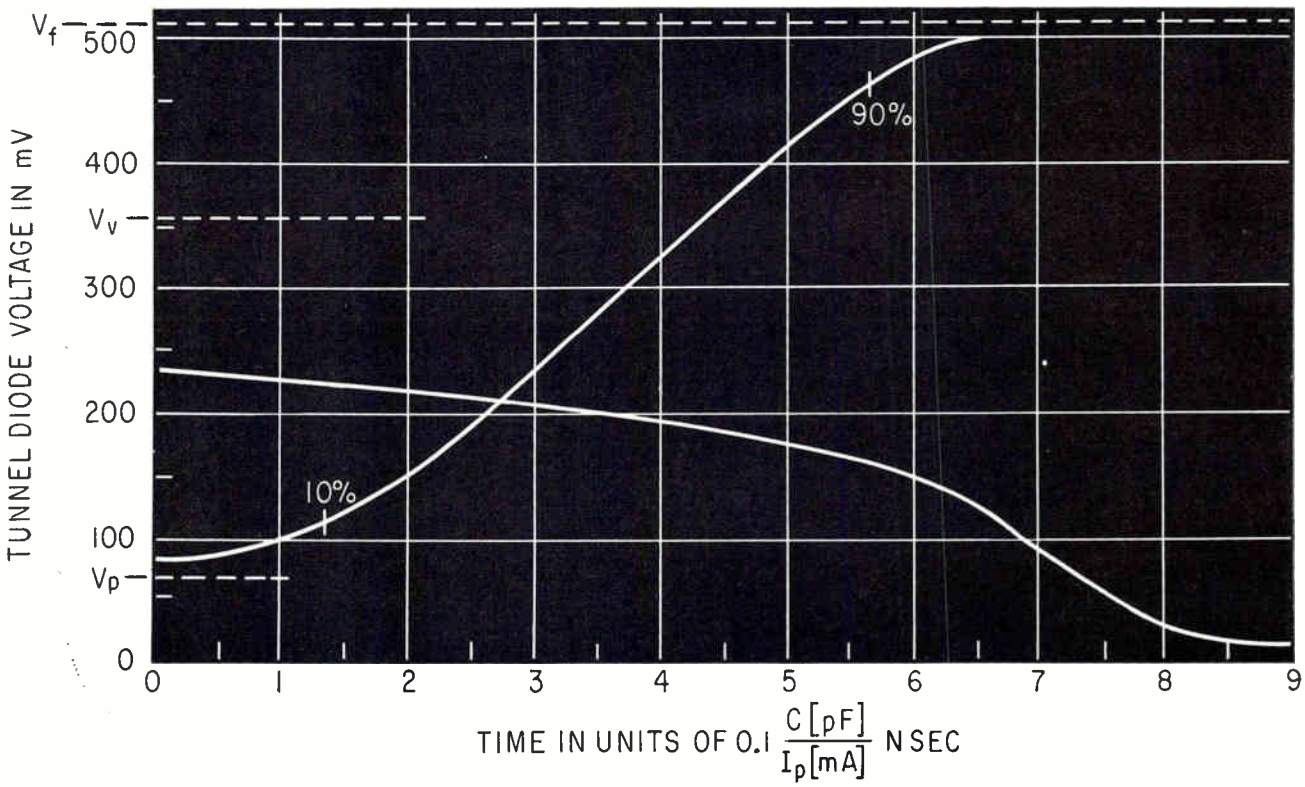
Each diagonal line of Fig. 1C corresponds to five minor divisions of Fig. 2. The voltage change for each diagonal constructed in Fig. 1C is then plotted in Fig. 2. The first intersection of diagonal and I_p line is at 87 mv, and this voltage is plotted at 0 time in Fig. 2. The next intersection is seen to be at 90, and so the next plot is at 90 mv for 0.5 time. The next intersection is at 100 (for 1 time unit), and so on. The same procedure is followed for the high-to-low voltage transition.

APPLICATION—The waveform of Fig. 2 applies to most germanium diodes, since the time scale is in terms of C and I_p. The general curve is possible since most germanium tunnel diodes have the same valley, peak and forward voltages and the same general shape of characteristic curve. Switching times are proportional to C and inversely proportional to I_p. If the rise time from V_p to V_f is defined by its 10 and 90-percent points, it may be taken from Fig. 2 as

$$t_r = 0.43 \frac{C \text{ (pf)}}{I_p \text{ (ma)}} \text{ nsec}$$

The fall time from V_v to a point near the origin is long, since the diode slowly enters regeneration near V_v (see Fig. 1C). Note the fast transition as the voltage falls near V_p. This transition has about one-fourth the amplitude and the same rate as the rising transition.

If the source and load resistances are not high enough to justify the current-source assumption, the static V-I curve will not be like that shown. Then a special construction similar to Fig. 1C should be made, using the V-I curve and load line.



SWITCHING *waveform derived from Fig. 1C shows rise and fall times, and is applicable to most germanium tunnel diodes—Fig. 2*

Cubic digital system tests 1100 Clevite diodes per/hr — safeguards reliability

As performance specifications for electronic devices become more stringent and the demand for high reliability units increases, manufacturers must be able to program tests for a quantity of devices simultaneously. The Cubic line of quality digital instruments is designed for easy integration into flexible, multi-purpose testing systems.

At the Clevite Transistor Plant in Waltham, Massachusetts, a Cubic system based on the Model V-70P Digital Voltmeter checks semiconductor devices to assure reliability. This high-speed Cubic system tests more than 1100 computer diodes per hour for reverse leakage current and forward voltage drop. Data obtained from these measurements are recorded and stored on commercial data processing cards. A complete test history of a given diode type with up to five entries on the same card can be made by repetition of these tests after the diodes have been subjected to life tests, operational burn-in and high temperature bake time. The data processing cards representing a manufacturing lot can be screened in a computer system according to a customer's specifications. In this manner, possible diode failures can be culled and the performance or reliability distribution plotted for the entire lot. This Cubic system is one of hundreds especially adapted to a wide variety of industrial applications. For additional information on digital instruments or digital systems, write telling your requirements to Department A-187.

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R-F Energy Powers Latest Biomedical Devices

Permanent implants can be operated by external coils, eliminate batteries

BIOMEDICAL ELECTRONICS is developing a versatile array of circuits and applications for r-f power transfer devices, according to the Chicago Conference on Engineering in Medicine and Biology.

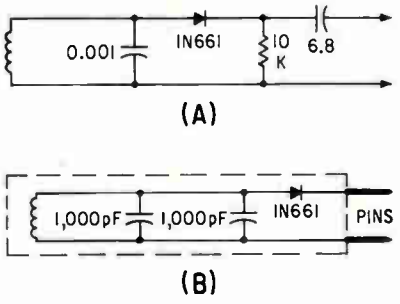
An implantable passive squib for biomedical telemetry was introduced by Honig Laboratories, Brooklyn, N. Y. Requiring no internal power or batteries, the 0.05-cubic inch squib weighs three grams; when permanently implanted six inches or deeper in tissue, it can return a 1-to-10-millivolt signal throughout the patient's life.

An ultraminiature transformer within the squib steps up externally radiated r-f energy and uses it to vary the capacitance of a reverse-connected diode and thus the resonant frequency of a 5-to-10-megacycle tuned circuit. The returned signal can then be demodulated by an external receiver and processed by conventional techniques.

The passive squib could be used as a permanent heart monitor, as a monitor for parts of the nervous system, or for remote operation of an artificial hand, leg or larynx by the voluntary nervous system. Other adaptations could monitor pressure, temperature, chemical pH and the like, Honig said, but some of these would require a squib sensitive to voltages in the 0.1 to 1-mv range.

Inductor antennas in the implanted squib permit freedom of movement without degrading the telemetered information. Suitable positioning of the external apparatus allows omnidirectional operation.

PACEMAKER PROGRESS — A dime-sized pacemaker, remotely energized by a transistor r-f pulse generator, was discussed by J. Schuder, University of Missouri.



EXPERIMENTAL *pacemaker smaller than dime, (A), an improved version, (B)—Fig. 1*

One experimental circuit connected a rectifying diode in series with a tank, and one of its pin electrodes, and achieved a two-percent energy transfer efficiency for one gram of weight. (Fig. 1A)

Electrolytic corrosion was minimized in the second circuit, of Fig. 1B, which holds net charge transfer to zero by maintaining a small reverse current during the period between pulses.

EFFICIENT TRANSPORT — Efficiency of the second circuit can reach about 1 percent using currently available transistors, Schuder said. This makes the device attractive as a source of the 60 milliwatts required by the transmitter. (Fig. 2) Batteries would weigh about a third of a pound and would be replaced about once a week.

Tissue losses increase from about 0 to 10 percent of the power applied to the coupling coil outside the chest, as the operating frequency goes up from 300 Kc. These losses impose an upper frequency limit on operation of the device, Schuder said.

Microminiature pacemakers are imbedded in epoxy resin and covered with Silastic before they are attached to the heart's left ventricle by two needle electrodes and four sutures.

Schuder also discussed wireless transmission of up to 90 watts of r-f energy inside the chest—using a radiant cage of mutually orthogonal coils to illuminate a receiving coil centered inside of the cage.

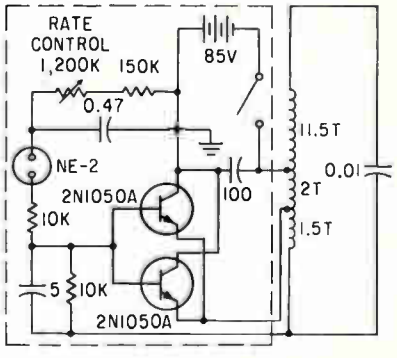
Preliminary experiments with dogs suggest that human heart patients of the future may prefer moving their bed inside one of these cages, instead of wearing bulky external battery packs to bed, he said.

An electronic bladder stimulator was discussed by William Bradley, University of Minnesota.

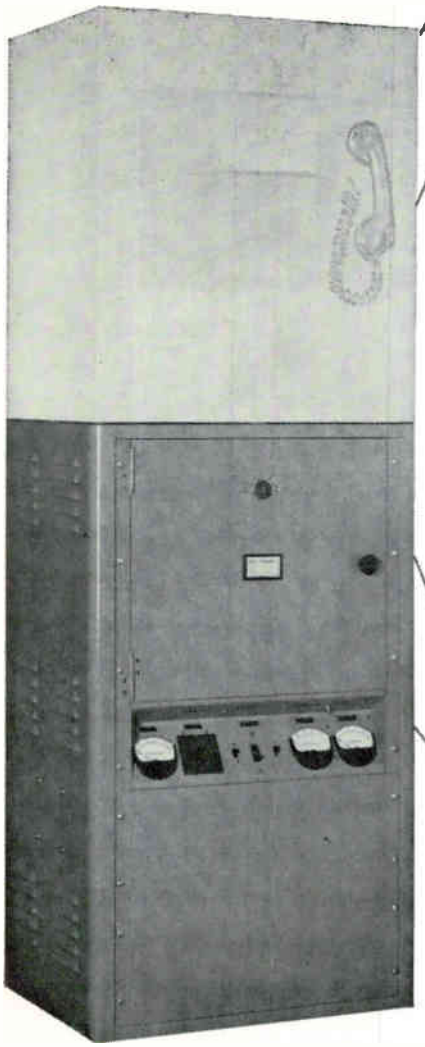
The external transmitter—developed by Medtronics, Inc., Minneapolis, includes a 1-Mc pulse modulated 50-watt oscillator, feeding r-f energy to a loop antenna which is held over the implanted receiver-stimulator.

The implanted passive receiver encapsulates a fixed tuned tank circuit, diode rectifier, r-f filter and output coupling capacitor in a 1-2 inch unit which is connected to the bladder by a half dozen 0.5-cm stainless steel disc electrodes (see Fig. 3.)

Biphasic 1-8-msec pulses measuring 5-15 volts peak-to-peak have effectively evacuated bladders of experimental dogs handicapped by spinal cord injuries for up to nine months. Electrode reaction has



TRANSMITTER *operates pacemaker from outside of rib cage—Fig. 2*



USE AEROCOM'S AMPLIFIER FOR MORE COMMUNICATION POWER!

AEROCOM'S Linear Amplifier used with conventional low power SSB transceivers for excitation, provides power output of 1000 watts PEP, continuous service. The SSB exciter should have at least an output of 65 watts PEP to obtain maximum output of the amplifier.

The Model 10LA amplifier is housed in a cabinet (22" Wx14¾" Dx36¾" H) which can serve as a base for conventional SSB exciter, or amplifier may be placed a short distance away from the associated exciter, if necessary for convenience.

Frequency range of 10LA is from 2 to 20mc, covered in 6 bands. Up to 4 independent non-simultaneous channels are provided. These four channels are selected externally by exciter channel control. One tuning unit is provided for each frequency specified up to maximum of four.

The 10LA amplifier is designed to work into a 50 ohm coaxial feed line. One output coaxial receptacle, common to all four channels, or 4 output coaxial receptacles (one for each channel) are available; each channel normally requiring its own antenna. For multi-channel operation with 1 antenna it is recommended that Aerocom Model ATU-410 antenna coupler be used.

A built-in directional coupler provides monitoring of output power and SWR. Grid current, plate current, filament voltage and high voltage are metered.

Harmonic output attenuation: second harmonic is at least 55 db down and higher harmonics are at least 70 db down. Noise level is 40 db below 1000 watts PEP output. Distortion products, in two-tone test, are at least 35 db down, depending on characteristics of exciter.

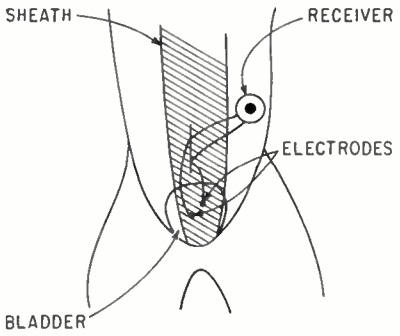
This linear amplifier, like all Aerocom equipment, is ruggedly constructed to give long trouble-free service. Additional information and technical data on request.

AER-O-COM

3090 S. W. 37th Avenue — Miami 33, Florida

been minimal, Bradley reported.

The device has also excited bladders of three human patients suffering bladder disfunction, following spinal cord or brain injuries. Bradley suggested that future users may include human patients



PASSIVE R-F *receiver implanted in dog stimulates bladder—Fig. 3*

suffering chronic neurological spinal cord disease with bladder dysfunction.

Regional f-m telephone networks should be a beginning step toward averting future disasters—such as the recent thalidomide tragedy—suggested Saul Larks, Marquette University.

ECG TRANSMISSION — New f-m telephone data transmission techniques now make it possible to transmit fetal electrocardiographic data in seconds or minutes, from any point served by telephone.

Although medical techniques also exist for early pre-natal detection of congenital cardiac malformation, they have not been widely disseminated or used in research outside one or two laboratories.

Preliminary tests of potent drugs should include fetal electrocardiograms from pregnant animals of several species, Larks said. Wide use of fetal ecg techniques as a mass screening study for all mothers in pregnancy at optimal times, such as 22 weeks, could pick up many congenital cardiac defects and spot their causative agents months earlier.

Regional conference and discussion networks for wider mutual comprehension of newest research advances could be expanded to national and eventually global scale, Larks suggested.

Transmission equipment for the f-m networks—developed jointly with Magnavox—consists of a simple f-m transmitter-sender, directly or acoustically coupled to standard switched telephone lines or Dataphone.

At the receiver, a f-m discriminator or equivalent Dataphone receiver converts f-m into an a-m signal, which can be written out or presented on an oscilloscope.

Hailstone Radar Echoes Suggests New Antennas

ARTIFICIAL hailstones are better radar reflectors than Luneberg lenses of the same size. This observation made in some recent experiments suggests the possibility of simpler and more economical radar targets and antennas.

The experiments were conducted to find an explanation for the strong radar reflections that occur during hail storms. The tests were made at the U. S. Air Force Cambridge Research Center, Office of Aerospace Research. Plexiglass spheres having varying refractive indices were used to simulate hailstones. A 7.2-cm sphere was found to have a cross section 2 db larger than the same size Luneberg lens, which is theoretically the perfect focusing device.

In earlier experiments at the University of London, D. Atlas of AFCRL measured backscatter from artificial hailstones. He found that a dry sphere of ice with a diameter larger than about two wavelengths scattered more efficiently than a metal sphere of the same size. He suggested that this effect might be the result of reflection and focusing of energy from the back surface of the ice.

Using geometric optics, it is found that in spheres with a refractive index between 1.4 and 2 there is a ray that comes to perfect focus at the rear pole of the sphere and returns to the radar from the conjugate point on the circle of incidence. In fact, all rays incident along this circle are returned to the radar. Radar cross section should therefore be enhanced by a predictable amount if a metal cap is placed at the rear pole.

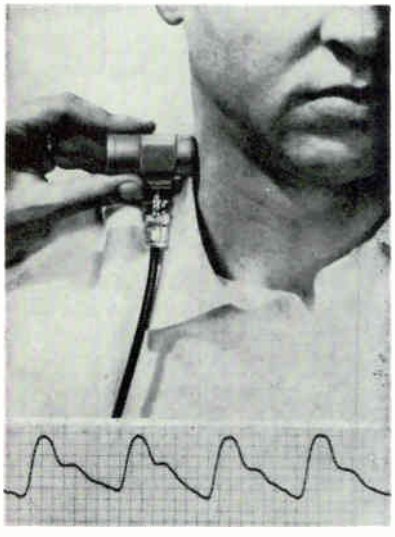
CROSS SECTIONS—Experiments were conducted with a 7.2-cm artificial hailstone on a 3.2-cm backscat-

ter range. The sphere, with a refractive index of 1.61 compared to 1.78 for ice, had a cross section 10 db greater than a metal ball the same size. Radar cross section was enhanced an additional 8 db by adding the metal cap, compared to a predicted enhancement of 7.5 db. This result confirms that energy is reflected from the back surface of the sphere.

Each sphere in a sense acts like a Luneberg lens, which is designed so that all incident energy is reflected toward a rear pole cap and reflected along reciprocal paths to the radar. Based on calculated backscatter cross sections for a reflective index of 1.78 (ice), a sphere should be equal to or better than a Luneberg lens for diameters up to 6.4 wavelengths, where gain is about 400. In practice, the Luneberg lens compares even less favorably. Thus at 3-cm wavelengths, a Luneberg lens less than a foot in diameter is of doubtful value.

A sphere of constant refractive index is much simpler to produce than a Luneberg lens with adjacent shells of increasing refractive index toward the center. Thus such spheres are economical targets, and their use as antennas is suggested.

Ultrasonic Somograph



ARTERY PULSE *recording was made with ultrasonic somograph developed by Sonomedic Corp., Westwood, N. J. Low-power, pulsed beam can also be used with cro display to measure organ and bone dimensions. Operating frequencies range from 500 Kc to 4 Mc. Depth resolution is ¼ mm at 4 Mc*

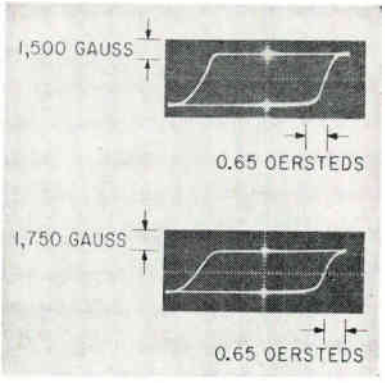
Getting New Shapes With Rubber Ferrites

Binders eliminate costly processing steps, extend use of ferrite logic elements

DIFFICULTIES in processing ferrites and limitation in the variety of shapes produced are factors which, up to now, have hindered their more widespread use and application.

General Motors' R. N. Hollyer Jr. and E. A. Hanysz describe a method to fabricate ferrites having complicated shapes by mixing ferrite powder with a rubber or plastic binder using a standard rubber mill. The ferrite batch produced is in the form of a uniform-density sheet that has constant magnetic properties throughout the material. The new method requires only various types of cutters or molds to produce a given shape and eliminates the need for costly dies and presses.

BINDERS USED—Polyvinyl chloride (vinyl) is a good binder when milled on properly heated rolls. The ferrite sheets also have been made using raw rubbers, such as natural rubber, SBR, polyacrylate, Buna N, and Butyl. Conventional practices for rubber compounding, mixing, and subsequent vulcanization proved applicable with these raw rubber binders. Percentage of binder in experiments reported by Hollyer and Hanysz has ranged from 12 to 18 percent by weight. The maximum ferrite powder loading of the mix was found to vary according to the physical characteristics of the powder and the binder used.



MAGNETIZING *characteristics of ferrites made with rubber or vinyl binders (top), and by a conventional ferrite (bottom) are shown in above square loop hysteresis curves—Fig. 1*

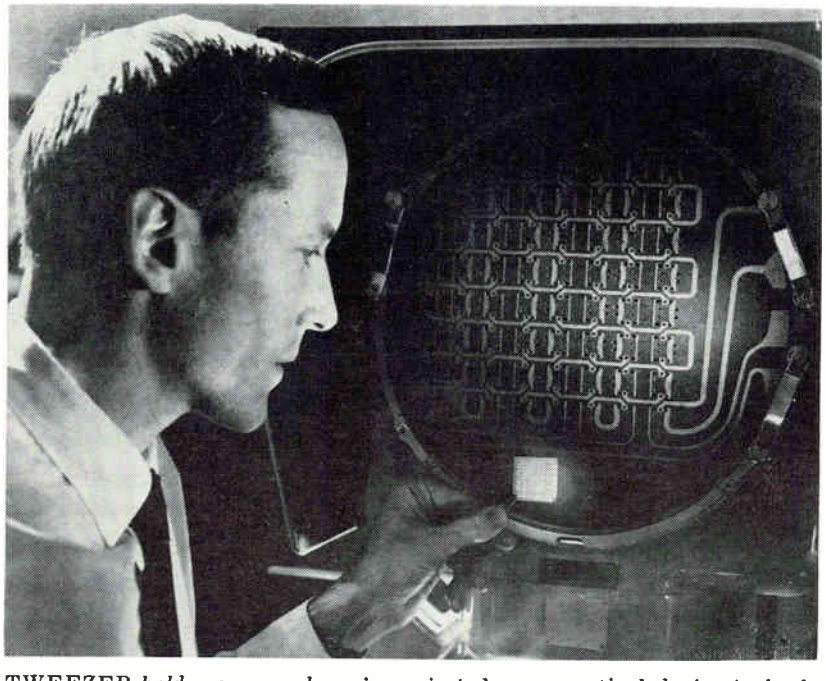
LOW COST—One important advantage claimed for the GM process is the low cost of producing ferrite pieces having complicated geometry. At present, the process is being used by the Electronics and Instrumentation Department of the Research Laboratories to produce the so called MAD elements, multiple aperture devices used in computer and logic circuits. These elements, currently too expensive to produce in certain configurations, may be produced at a low enough cost to allow their use in any device using logic circuits.

Magnetic characteristics of the square loop rubber ferrites used in the computer applications are said to be equal or better than those prepared by conventional methods.

Flexibility of the new fabricating technique has resulted in further research in areas where rubber ferrites can save money in other applications, such as stators used in d-c motors.

Method used to make rubber ferrites closely resembles the usual method of making ceramic materials. The mass emerges as a hard ceramic. During the sintering proc-

Memory Plane Formed by Photography

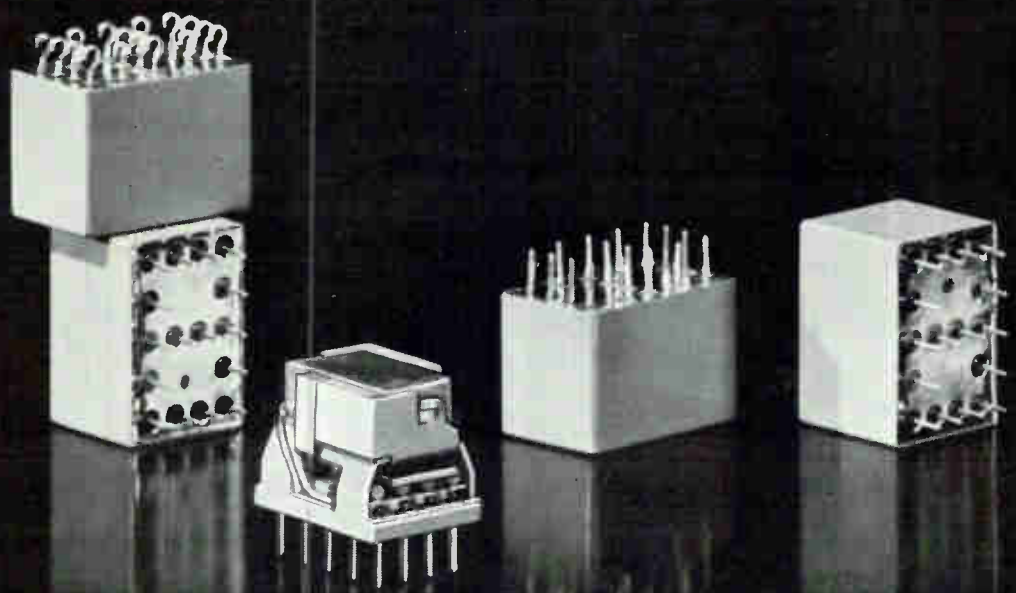


TWEEZER-*held memory plane is projected on an optical device in background. New RCA unit differs from standard computer memory in its use of permalloy transfluxors for memory cells, rather than ferrite cores. Memory is formed on single sheet by photographic processes, rather than manufactured separately and strung on cores. Tiny unit can process 100,000 items per second, is adaptable to automatic production*

New

micro-miniature

4-pole latching relay has sealed coils for greater reliability



TL SERIES This new latching relay's high inherent reliability is due to hermetically sealed coils, bifurcated gold plated silver alloy contacts and a unique magnetic structure.

Other features: Fast operate time, virtually no bounce, high shock (in excess of 100g) and vibration (30g to 2000 cps) resistance, small size (0.56 cubic inch). This relay meets or exceeds all applicable sections of MIL-R-5757D and PD-R 187.

Engineering samples are now available from Potter&Brumfield. Call your P&B representative for complete information.

TL ENGINEERING SPECIFICATIONS

Size: 1.031" long, .725" wide, .750" high max.
Weight: Approx. 1¼ ozs.
Contact Arrangement: 4PDT (bifurcated, gold plated silver alloy).
Rated: Dry circuit to 3 amps at 28 v dc res.
Life: 100,000 operations at max. rated load.
Coil Power: For two-coil relays: Approx. 1 watt (nominal at 25°C). For single coil relays: Approx. 0.5 watt (nominal at 25°C).
Operate Time: 6 milliseconds max. at nom. voltage at 25°C coil temp.
Transfer Time: 0.5 milliseconds approx. at nom. voltage at 25°C coil temp.
Temperature Range: −65°C to +125°C.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

AMF **POTTER & BRUMFIELD**

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

CIRCLE 57 ON READER SERVICE CARD

ess the grains weld to one another, some grow, some disappear, voids are filled, and the entire mass shrinks, sometimes as much as 20 percent.

Depending on their composition, ferrites may be permanently magnetic (so called hard ferrites), or they may have relatively low intrinsic magnetization but high permeability (soft ferrites). Useful hysteresis characteristics have applications in computers and logic circuits (see Fig. 1, p. 56).

Interest in Radiation Effects Is High

Work may offer clue to an understanding of molecular architecture

EFFECTS of nuclear radiation exposure on materials and devices is presently an area of high interest at several electronics laboratories. Studies of irradiated matter may be very important in creating materials and devices to order. This may be significant to "molecular engineering."

The fact that atoms may be dislodged from crystals by fast particles has been known since the first reactors were developed. A great deal of knowledge is now being built up concerning changes in electrical properties, thermal conductivity, and laws of molecular architecture.

This week several electronics laboratories report activities on radiation effects, say much of this work is still under wraps.

Work at Bell laboratories is conducted to investigate factors and relations controlling changes in properties of materials and devices exposed to gamma and neutron radiation. Aim of their nuclear electronic effects program (NEEP), is to develop materials, devices and circuits resistant to radiation. Bell is now investigating semiconductors, ferroelectrics, ferromagnetics, and piezoelectric materials.

One program at Stanford Research Institute concentrates on radiation effects in magnetics and dielectrics. Aim is to clarify how radiation sensitivity is related to the composition and structural perfection of the specimens. Researchers will establish the rate of recovery of useful magnetic and dielectric properties of materials.

At IBM, the effects of high-intensity pulsed nuclear radiation exposure on selected devices and materials (their SCORRE program) used in critical high-speed circuits is under investigation. One test series has irradiated ferrite and wound cores used for memory and logic applications. A preliminary check of results, recently reported, indicates that no significant pulse radiation effects have been detected in either the pulse or disturb tests. IBM is also investigating components used in airborne digital computers and includes capacitors, transistors and diodes.

DAMAGE THRESHOLDS — General Electric has a program concentrating on radiation effects on microwave devices. Another GE program is investigating radiation damage thresholds of elements. Changes in residual electrical resistances have been measured for a number of metals as a function of electron energy in the range from 0.5 to 1.5 mev. Irradiations were performed at less than 20 deg K and recovery measurements have been made up to 300 deg K.

An analysis of data on experimental radiation effects for the military is being conducted at Edgerton, Germeshausen & Grier, Inc.

Previous work on nuclear radiation of electronic components was reported by Admiral Corporation. Analysis of past data revealed basic weaknesses and indicated whether the component under analysis could be improved by a better choice of materials, or whether component did not constitute a radiation problem. Admiral has evaluated several types of capacitors: mylar, ceramic and vitreous enamel types, high-

temperature film resistors, transistors, transformers, relays switches and transmission cables.

Frederick Seitz, now chairman of the department of physics at the University of Illinois, has compiled an extensive bibliography on the effects of irradiation on metals.[1]

REFERENCE

(1) Frederick Seitz, Effects of Irradiation on Metals, *Rev of Mod Phys*, p 656, Oct., 1962; also *Science*, p 563, Nov. 2, 1962.

Microwave Tube Operates At High Temperature

INVESTIGATION of factors permitting long life operation of microwave tubes at very high ambients resulted in the successful development of a magnetron that operates for 400 hours at 400 deg C without need for cooling.

The glass high-voltage bushing and output window were replaced with high alumina ceramic parts. Steel magnet poles were redesigned and clad with OFHC copper sheet. All silver solder used for braze joints was replaced with gold-copper and gold-nickel alloy solders, copper solder, or heliarc welding.

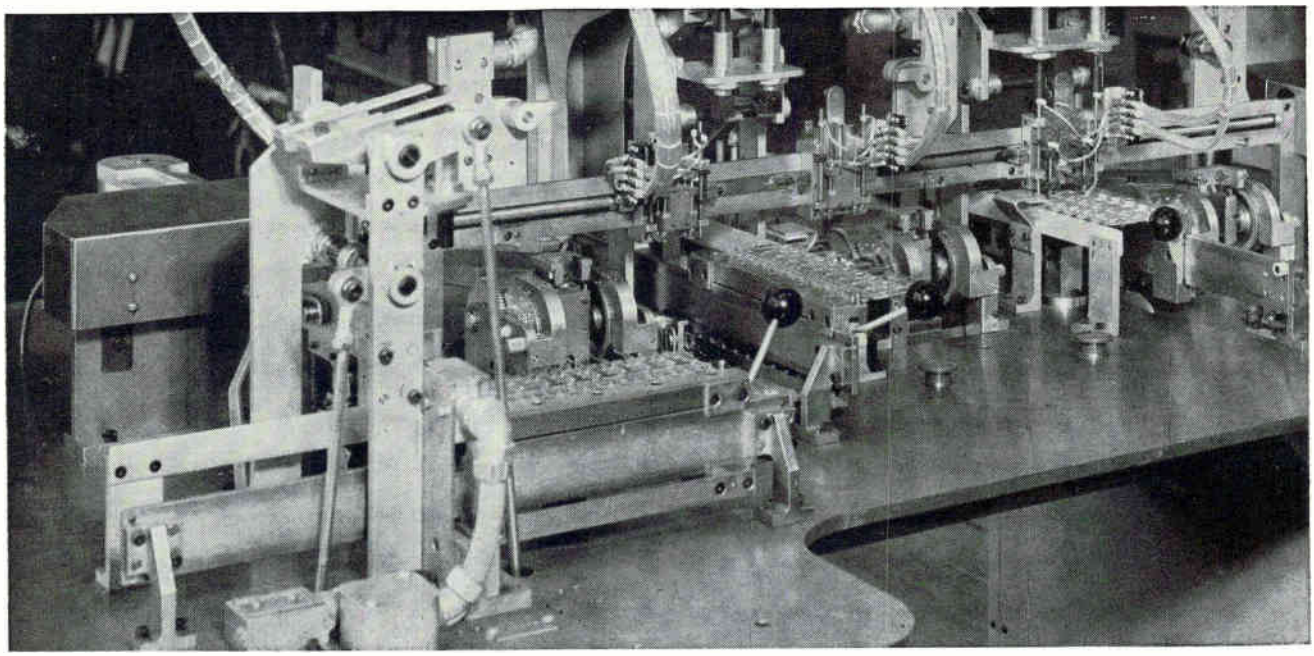
The copper was selected because of extremely low diffusion rate of hydrogen, carbon and oxygen, and because copper won't poison a thoria cermet-type cathode. Copper cladding and steel were joined together by 825 gold-nickel solder.

Double-vacuum bakeout was selected as the exhaust processing method to eliminate gas permeation through the tube envelope during processing, reduce thermomechanical bakeout stress, and allow for a sealoff vacuum of 10^{-9} torr.

Four tubes were constructed and evaluated: the prototype, a tube life tested at 240 deg C anode temperature with the extremeties of the tube at 200 deg C, and two other tubes life tested at 400 deg C overall.

Materials capable of withstanding higher temperatures than copper are presently being evaluated for use as anode material.

Work was reported by Raytheon's Raymond Dyer at company's Spencer Laboratory.



NETWORK BOARD *welder machine makes a minimum of 10,000 welds an hour on 120 boards*

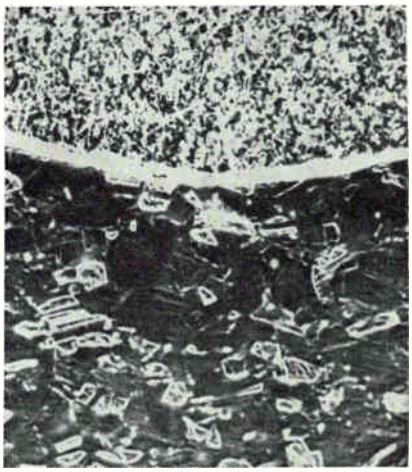
Low-Voltage Welding Lowers Costs

Makes more connections in a given area. Has short weld cycle and high speed.

By J. S. GELLATLY
Western Electric, Inc.
Chicago, Illinois

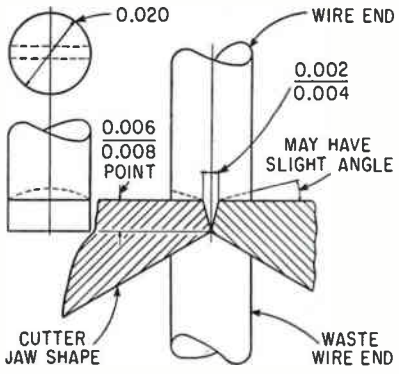
POTENTIALS in the range of 35-75 volts as compared with the 1,000-1,500 volts in high-voltage percussion welding have been used to obtain optimum percussion welds in 150-300 microsecond time intervals. The low voltage percussion welding process has been developed to a stage of reliability and quality attractive for selected applications. A direct capacitor discharge enables the weld energy to be closely controlled by the voltage to which the welding circuit capacitors are charged. Also contributing to weld-energy control is arc current duration as determined by a special feather-edged welding tip that intensifies the electric field on the end of the wire. This tip enables the arc to be struck at a distance of only a few angstroms as against the several thousandths of an inch separation in high voltage percussion welding.

Because of the short weld time, heat transfer is limited to a very minute value making the process attractive for connecting heat sensitive devices. High arc temperatures and extremely short arc duration enable the joining of metals of high electrical and thermal conductivity to each other and also to metals of differing characteristics. Refractory metals may also be joined to other metals. Currently, machinery has been developed to weld: leads to resistor caps, leads to dry reed switches, capacitors and resistors to network circuit boards.



THIN FUSION *area and unchanged grain structure indicate small heat effects in tinned copper-to-nickel silver weld*

SYSTEM UNITS—Two basic units —a mechanical system and an electrical system—make up the device actuating the process. The mechanical system includes a movable jaw that accelerates the wire towards the terminal to which the wire is to be welded. Suitable movable clamps or chucks are also used as wire-holders. The electrical system consists of a bank of capacitors, suitable d-c charging source and, in the case of a multiple welding set-up, some isolating diodes to prevent interchange of energy between individual capacitor banks through the charging source. One side of



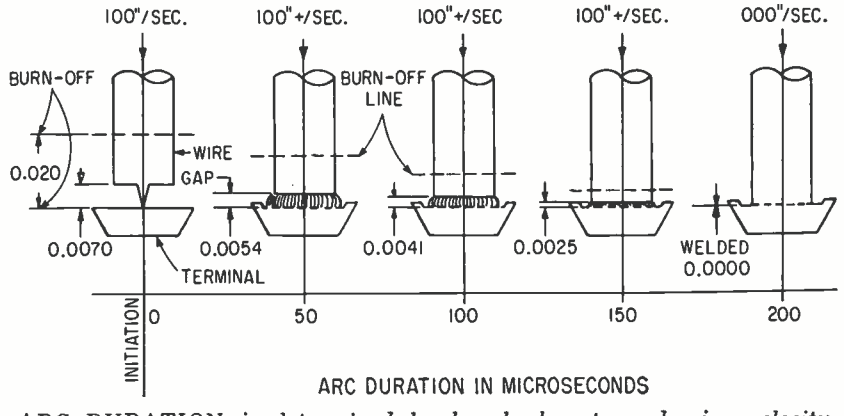
FEATHER-EDGED *tip is cut at wire ends using the proportioned dimensions shown—Fig. 1*

the capacitor bank, usually the negative, is connected to the terminal holding device. The other pole attaches to the movable jaw holding the wire to be welded.

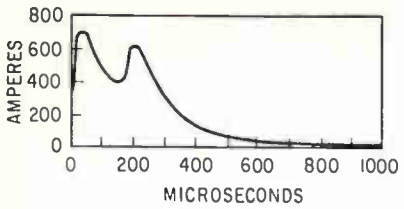
FEATHER-EDGED TIP—In low-voltage percussion welding, potentials in the range of 35-75 volts make arc initiation difficult. A special tip was designed to intensify the electric field on the end of the wire. Without such a tip, arc initiation is very erratic and, at high wire approach velocities, the arc may not strike. The tip represents the optimum shape as derived from extensive studies covering conical, pyramidal, unsymmetrically cut, and other types. As might be expected, for a given wire size, approach velocity, and stored energy, the volume of material within a given shape is also very important. For most instances, utilizing round wire, the dimensions of Fig. 1 may be proportionally scaled. The razor-like, feather-edge tip will burn back and vaporize rapidly as the arc plasma expands over the full wire end area to provide the maximum molten section for welding. The arc is extinguished by contact of the molten surfaces when the rate of burn-back is exceeded by the approach velocity of the wire.

TIME INTERVAL—The typical situation for arc initiation, burnback, and welding is shown in Fig. 2. This is illustrative of such welding as #22 or #24 tinned copper wire to a nickel-silver or copper nickel-switch (or relay terminal). The mechanical system provides a constant velocity of 100 inches. The total capacitance and charging voltage have been selected so that approximately one-half the stored energy is dissipated in the arc prior to extinction. Thus, as pictured, the controlling parameters: velocity, volume of melted metal, and arc energy, are proportioned to accomplish the weld in 200 microseconds.

ARC CURRENT—Figure 3 is an example of what is considered to be a desirable arc current curve for the typical case of welding #24 tinned copper wire. Note the rapid rise of arc current with the peak occurring at about 35 to 40 microseconds after arc initiation. The peak is followed by a typical exponential decay of arc current with arc extinction occurring at 190 microseconds. The second current peak represents the residual energy stored in the capacitors being discharged through the completed weld. Note the approximate equality



ARC DURATION *is determined by burnback rate and wire velocity. Optimum welds result when duration lies between 150 and 300 microseconds—Fig. 2*



RAPIDITY *of process minimizes loss of weld heat prior to arc extinction after 190 microseconds—Fig. 3*

of the energy areas under the two sections of the current curve as defined from arc initiation to closure and closure to zero current.

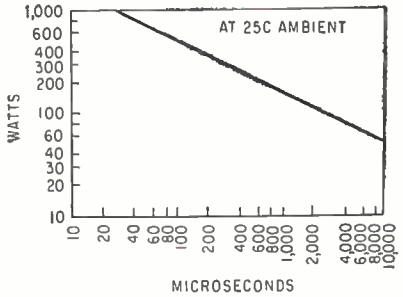
Storage Space Saved By Tool Cabinets

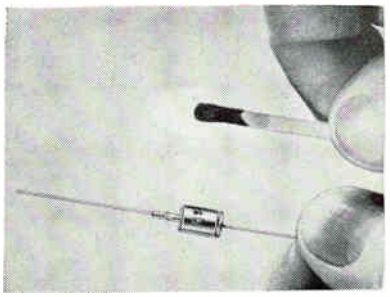
SERVICE *manpower for old tool system (top) was greatly reduced by new system (bottom)*

THIRTY TWO industrial storage cabinets store $100,000 worth of tools, accessories and equipment at Raytheon's Airborne Operation plant. Use of the cabinets increases aisle widths over that in the former conventional setup which used a much larger area of about 700 square feet. Formerly, individual items were stored in some 65 sections of open metal shelving running 7 feet in height, requiring use of ladders or stools. Charts were needed to locate 7000 different items in the tool crib inventory. The storage cabinets, manufactured by Vidmar, are 59 inches high and take up less than half the former space.

Diode Dissipates 1 Kw Reverse Power

Miniature silicon axial-lead rectifier exceeds EIA-NEMA Class-B service





ANNOUNCED by General Instrument Corp., Rectifier Div., 65 Gouverneur St., Newark, N. J., the small (0.57-in. length), flangeless, pigtailed-mounted silicon rectifiers, type V.I.P., are rated at 2 amperes and have built-in voltage impulse protection against reverse overvoltages with reverse power dissipation of 1 Kw for 25 μsec transients. These rectifiers use controlled avalanche characteristics to dissipate large reverse power pulses without protective circuits. The 1N3938, 1N3939 and 1N3940 are rated up to 600 v pv, and exceed requirements of EIA-NEMA class-B service.

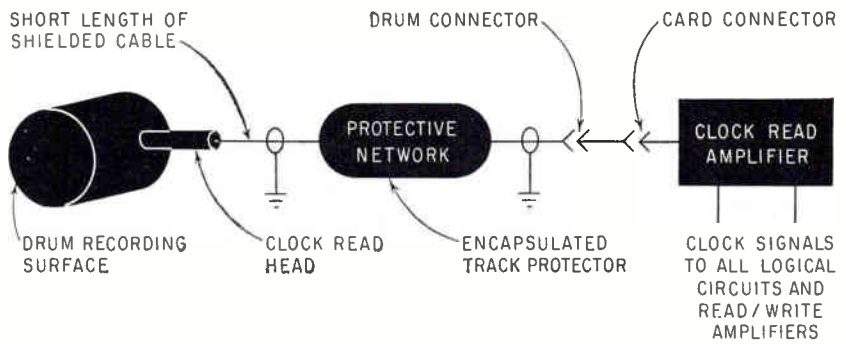
Avalanche breakdown at 0.05 ma d-c and 25 C ambient is up to 1,000 v, rms input is up to 420 v, d-c blocking voltage is up to 600 v, and average forward current at 25 C ambient is 2 amperes down to 0.5 ampere at 150 C ambient. Peak surge current, ½ cycle non-recurrent at 25 C ambient, no load is 70 amperes, dropping to 30 amperes at 85 C ambient superimposed on full load.

Peak forward voltage drop at 6 amperes, 25 C ambient is 1.1 v, reverse current full cycle average is 200 μa, and maximum d-c reverse current at rated d-c blocking voltage is 5 μa at 25 C and 500 μa at 150 C. Avalanche voltage slope is typically 3 v. Thermal impedance, junction to air, is 85 C per watt.

CIRCLE 301, READER SERVICE CARD

Preventing Accidental Erasure of Clock Tracks

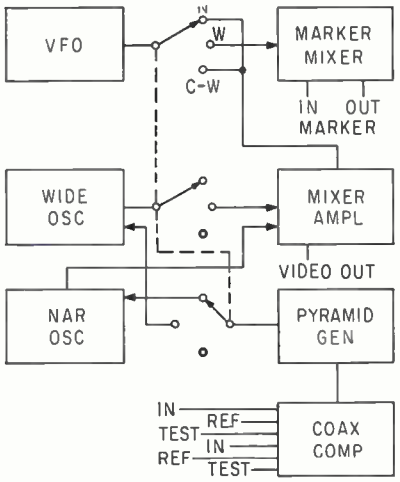
DEVELOPED by Westwood Div., Houston Fearless Corp., 11801 West Olympic Blvd., Los Angeles 64, California, the track protector prevents accidental erasure or distortion of magnetically-recorded clock tracks on memory drums and eliminates engraving drum tracks and the low readback voltages and signal-to-noise ratios inherent in engraved tracks. Readback signal is not affected by device. Available with clock frequencies between 25 and 500 Kc, the device prevents erasure or damage to a magnetically-recorded track when a-c voltages up to 230 v, transient and d-c voltages up to 600 v and head drive voltages of any frequency were applied. If a clock track is read with the same head used for recording, there is a high degree of risk that the head may be subjected to transient electrical conditions that may erase part or all of the track. The same thing is true of data tracks, but digital systems almost invariably are equipped to re-record data tracks. When the clock track is damaged, specialized clock-writing equipment has to be used. Clock tracks have been damaged through routine use of ohmmeters, soldering irons that create thermoelectric forces in the electrical circuit of the clock read head, or even by plugging or removing the clock read amplifier card with system power on. As shown in the sketch, the track protector (consisting of passive elements) is placed in the head cable between the head and drum connectors. (302)



Sweep Generator Covers 1 Kc to 15 Mc Range

RECENTLY announced by Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pennsylvania, the model 1015 video sweep generator covers the range between 1 Kc and 15 Mc, has a stable narrow

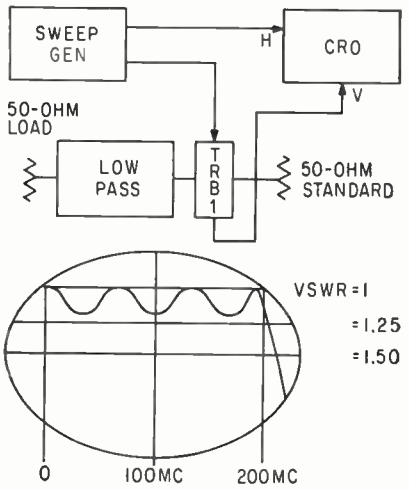
sweep of 600 Kc maximum (20 cps residual f-m), and a wide sweep (10 Kc to 15 Mc) for video applications. Response is flat with ±0.15 db maximum variation. Three types of output are provided: wide sweep covering the entire range between 10 Kc and 15 Mc; narrow sweep widths of 0 to 400 Kc centered anywhere between 1 Kc and 15 Mc; and a c-w output. Device output is 2.0 v rms. Other features include manual or automatic sweeping, sweep repetition ranges ranging from 1 sweep per 2½ minutes to 60 sweeps per second, built-in marker generator, and a built-in coaxial switch synchronized to the sweep to permit parallel substitution for measurement by comparison. Output impedance is 50 or 75 ohms and a calibrated output meter is provided. As shown in the sketch, two signals are combined in the mixer amplifier. In narrow position, a stable calibrated variable oscillator beats with a narrow sweep oscillator held at constant frequency so that sweep width does not change as center frequency is varied. In wide position, same vfo is used as frequency marker. In c-w operation, modulation is removed from narrow sweep oscillator. Pyramid generator is variable between 1 sweep per 2 minutes to 60 sweeps per second. Pyramid generator also drives the coaxial comparator.



CIRCLE 303, READER SERVICE CARD

Decade Inductor for Audio and Low R-F

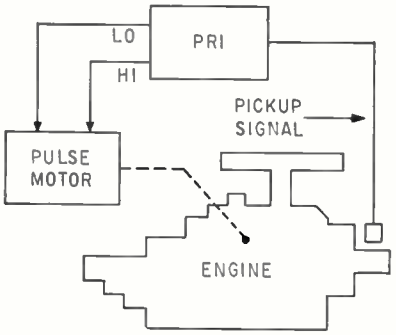
NEW from Bundy Electronics Corp., 44 Fadem Rd., Springfield, N. J., is a decade inductor designed to provide incremental steps of inductance for use in comparison circuits, wave filters, equalizers, tuned circuits and analyzers in the design stage. Sixteen inductors are used in four decade stages between 0 and 11.110 henries in steps of 1 mh. Dissipation factor is 0.01 at 0 Kc, d-c resistance is approximately 45 ohms per henry, voltage is 500 v rms and accuracy is based on nominal value at zero frequency and initial permeability. Since the inductance values are determined at zero frequency and initial permeability, a frequency versus change in inductance chart over the useful frequency range is included to show the magnitude of effect of frequency on inductance values and provides means of obtaining precise values at any frequency. (304)



Reflection Coefficient and VSWR Detector

MANUFACTURED by Telonic Eng. Corp., P. O. Box 277, Laguna Beach, California, the model TRB-1 Rhotector is a precision impedance comparator with range between 5 and 900 Mc, 30 db minimum unbalance, and output impedance of 20,000 ohms, negative polarity. The device is a symmetrical frequency-insensitive bridge, with two legs consisting of externally-connected impedances and r-f power supplied to the input port. The device generates a detected output voltage proportional to the coefficient of reflection between the impedances, unbalanced of negative polarity. Since the output time constant is 4 μsec, the device can be used with swept or modulated sources to display a vswr

vs frequency curve on a cro. In a typical application, the unknown impedance is compared with a standard matched load impedance. Output voltage magnitude is a monotonic function of the vswr of the unknown impedance referred to the standard with output null for unity vswr. Output indicator is calibrated by substituting one or more standard mismatched loads for the unknown impedance. Although optimized for 50 ohms, it can be used effectively for any standard coaxial impedance level. (305)

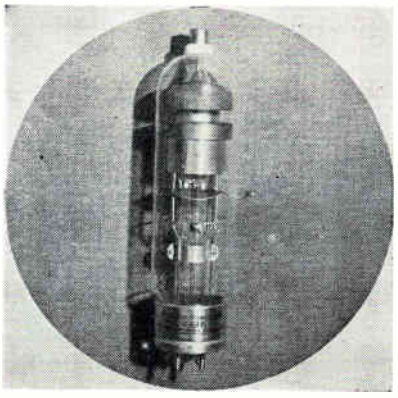


Pulse Rate Indicator also Has Threshold Detectors

ON the market from Performance Measurements Co., 15120 Third Ave., Detroit 3, Michigan, the type PRI transistorized pulse rate indicator measures varying-frequency input pulses to 0.1 percent and indicates on a 0.25-percent deviation meter. Input pulses having a direct relationship to the variable being measured can be in the form of low-level pulses or sine waves down to 5 mv or up to 400 v at frequencies between 10 cps and 10 Kc. Upper and lower threshold detectors can be set to particular points to 0.1-percent accuracy. Relay contacts are rated at 5 amperes. Input transducers that can be used include magnetic, inductive and capacitive pickups, internal combustion ignition, contact closures, photoelectric and photovoltaic cells, and essentially any other repetitive electrical pulse. Irregularly-shaped pulses are rectified and filtered and resulting pulses are converted to rectangular ones by a trigger circuit. These activate a multivibrator to produce pairs of rectangular pulses, 180 degrees out of phase and half frequency. These output pulses go to a constant-width generator to produce pulses of constant width at

a frequency equal to the trigger pulse. Amplitude limiting circuits maintain level constant. The meter circuit integrates to produce an analog signal proportional to speed sensed at input. This analog signal can also be used for feedback rate control to vary unknown rate as shown on p. 67. If rate from engine ignition coil (compared to low set point of device) goes below set, low contact alarm powers pulse motor to feed more fuel to engine. If rate exceeds top set point, fuel flow is reduced.

CIRCLE 306, READER SERVICE CARD



Half-Wave Rectifiers Have 20,000 PIV

NATIONAL ELECTRONICS, INC., Geneva, Ill., announces the NL-6894 and NL-6895 mercury vapor h-v half-wave rectifiers. They have multiple ratings, depending upon the application and operating temperature. Ratings are: max d-c amperes output, up to 2.5; max instantaneous amperes output, up to 11.5; max piv up to 20,000; and condensed mercury temperature limits, 20 C up to 60 C. Other ratings applying to all applications: filament volts, 5; filament amperes, 9 to 11; filament heating time, 20 sec. (350)

Subminiature Blower

GLOBE INDUSTRIES, INC., 1784 Stanley Ave., Dayton 4, O. An a-c blower, which delivers 20 cfm air flow at 0.5 in. of water in a package weighing just 4.2 oz, is designed for both 400 and 800 cycle operation at 115 v a-c, and has a 2,000 hr life while meeting all applicable MIL environmental specifications. (351)

High Frequency Hybrid Solves Balun Problems

ADAMS-RUSSELL CO., INC., 280 Bear Hill Road, Waltham 54, Mass. New h-f hybrid is a balanced to unbalanced transformer that offers an off-the-shelf solution to broadband power splitting and balun problems. Features include: extreme broadband performance (5 Mc to 32 Mc), high isolation, low insertion loss, and excellent phase balance. The vswr is less than 1.5 when all ports are terminated in 75 ohms. Dimensions are: 5 in. wide by 4 in. high by 1 in. in depth. (308)

Zener Regulators Offer High Reliability

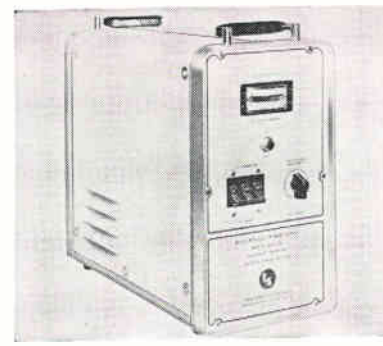
POWER COMPONENTS, INC., P. O. Box 421, Scottdale, Pa. The Z series Powercomp Zener regulators are available with voltages ranging from 6.8 to 200 v and power ratings of 1w, ¾ w and ½ w. Standard tolerances on all units are 1 percent, 5 percent, 10 percent and 20 percent. Ultra low reverse leakage current specifications exemplify processed-in reliability. Specially designed pure silver leads further improve reliability by locking the device in a high temperature, high pressure molded package. (309)

Gas Laser Produces C-W Light

OPTICS TECHNOLOGY, INC., 248 Harbor Boulevard, Belmont, Cali-

up or drop out with the model E790 or E791. Use where different settings are required, or in labs for development of prototype systems. Available in 4pdt arrangement for up to 10 amp resistive at 32 v d-c and/or 115 v a-c continuous duty with max recycle of 0.025 sec. Units are protected from transient spikes.

CIRCLE 314, READER SERVICE CARD



D-C Power Supply Weighs Only 100 Lb

CHATHAM ELECTRONICS DIVISION of Tung-Sol Electric Inc., Livingston, N. J. Model R2432-100 solid state power supply provides 0-100 amp at 24-32 v d-c from a standard 200-240 v, 60 cps a-c source. Unit comes with standard equipment for remote sensing and parallel operation and radio noise is internally suppressed per MIL-I-26600 and MIL-I-6181D. Regulation is ±0.75 percent line and ±0.35 percent load. Response time is 100 millisec for a full load swing and the unit can withstand a 100 percent overload for 5 minutes, or 500 percent for 1 sec. **(315)**

Pressure Transducer Has Digital Output

STATHAM INSTRUMENTS, INC., 12401 W. Olympic Blvd., Los Angeles 64, Calif. Model P606 digital pressure transducer converts pressure into a 7-bit unambiguous binary code output which divides the pressure into 128 discrete parts. The instrument's output can be read visually

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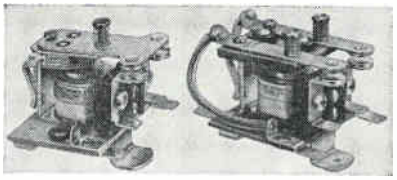
Gas Laser Produces C-W Light

OPTICS TECHNOLOGY, INC., 248 Harbor Boulevard, Belmont, Cali-

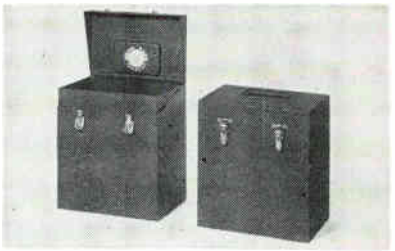
fornia. Model 150 produces visible light at 6328 Angstroms. Accessories are available for infrared output at 1.153 microns. Output is ideal as a source for modulation and long-path interferometer experiments, demonstrations in classical optics and various systems applications. Its precision mirrors adjust to produce various mode patterns. The laser may be table or optical bench mounted. A removable metal case protects the helium-neon gas tube and mirrors.

CIRCLE 310, READER SERVICE CARD



Power Relays Are Upright Mounting

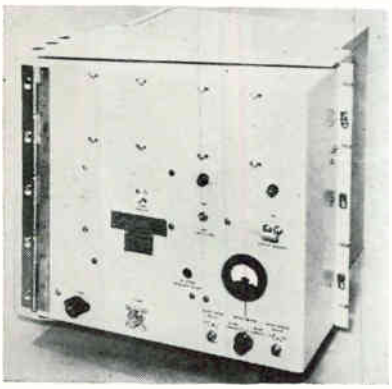
SNYDER ELECTRONICS CORP., 212 E. North St., Waukesha, Wisc., offers the series 240 and 242 power relays. Each unit will carry 25 amperes resistive load at 230 v a-c. A million cycles at rated load was applied to the 240 relay without a failure and with no apparent wear of the contacts. Contact material is silver cadmium oxide alloy. Coil operating voltage, 6 v to 250 v; d-c, 6 v to 110 v. Insulating materials: molded phenolic (Durez 1544) and laminated phenolic Grade XP. Insulation resistance: 50 megohms min. Breakdown voltage: 1500 v rms between all elements. (311)



Shielding Container Preserves Magnetic Tape

MAGNETIC SHIELD DIVISION PERFECTION MICA CO., 1322 North Elston Ave., Chicago 22, Ill., offers a rugged Netic Co-Netic magnetic tape shielding container which keeps vital military and industrial recordings in their original condition and unaffected by exposure to unpre-

dictable magnetic fields during transportation or storage. The hinge's axis is located on the container's topmost edge. An overlapping magnetic shunt strip heliarc welded into the cover eliminates the magnetically open gap that would otherwise be present in the space occupied by the stainless steel hinge. This makes for compact storage and easy removal of stored tapes. (312)



Parametric Amplifier Tunes Over 350-475 Mc

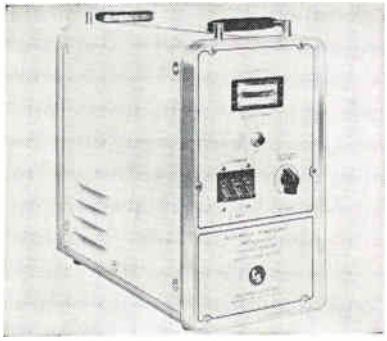
AIRBORNE INSTRUMENTS LABORATORY, Deer Park, L. I., N. Y., offers tunable parametric amplifiers designed for use with quadruple diversity troposcatter communication systems. Model 1789 is tunable over the range from 350 to 475 Mc and has a nominal noise figure of 1.5 db. Although designed for use with the AN/FRC-39 receiver, the unit is easily adapted to other systems. The amplifier is housed for installation in a standard 19-in. rack and is easy to tune and operate. (313)

Time Delay Relay Has Adjustability

WHEATON ENGINEERING DIVISION, Hurletron Inc., 920 Manchester Road, Wheaton, Ill. Dial your time up to 1,000 sec ±5 percent, lock the micro dial and time either on pick

up or drop out with the model E790 or E791. Use where different settings are required, or in labs for development of prototype systems. Available in 4pdt arrangement for up to 10 amp resistive at 32 v d-c and/or 115 v a-c continuous duty with max recycle of 0.025 sec. Units are protected from transient spikes.

CIRCLE 314, READER SERVICE CARD



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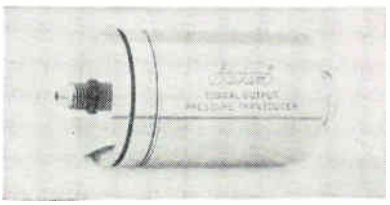


Pressure Transducer Has Digital Output

STATHAM INSTRUMENTS, INC., 12401 W. Olympic Blvd., Los Angeles 64, Calif. Model P606 digital pressure transducer converts pressure into a 7-bit unambiguous binary code output which divides the pressure into 128 discrete parts. The instrument's output can be read visually

or it can be fed directly into a magnetic tape system, typewriter system, etc. Transducer measures pressures from 0-1 psi through 0-1000 psi full scale; absolute, gage, and differential. Combined non-linearity and hysteresis is less than ±1 percent full scale. Input is 1 to 10 v; output is a 7-bit binary code, 1 to 10 v. Unit operates over a temperature range of −65 F to +250 F. **(316)**

Double Stub Tuner Covers 40 to 400 Mc

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. By using a helical inner conductor in both the stubs and in the body between the stubs, the electrical length of the DS-109H has been made much greater than its mechanical length. A mechanical travel of the stubs of only 53 cm is equivalent to a change in electrical length in excess of 300 cm. Within the specified frequency range, the DS-109H will match any impedance in a 50 ohm line resulting in a vswr of less than 7.0. Price is $250. **(317)**

Current Limiter Regulates to ± 1 Micromho

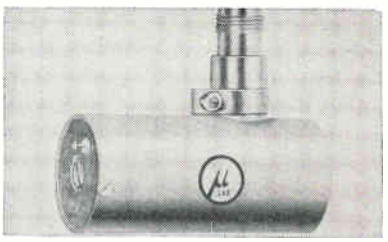
CIRCUIT DYNE CORP., 480 Mermaid St., Laguna Beach, Calif., has available a low level current limiting de-

vice capable of ±1 μmho regulation. Model CP-8 is a two-terminal component that may be specified with any current level from 2.1 to 1 ma in 5 percent increments. Measuring only 0.8 in. in diameter by 1.05 in. long, the device is encapsulated in epoxy and is available with single-ended or axial leads. It is a silicon type, capable of handling up to 40 v and operating in a temperature range of −55 to +100 C. Over-all current regulation is ±0.1 percent.

CIRCLE 318, READER SERVICE CARD

Protective Coating

COLUMBIA TECHNICAL CORP., Woodside 77, N. Y. A single-component high temperature coating, Humi-Seal type 1C42, is recommended for treatment of precision power resistors to pass MIL-R-26C specifications. (319)



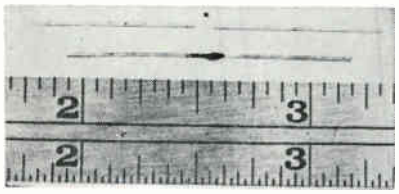
Cavity Oscillators Span 960 Mc to 5.9 Gc

MICROLAB, Livingston, N. J., offers a series of cavity oscillators covering the frequency range from 960 Mc to 5,900 Mc in four units, each within 10 percent tuning range. Designed around a ceramic triode, these units are used in local oscillators, drivers for harmonic generators and c-w signal sources. Four models cover C, S, SL, and L band applications. Units are minimum size and light weight, varying from 3.0 oz to 6.0 oz. Tuning is accomplished by means of a single screw adjustment. (320)

Signal Sampler and Memory Module

TEMPO INSTRUMENT, INC., Plainview, L. I., N. Y., has available a sample and hold miniature module which provides a sustained output

voltage of a sampled analog signal. The transistorized module provides an accurate long-term voltage level output equal to the instantaneous amplitude of a sampled signal. The unit incorporates new solid-state circuits which perform this function accurately and economically. Module provides a high input impedance and low output impedance, and is capable of sampling at a fast rate. **(321)**



Microwave Switches Use Ribbon Leads

MICROSEMICONDUCTOR CORP., 11250 Playa Court, Culver City, Calif., has available two lines of microwave switches (750 mw and 300 mw). For insertion into waveguides, the 0.150 in. length by 0.060 in. diameter size of the 300 mw unit are most desirable. This is further enhanced by the use of a ribbon lead. Single junction silicon devices have high back resistances capable of 1500 v piv. Capacitances below 1 pf are standard. Devices are operational from — 65 C to + 175 C and meet or exceed MIL-S-19500 C and MIL-STD-202B. **(322)**

Digital Voltmeter

COHU ELECTRONICS, INC., Kin Tel Division, 5725 Kearny Villa Road, San Diego 12, Calif. Model 502 BZ, an a-c/d-c digital voltmeter for submarine and other special environment applications, measures d-c between ± 100 μv and ± 1,000 v, a-c from 30 cps to 10 Kc between 1 mv and 1,000 v. **(323)**

Plug-In Oscillators

SUMMERS AND MILLS, INC., 1511 Levee St., Dallas 7, Texas. Plug-in single frequency oscillators feature 20 cps to 500 Kc selection, planar transistor reliability, 10 v rms output, and low price. **(324)**

Literature of the Week

PIEZOELECTRIC CERAMICS Clevite Electronic Components, 232 Forbes Road, Bedford, O., has available a 12-page booklet entitled "Modern Piezoelectric Ceramics."
CIRCLE 325, READER SERVICE CARD

AIR DATA INSTRUMENTS Giannini Controls Corp., 1600 S. Mountain Ave., Duarte, Calif. Easy reference catalog describes 17 typical products in a line of air data instruments. (326)

ENVIRONMENTAL TEST LABORATORY Philco Corp., 3825 Fabian Way, Palo Alto, Calif., has published a 10-page brochure describing the environmental test laboratory of its space division, Western Development Laboratories. (327)

DIRECT-WRITING RECORDER Brush Instruments, division of Clevite Corp., 37th and Perkins, Cleveland 14, O. Booklet describes uses of the direct writing recorder as applied in supervision, troubleshooting and maintenance of telecommunications equipment. (328)

THERMOSTATS Chatham Controls Corp., 124 River Road, Chatham, N. J. A six-page color brochure covers a line of miniature and subminiature thermostats. (329)

FACILITIES General Electric Co., P. O. Box 8555, Philadelphia 1, Pa., has published a booklet describing the new antenna and radar cross-section laboratory at its Valley Forge Space Technology Center. (330)

GALVANOMETER Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. The high frequency capability of the type 7-365 galvanometer is described in a two-page bulletin. (331)

REED RELAYS Industrial Timer Corp., U. S. Highway 287, Parsippany, N. J. Bulletin 450 contains complete details and prices on five new types of dry reed relays. (332)

PORTABLE OSCILLOGRAPH Massa Division of Cohu Electronics, Inc., 280 Lincoln St., Hingham, Mass. Data sheet describes a two-channel strip-chart recording system in a portable package. (333)

PHOTOELECTRIC COUNTER Electro Devices Inc., 75 Adams St., Newton, Mass. Bulletin gives information on solid state photoelectric counter for use with new or existing toroid winders. (334)

TEMPERATURE TAPE Control Indicating Corp., Bradley Field, Windsor Locks, Conn. Six-page folder contains technical data and application information on linear temperature tape. (335)

SNAP-ACTION SWITCHES MicroSwitch, Freeport, Ill. *Micro Tips* No. 31 contains ideas submitted by plant engineers and electricians showing

how they have used snap-action switches to increase production efficiency. (336)

HALL EFFECT COMPONENTS Instrument Systems Corp., 111 Cantiague Road, Westbury, L. I., N. Y. A complete line of Hall effect components and devices is described in an 8-page, 2-color catalog, No. H-20014. (337)

H-F PHASE SHIFTERS Nilsen Mfg. Co., P. O. Box 127, Haines City, Fla. Technical data sheet covers a series of r-f phase shifters operating at specific user frequency from 5 to 40 Mc. (338)

WIDEBAND TRANSISTOR AMPLIFIERS Radio Corp. of America, Somerville, N. J., has available a pamphlet entitled "Design of Wideband Transistor Amplifiers." (339)

D-C POWER SUPPLY Engineered Electronics Co., 1058 E. First St., Santa Ana, Calif. Technical data sheet is available on a solid-state, triple six-volt d-c power supply with voltage regulation of 0.1 percent. (340)

DIRECTIONAL CROSSGUIDE COUPLERS Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Centre, Natick, Mass. Catalog XT62 describes more than 125 crossguide couplers in EIA waveguide sizes WR28 through WR284. (341)

D-C AMPLIFIER Dana Laboratories, Inc., 630 Young St., Santa Ana, Calif. Data sheet 34 describes model 2000 solid-state, wideband, differential, low-level d-c amplifier. (342)

VOLTAGE CALIBRATOR RFS Engineering Co., 2nd and Westmoreland Sts., Philadelphia 40, Pa. Bulletin describes model 1200 voltage calibrator that will precisely measure the amplitude of a signal on an oscilloscope and also check the bandwidth of the oscilloscope. (343)

COUNTER-TIMERS Eldorado Electronics Co., 1832 Second St., Berkeley 10, Calif. A two-page bulletin contains illustrations and technical description of the 720 series counter-timers. (344)

DETECTOR/READOUT Trio Laboratories, Inc., Plainview, L. I., N. Y. Bulletin TL-500 describes model ID-1 precision voltage-sensitive detector/readout. (345)

SILICON RECTIFIERS Bradley Semiconductor Corp., 275 Welton St., New Haven 11, Conn. Brochure covers the Redtop line of silicon rectifiers that feature integral insulation, high thermal conductivity and double diffused junctions. (346)

MOTOR-RUN CAPACITOR Aerovox Corp., New Bedford, Mass. Bulletin 172B2 gives details on a reduced size a-c motor-run metal cased tubular capacitor. (347)

FACILITIES Milletron, Inc., 454 Lincoln Highway East, Irwin, Pa., has published a brochure outlining its personnel, experience and facilities for instrumentation and control systems in the nuclear and industrial fields. (348)

3M Company Building Third Plant

CONSTRUCTION of a third domestic magnetic tape manufacturing plant has been undertaken by Minnesota Mining and Manufacturing Co. at Camarillo, Calif., about 45 miles northwest of Los Angeles.

The 125,000-square-foot plant is scheduled for completion late next year. Ultimately, it will increase the firm's magnetic tape capacity by 35 percent. The plant will employ about 50 persons initially. However, the force is expected to increase to between 200 and 300 persons as production is boosted.

The company has a tape production facility at Hutchinson, Minn., and opened an east coast plant at Freehold, N. J., about 18 months ago.

The 3M Company produces more than 200 stock magnetic tape and accessory items and 1,000 special order products. It was a pioneer in the production of magnetic tape in the United States, producing its first commercially-usable tape in 1947.

The firm has developed specialized tapes for audio and video recording, and for instrumentation applications, including guided missile and satellite projects, geophysical exploration, automated equipment, telemetering, computers and data processing.

Godycki Accepts Bourns Post

L. E. GODYCKI has been appointed manager of materials research for the Trimpot division of Bourns, Inc., Riverside, Calif. His immediate tasks will include research in advanced materials for use in Trimpot potentiometers, precision potentiometers, and relays.

Godycki was formerly a senior research scientist for Electro-Optical Systems in Pasadena.

Radiation at Stanford Names Top Engineers

RADIATION AT STANFORD, Palo Alto, Calif., has appointed Vernon L. Smith as chief engineer and Gene E. Tallmadge as assistant chief engineer.

Smith comes to Radiation at Stanford after 11 years at the U. of California's Lawrence Radiation Laboratory, where he headed an electronics project group. In his new post he will be responsible for design and development of high-power electronic systems.

Tallmadge joined Radiation at Stanford in 1955. He has served as group leader and project engineer for the development of a number of special and exotic high-powered transmitters.

GE Appoints New Office Head

K. M. FULLERTON has been named manager of General Electric's new Defense Programs Operation in San Bernardino, Calif. He will coordinate his company's aerospace and defense systems business in this area with such organizations as the AF Ballistic Systems division at Norton AF Base.

Prior to this appointment, Fullerton was district manager for GE's Missile and Space division in Los Angeles.

Vergeichik Assumes Fairchild Position

APPOINTMENT of John Vergeichik as director of engineering for Fairchild Camera and Instrument Corporation's Defense Products division, Clifton, N. J., is announced.

He comes to Fairchild from Maxson Electronics Corp. where he was engineering assistant to the president.

Gulton Industries Hires Elwood

APPOINTMENT of Albert A. Elwood as technical director of Gulton Industries' new Marine Instrumentation Group at Pompano, Fla., has been announced. He will be responsible for development of oceanographic instruments, underwater sound systems and complete data acquisition and reduction systems for the solution of oceanographic problems.

Prior to joining Gulton, Elwood

NOW... wound to any specs — in any quantity

Supplying exactly the coil forms you want — ceramic or phenolic; standard, printed circuit or shielded — is just one CAMBION® service. Winding them to your exact specifications is another — which eliminates all the time and much of the expense of your own coil winding. CAMBION is fully equipped to custom-wind your coils precisely, lab-test them thoroughly to your qualifications and deliver them fast in any quantities you order. Like all CAMBION components they're quality-guaranteed. For prompt technical aid in meeting your requirements for custom-wound coils, call your CAMBION Engineering Representative, or mail your blueprints to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts.

CAMBRIDGE THERMIONIC CORPORATION
CAMBION®
The guaranteed electronic components

CIRCLE 214 ON READER SERVICE CARD

New DIFFUSION FURNACE
with Kanthal A-1 elements

MODEL K-36
Tube Furnace tube I.D. 2½"
end zones 29½"
center zone 11"

Many design features utilized in the new Despatch K-36 combustion and diffusion furnace combine to give it broader applications and new dependability for laboratory and production work.

The Kanthal 3-zone A-1 elements are divided into end and center zone heats. The silicon control rectifier and transformer assembly with proper instrumentation provides accurate ±½° F. heat uniformity current control. The all ceramic exterior tubes and the efficient new type insulation, alumina-silica fibers in multiple layers, combine to maintain a cool shell even when the furnace is operated at capacity heat.

The new Despatch K-36 features are well suited to analytical work of semi-conductor deposits, for diffusion involving vapor growth, for combustion carbon determination.

For complete information write for bulletin 206-6F.

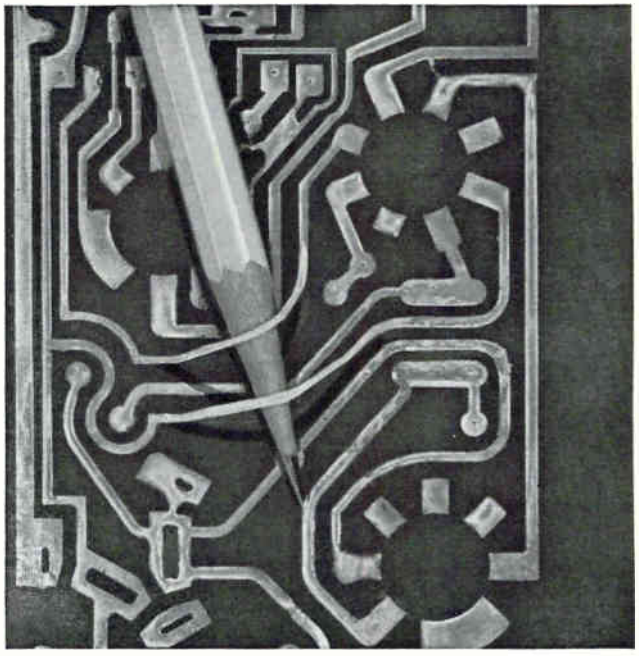
DESPATCH OVEN CO.

Laboratory ovens · Burn-off ovens · Sterilizers · Drawer ovens
Pot-type furnaces · Box furnaces · Walk-in batch ovens

DESPATCH OVEN CO. 619 S.E. 8th St., Minneapolis 14, Minn.

CIRCLE 215 ON READER SERVICE CARD

Printed Circuit Designers! AVOID Wire Failures at Soldering Temperatures



You've never had a printed circuit fail at room temperature. But you may often have experienced loose wire trouble in the soldering pot or during solder roller coating.

Synthane G-10R, a special glass epoxy base laminate, was developed especially to eliminate wire failures during the soldering operation—approximately 500°F.

G10-R meets or beats NEMA and MIL specs for peel strength at room temperature and has a *hot* peel strength of 2 to 4 lbs. per inch of width after immersion for 15 seconds at 500°F* instead of the customary 0.1 to 0.2 lbs. per inch of width.

G-10R is available in sheets 36" x 36" or 36" x 48" and in the usual foil thicknesses. Write for new folder on all Synthane metal-clad laminates.

*Tests made on 1/16 & 1/8" wires.

SYNTHANE CORPORATION OAKS, PENNA.
GLendale 2-2211 TWX Valley Forge 735U
Synthane-Pacific 518 W. Garfield Ave., Glendale 4, Calif. TWX GLOL 4417U

Synthane Corporation, 36 River Rd., Oaks, Pa.

Gentlemen:

Please send me your latest brochure on Synthane G-10R and other Synthane copper-clad laminates.

Name_____

Address_____

City_____ Zone____ State_____

CIRCLE 79 ON READER SERVICE CARD

was in charge of the Underwater Instrumentation department of Airpax Electronics, Inc.

Redcor Corporation Advances Fuller

DONALD W. FULLER has been elected vice president of engineering by the board of directors of Redcor Corp., Canoga Park, Calif. His former position was director of engineering.

Redcor designs and manufactures a complete line of precision components for use in data acquisition and systems control.

Edcliff Instruments Appoints Swirsky

BURTON D. SWIRSKY has been named engineering manager at Edcliff Instruments, Inc., Monrovia, Calif.

Swirsky joins Edcliff following five years with Spectrol Electronics Corp. where he was manager of the Special Products division.

E&M Laboratories Hires Koontz

E&M LABORATORIES, Van Nuys, Calif., announces the appointment of Rollin Harold Koontz as project

engineer. He will direct the company's efforts in advanced state-of-the-art microwave components to complement the line of ferrite devices and coaxial switches currently being marketed.

Most recently, Koontz was senior engineer responsible for filter research at Rantec Corp.

Adler Appoints Executive Engineers

THOMAS J. SALTER and Zen J. Stevens, both formerly with International Electric Corp., have been appointed executive engineers in the systems engineering department, Government Products division of Adler Electronics, Inc., New Rochelle, N. Y.

Adler is a producer of telecommunications systems and communications equipment.

Melpar Names Kahn Chief Engineer

DAVID A. KAHN has been named chief engineer of Melpar, Inc., Falls Church, Va. He was formerly systems associate of the firm, acting as a consultant for the company's military systems programs.

Before joining Melpar in May, Kahn was the system research manager of the Cornell Aeronautical Laboratory.

Assign Jackson to New Position

APPOINTMENT of Harry A. Jackson as resident plant manager for Spectrol Electronics of Canada, Ltd., has been announced by the com-

pany's parent firm, Spectrol Electronic Corporation of San Gabriel, Calif. Jackson has been employed by Spectrol-San Gabriel for seven years with assignments in engineering and sales.

Spectrol manufactures precision and trimming potentiometers and turns-counting dials.

PEOPLE IN BRIEF

Robert O. Gardner, formerly with Standard-Kollsman, named director of engineering of Calibration Standards Corp. Two promotions at Adler Electronics, Inc.: **Gordon Jones** to supervisor of the production estimating section in the Mfg. Operations div., **Lester Kowalsky** to supervisor of the production engineering section. **Arthur L. Charlton** advances to v-p, mfg., for Video Corp. **George W. Leisz** moves up to v-p and g-m of the Inertial Navigation Product div. of Autonetics. **Donald M. Worden**, previously with Reed & Reese, Inc., appointed western regional military coordinator of Weston Instruments div. of Daystrom, Inc. **Jack R. Lyons** leaves Sorensen Co. to join the Electronics div. of Research-Cottrell, Inc., as sales mgr. **Chester C. Pond** from Philco Corp. to General Atronics Corp. as assistant to the president. **Joseph J. Sinacore**, formerly with R-Tronics, Inc., now plant mgr. for Marstan Electronics Corp. General Electric Co. ups **James A. Stark** to mgr., engineering, for the Audio Products dept. **Haddon S. Wilson** advances to mgr., engineering, of RCA's Microwave dept. **Donald K. Latshaw** elevated to plant and production mgr. of Kane Engineering Laboratories. **Thomas R. Maher**, ex-Packard Bell Electronics, now g-m of the Electronic div. of The Magnavox Co. of Tennessee. **Roy A. Lindberg**, former president of Lindberg Engineering Co., elected chairman of the board. **Fred A. Hansen**, formerly a v-p, named new president for Lindberg. **David P. Weinberger** leaves Burroughs Corp. to join General Kinetics Inc. as a computer applications engineer.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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

STRICTLY CONFIDENTIAL

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

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
ALLEGANY BALLISTICS LABORATORY Operated by Hercules Powder Co. Cumberland, Maryland	108*	1
ARGONNE NATIONAL LABORATORY Argonne, Illinois	92*	2
ATOMIC PERSONNEL INC. Philadelphia, Penna.	84	3
BELL AEROSYSTEMS COMPANY Division of Bell Aerospace Corp. A Textron Co. Buffalo, N. Y.	110*	4
BRISTOL COMPANY Waterbury, Conn.	110*	5
BUREAU OF NAVAL WEAPONS Sunnyvale, Calif.	82	6
COLLINS RADIO COMPANY Cedar Rapids, Iowa	101*	7
DOUGLAS AIRCRAFT CO. Missile & Space Systems Division Santa Monica, California	17	8
GENERAL ELECTRIC CO. Apollo Support Department Daytona Beach, Florida	107*	9
JET PROPULSION LABORATORY Pasadena, California	109*	10
MOTOROLA, INC. Chicago, Illinois	106*	11
NATIONAL CASH REGISTER CO. Dayton, Ohio	110*	12

(Continued on following page)

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

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

Personal Background

NAME .....

HOME ADDRESS .....

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

HOME TELEPHONE .....

Education

PROFESSIONAL DEGREE(S) .....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check)

121462

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

EMPLOYMENT OPPORTUNITIES

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

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

— RATES —

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

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

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

Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

PRODUCT DEVELOPMENT ENGINEER

The design manufacturer of a national product line of airborne and space vehicle components wishes to add to its engineering staff. Current product lines include control motors, synchronous motors, motor tachometers, thin metal film precision potentiometers and trimmer potentiometers.

An engineering degree or the equivalent and at least 5 years of engineering experience are required to qualify. Emphasis will be placed on a good fundamental background and established capability in new product development.

LOCATION: SUBURBAN LONG ISLAND

. . . SALARY OPEN . . .

P-1179. Electronics
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

An Equal Opportunity Employer

E. E.'s

for FEE-PAID Positions
WRITE US FIRST!

Use our confidential application for professional, individualized service . . . a complete national technical employment agency.

ATOMIC PERSONNEL, INC.
Suite 1207L, 1518 Walnut St., Phila. 2, Pa.

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from preceding page)

NORTHROP CORPORATION Beverly Hills, California	89*	13
NORTHROP CORPORATION Norair Division Hawthorne, California	91*	14
REPUBLIC AVIATION CORPORATION Missile Systems Division Mineola, Long Island, N. Y.	106*	15
SCOPE PROFESSIONAL PLACEMENT CENTER Watlham, Mass.	110*	16
TEXAS INSTRUMENTS INCORPORATED Apparatus Division Dept. Dallas, Texas	108*	17
P 1179	84	18

* These advertisements appeared in the Dec. 7th issue.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED ——RATES—— **UNDISPLAYED**

The advertising is $27.25 per inch for all advertising other than on a contract basis. AN ADVERTISING INCH is measured ⅞" vert. on a column, 3 cols.—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

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

BOX NUMBERS count as one line additional.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions.

Send NEW ADVERTISEMENTS or Inquiries to Classified Adv. Div. of Electronics, P. O. Box 12, N. Y. 36, N. Y.

The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

SAVE TIME AND MONEY ON PURCHASING RELAYS

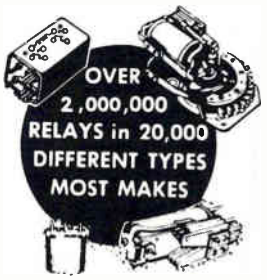
IMMEDIATE DELIVERY WITHIN 48 HOURS
OFF THE SHELF ITEMS

• THIS MONTHS SPECIALS •

MERCURY WETTED CONTACT RELAYS

W.E. 275A: 10.1 ma; 2500 ohm; SPDT; #R2513; exact equivalent to Clare HG1001.....$8.00 ea. 10 for $72.00.

ADLAKE MW16D2-4: 8.1 ma; 4000 ohm; SPDT; #R3340; exact equivalent to Clare HG1002..7.50 ea. 10 for 67.50.



DELIVERY WITHIN 10 DAYS
ITEMS REQUIRING REASSEMBLY AND/OR ADJUSTMENT

SEND FOR LATEST CATALOG E

Universal RELAY CORP.

42A White St., New York 13, N. Y., WA 5-6900

CIRCLE 950 ON READER SERVICE CARD

SMALL AD but BIG STOCK
of choice test equipment and surplus electronics
Higher Quality—Lower Costs
Get our advice on your problem
ENGINEERING ASSOCIATES
434 Patterson Road — Dayton 19, Ohio

CIRCLE 951 ON READER SERVICE CARD

PROFESSIONAL SERVICES

GIBBS & HILL, Inc.
Consulting Engineers
Systems Engineering
Operations Research • Development
Field Studies • Design • Procurement
Power • Transportation • Communications
Water Supply • Waste Treatment
393 Seventh Avenue — New York 1, N. Y.

Wilgreen

can deliver **Amphenol**
Bendix
Cannon
CONNECTORS
FITTINGS & CLAMPS

We stock more than 5,000,000 MS/AN CONNECTORS . . . of 50,000 variations! In PRODUCTION QUANTITIES . . . we sell BELOW "O.E.M." PRICE . . . and offer IMMEDIATE "OFF-THE-SHELF" DELIVERY!

FREE . . . Send for latest brochure *"LIST-PRICE SHEET"*

WILGREEN INDUSTRIES, Inc.
102 Warren Street, New York 7, N. Y.
WOrth 4-2490-1-2 Wire: FXK

CIRCLE 952 ON READER SERVICE CARD

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS 3 & 10 CM. SCR. 584 AUTOTRACK RADARS. AN/TPS-10 SEARCH. AN/TPS-10 HT. FINDERS. AN/FPN-32GCA. AN/APS-10 NAVIG. & WEATHER. AN/APS-15B PRECISION. AN/APQ-35B PRECISION. AN/APS-31A SEARCH. DOZENS MORE. .5-1-2 MEGAWATT HIGH POWER PULSERS.

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

RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 953 ON READER SERVICE CARD

FOR RESEARCH — DEVELOPMENT & EXPERIMENTAL WORK

Over 10,000 different electronic parts: waveguide, radar components and parts, test sets, pulsers, antennas, pulse xmfrs, magnetrons. IF and pulse amplifiers, dynamotors, 400 cycle xmfrs, 584 ant. pedestals, etc.
PRICES AT A FRACTION OF ORIGINAL COST!
COMMUNICATIONS EQUIP CO.
343 CANAL ST., N. Y. 13, WO 6-4045
CHAS. ROSEN (Fomerly at 131 Liberty St.)

CIRCLE 954 ON READER SERVICE CARD

POTTING APPLICATORS
MANUAL AND DISPOSABLE
6cc 12cc 30cc
FOR POTTING, ENCAPSULATING, AND SEALING OF MINIATURE COMPONENTS
PHILIP FISHMAN CO.
7 CAMERON ST., WELLESLEY 81, MASS.

CIRCLE 955 ON READER SERVICE CARD

GLASS TUBING
PYREX - NONEX - URANIUM
BULB & CYLINDERS
WRITE FOR FREE MONTHLY LIST
HOUDE GLASS COMPANY
PHONE COLFAX 4-4800
P.O. Box 206 — Keyport, N. J.

CIRCLE 956 ON READER SERVICE CARD

TUBE & COMPONENT
FREE...CATALOG
BARRY ELECTRONICS
512 BROADWAY — WAlker 5-7000
NEW YORK 12, N.Y. — TWX: NY 1-3731

CIRCLE 957 ON READER SERVICE CARD

ELECTRONIC

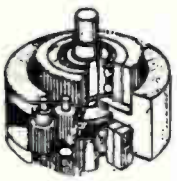
WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

C&H SALES CO.

2176-E East Calarada St.
Pasadena 8, California
MUrray 1-7393

SIMPLE DIFFERENTIAL WITH BALL-BEARING SUN GEARS



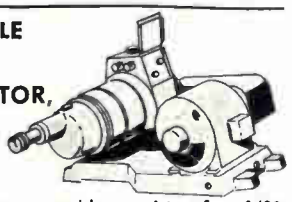
The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. ¼" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115 ..... each $15.00

RCA 6032 IMAGE-CONVERTER TUBE

Combined with suitable optical systems, this 3-electrode tube permits viewing of scene with infrared radiation. Scene to be viewed is imaged by optical objective upon semi-transparent photocathode. Spectral resp., S-1; good response up to about 1200A. Max. ratings, absolute, grid ±2, 20,000VDC or peak AC, grid ±1,200.
$9.95 ppd.

MINOR SWITCH 10-position, 3-pole, with stopper & reset coil 6-12 V. D.C. off-normal non-bridging wiper. wt.: 1 lb. $9.95

400-CYCLE MOTOR GENERATOR, PU-20



The generator assembly consists of a 1400-watt, 120-volt, 400-cycle inductor-alternator and a 400-watt, 27-volt D.C. generator. The alternator rotor and the D.C. generator armature are mounted on a common shaft, which is dual-belt-driven by a 3-H.P., 1750-R.P.M., 115/230-volt, single-phase 60-cycle electric motor. Weatherproof output box is mounted on top of the stator shell. It contains a rheostat, adjustable resistor, two pin jacks for plugging in an A.C. voltmeter. Size: 28" W., 33" L., 18" H. Weight, approx. 250 lbs.
Price $175.00

8-DAY ELAPSED-TIME SURPLUS AIRCRAFT CLOCK

Here's an accurate time-control center that'll help you win your next rallye. It not only tells you the date and time of day right to the second, it's a stop watch that gives you elapsed time in seconds, minutes, and hours! The 24-hour clock simplifies adding and subtracting elapsed time for your navigator. Manufactured by Elgin Watch Co. to exacting military specifications, it will remain accurate in spite of road bumps and vibrations. Uses no electrical connections. Does the job of high-cost equipment. Jeweled/Sweep Second Hand/Luminous Hands and Numerals/25-Hour Dial/Black Face and Plastic Case/3⅛" Mounting.
Cost the Government $185.00
Only $39.95 Postpaid

SPERRY VERTICAL GYRO

Part #673073, Mate: 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H.
Price $35.00

VARIABLE SPEED BALL DISC INTEGRATORS

(All Shafts Ball Bearing Supported)

No. 145 Forward & Reverse 2¼"-0-2¼". Input shaft spline gear 12 teeth 9/32" dia. ⅜" lang. Output shaft 15/64" dia. x 15/32" lang. Cantral shaft 11/32" x ⅛" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾" $17.50

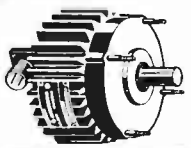
No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" lang: Output shaft 15/64" dia x 9/16" lang. Cantral shaft 11/64" dia. x 11/16" lang. Cast aluminum canstruction. Approx. size 4½" x 4½" x 4". **$18.50 ea.**

SMALL DC MOTORS

(approx. size over 3¾" x 1¼" dia.:
5067043 Delca 12 VDC PM 1" x 1" x 2", 10,000 rpm. $7.50
5067126 Delca PM, 27 VDC, 125 RPM, Gavernar Cantralled 15.00 ea.
5069600 Delca PM 27.5 VDC 250 rpm 12.50
#5069625 120 rpm, mfr. Delca, 27 VDC gavernor cantralled $15.00
5069230 Delca PM 27.5 VDC 145 rpm 15.00
5068750 Delca 27.5 VDC 160 rpm w. brake 6.50
5068571 Delca PM 27.5 VDC 10,000 rpm (1x1x2") 5.00
5069790 Delca PM, 27 VDC, 100 RPM, Gavernar Cantralled 15.00 ea.
#5069800 575 rpm, mfr. Delca, 27 VDC, PM reversible gavernar cantrolled, equipped with 27 VDC clutch $17.50
5072735 Delca 27 VDC 200 rpm gavernar cantrolled. 15.00
5BA10A11B GE 24 VDC 110 rpm 10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible 10.00
5BA10AJ52 27 VDC 145 rpm reversible 12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm 15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., 7 amp. contains brake 15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp 15.00

400 CYCLE PM GENERATOR

115/200 volts A.C. 1- ar 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" lang; ½" shaft, AN cannector. $75.00



9KVA 400-CYCLE GENERATOR

120/208 volts, 3-phase power factor 1.0 CCW rotation. Approx. 13½ lg. x 8" dia. 4000 rpm, mfg. Bendix Aviation P/N 1633-1A.
$150.00

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A, 115 volts A.C., 400 cycle, single phase patentiameter take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ milliion, CM²/sec. Weight 2 lbs. Dimensians 4-7/32 x 3-29/32 x 3-31/64.
Price $22.50

SELSYNS-SYNCHROS

1CT cant. Trans 90/55V 60 cy.	$27.50
1DG Diff. Gen. 90/90V 60 cy.	34.50
1F Syn. Mtr. 115/90V 60 cy.	34.50
1G Gen. 115V 60 cy.	34.50
1HDG	37.50
1HCT	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
23TR4 tarque receiver	34.50
23TR6 tarque receiver	37.50
23CT6 cantral transfarmer	37.50
23CX6 cantral transmitter	37.50
23TX6 tarque transmitter	37.50
7DG differential generatar	37.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7.50
2J5D1 Cant. Trans. 105/55V 60 cy.	17.50
2J5F1 Cant. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cant. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90 VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cant. Trans. 90/55V 60 cy.	37.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78410 Repeater 115V 60 cy.	20.00
FPE 49-7 Diehl serva matar, 115 volts, 60 cycle, 10 watts	30.00

400 CYCLE, 3 PHASE GENERATOR

BY MASTER ELECTRIC

Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 6 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" lang; overall dim. af unit: 21"6x18"x 20".
Price $395.00 each

SENSITIVE INTEGRATING GYROS

This is the famous HIG Gyro which is being used in missile guidance systems, radar stabilization and fine cantral systems. Government cast approximately $1500.
PRICE $50.00

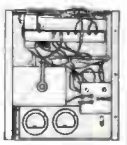
OIL CAPACITORS

1 MFD. 25,000 V. DC Westinghouse interteen type FP style 1313854.
$39.95 each
10 or more, $35.00 each.

HONEYWELL VERTICAL GYRO MODEL AG7044A17

115 volts, 400 cycles, single phase, 35 watts. Pitch and roll patentiameter pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. mamentum 12,500,000 gm-cm 2/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°; caging mechanism operates on 24 VDC.
$49.50

24 VOLT DC POWER SUPPLY



Input: 115/440 volts A.C. 60 cycle, single phase
Output: 24 volts D.C. at 25 amps tapped primary and secondary to vary voltage unit contains 0-30 volt D.C. meter and 0-30 amp meter, circuit breaker, filtered, selenium type rectifier approx. dim: 16" wide, 18" long 8½" high approx. wt.: 70 lbs.
PRICE ..... $49.50 each

SPECIAL PURPOSE TUBES

OA2	.80	4-125A	20.00	100TH	12.00	816	2.00	5836	50.00
OA2WA	1.50	4-250A	35.00	100TL	12.00	826	3.50	5837	50.00
OA3	.85	4-400A	35.00	FG-105	25.00	828	12.50	5840	2.50
OA5	5.75	4-1000A	95.00	FG-172	25.00	829B	10.00	5842	7.00
OB2	.60	4AP10	10.00	HF-200	15.00	832A	7.50	5845	6.00
OB2WA	1.50	4B31	15.00	212E	50.00	833A	37.50	5847	7.55
OB3	.75	4C35	12.50	242C	10.00	836	2.50	5852	5.00
OC3	.50	4CX250B	30.00	244A	3.50	837	1.25	5876	9.50
OD3	.50	4CX1000A	125.00	249B	8.50	842	7.50	5879	1.15
C1A	7.50	4D32	15.00	249C	6.50	845	12.50	5881	2.50
1AD4	1.75	4E27	10.00	250R	10.00	849	75.00	5886	3.50
1B24	7.50	4J32	100.00	250TH	25.00	851	50.00	5893	10.00
1B24A	17.50	4J34	100.00	251A	75.00	866A	2.00	5894	19.85
1B35A	3.50	4J50	100.00	259A	5.00	869B	75.00	5899A	2.00
1B59/R1130B	10.00	4J52	35.00	262B	4.00	872A	5.00	5915	1.00
1B63A	10.00	4J62	150.00	267B	5.00	884	1.25	5933	3.50
1C/3B22	5.00	4J63	150.00	271A	10.00	885	1.00	5948	150.00
1D21/SN4	5.00	4J64	150.00	274A	3.50	889RA	150.00	5949	100.00
C1K	7.50	4PR60A	50.00	279A	200.00	891R	200.00	5963	1.00
1P21	30.00	4X150A	12.50	283A	3.50	913	12.50	5964	.85
1P22	8.00	4X150D	12.50	287A	3.50	927	2.00	5965	.85
1P25	10.00	4X150F	20.00	QK-288	200.00	931A	5.00	5976	50.00
1P28	15.00	4X150G	25.00	HF-300	35.00	1000T	100.00	5993	5.00
1Z2	2.50	4X250B	25.00	300B	5.00	1237	5.00	5998	5.00
2-O1C	12.50	4X250F	30.00	304TH	35.00	VC-1257	975.00	6005	1.50
2AP1A	8.50	5ABP1	20.00	304TL	35.00	VC-1258	15.00	6012	4.00
2B23	20.00	5AHP7A	25.00	310A	3.50	K-1303	35.00	6021A	2.00
2BP1	10.00	5BP1A	9.50	311A	3.50	1500T	200.00	6028	2.75
2C36	22.50	5C22	17.50	313C	1.50	1603	3.50	6032	50.00
2C39	5.00	5CP1A	9.50	323A	6.00	1614	2.25	6045	1.15
2C39A	10.00	5CP7A	9.50	328A	4.50	1620	4.00	6072	1.25
2C39B	15.00	5J26	75.00	329A	4.50	1624	1.00	6073	1.50
2C40	7.50	5LP1A	20.00	336A	2.50	1625	.50	6074	1.50
2C42	4.00	5R4GY	1.25	337A	3.50	1629	.50	6080	3.35
2C43	7.50	5R4WGA	4.00	348A	4.50	1645A	4.00	6080WA	5.00
2C50	4.00	5R4WGB	6.00	349A	3.50	1846	50.00	6080WB	10.00
2C51	1.50	5R4WGY	2.00	350A	3.50	1850A	300.00	6081	25.00
2C53	7.50	5RP1A	9.50	350B	2.50	2000T	350.00	6082	3.35
2D21	.65	5UP1	12.50	352A	8.50	2050	1.25	6087	2.50
2D21W	1.25	5Y3WGT	1.25	354A	12.50	ZB-3200	150.00	6101	1.50
2E22	3.00	6AC7W	1.00	355A	12.50	5516	7.50	6115A	65.00
2E24	3.50	6AG5WA	1.50	393A	5.00	5528/C6L	3.50	6130	6.50
2E26	2.50	6AG7Y	1.00	394A	3.00	5545	25.00	6136	1.50
2J42	75.00	6AK5W	1.25	403B	3.00	5550	35.00	6146	3.00
2J51	50.00	6AL5W	.60	404A	7.50	5551/FG271	50.00	6159	3.50
2J55	100.00	6AN5	1.75	407A	3.75	5552/FG235	60.00	6161	35.00
2J66	200.00	6AN5WA	3.50	408A	2.75	5553/FG258	125.00	6163	15.00
2K22	25.00	6AQ5W	1.00	410R	75.00	5556/PJ8	20.00	6164	45.00
2K25	8.50	6AS7G	2.50	GL-414	80.00	5557/FG17	5.00	6186	1.60
2K26	35.00	6AU6WA	1.25	416B	20.00	5558/FG32	10.00	6189	1.60
2K28	25.00	6B4G	3.35	417A	7.50	5559/FG57	10.00	6197	1.75
2K29	25.00	6BA6W	.75	418A	7.50	5560/FG95	20.00	6199	35.00
2K30	50.00	6BF7W	2.00	420A	5.00	5561/FG104	40.00	6201	1.75
2K33A	175.00	6BL6	20.00	421A	7.50	5586	125.00	6202	1.50
2K34	100.00	6BM6	20.00	422A	10.00	5590	1.00	6211	.75
2K35	200.00	6BM6A	30.00	423A	4.00	5591	3.00	6213	2.50
2K39	125.00	6C4W	2.50	427A	4.00	5603	3.00	6216	3.00
2K41	35.00	6C21	25.00	429A	6.50	5608A	5.00	6236	125.00
2K42	150.00	6F4	5.00	432B	7.00	5636	2.25	6263	9.00
2K43	175.00	C6J	10.00	GL-434A	10.00	5641	2.00	6279	17.50
2K44	125.00	6J4	1.75	450TH	50.00	5642	2.25	6280	30.00
2K45	20.00	6J4WA	2.50	450TL	40.00	5647	3.50	6291	35.00
2K47	150.00	6J6W	.75	CK-503AX	1.00	5651	1.00	6292	40.00
2K48	60.00	6J6WA	1.00	575A	15.00	5654	1.50	6293	4.50
2K50	100.00	6L4	3.00	578	5.00	5656	5.00	6299	37.50
2K54	15.00	6L6GAY	1.25	NL-615	7.50	5665	40.00	6303	65.00
2K55	15.00	6L6WGA	1.50	NL-623	10.00	5667	125.00	6316	100.00
2K56	50.00	6L6WGB	2.00	631-P1	5.00	5670	1.00	6328	7.50
2X2A	1.25	6Q5G	2.50	673	15.00	5672	1.35	6336	8.75
3A5	1.00	6SJ7WGT	1.25	677	50.00	5675	9.50	6336A	12.75
3AP1A	12.50	6SK7W	1.00	BL-696	35.00	5678	1.50	6350	1.25
3B4	2.50	6SL7WGT	1.25	701A	5.00	5684	9.50	6363	90.00
3B24W	3.00	6SN7W	.75	707B	2.50	5685	15.00	6364	130.00
3B24WA	5.00	6SN7WGT	1.00	NL-710	10.00	5686	2.25	6385	10.00
3B25	2.50	6V6GTY	1.00	715C	15.00	5687	1.50	6390	125.00
3B26	3.50	6X4W	.75	719A	12.50	5691	5.00	6394	12.75
3B28	3.00	6X5WGT	1.00	721B	5.00	5692	3.50	6442	25.00
3B29	5.00	7MP7	22.50	723A/B	3.50	5693	3.50	6476	10.00
3BP1A	7.50	10KP7	15.00	725A	10.00	5696	1.00	6485	1.50
3C22	25.00	12AT7WA	1.25	726A	5.00	5718	1.50	6528	12.75
3C23	5.00	12AU7WA	1.50	726B	5.00	5721	100.00	6550	3.50
3C24/24G	5.00	12AX7W	1.35	726C	10.00	5725/6AS6W	1.50	6655	40.00
3C45	3.50	12AY7	1.00	750TL	112.50	5726	.75	6807	25.00
3CX100A5	15.00	12GP7	25.00	NL-760	25.00	5727	1.25	6816	40.00
3D21A	5.00	X-13	150.00	BL-800	75.00	5728/FG67	20.00	6877	12.50
3E29	7.50	C16J	25.00	802	7.50	5734	15.00	6883	3.50
3GP1A	12.50	HK-24	5.00	803	5.00	5749	1.00	6888	3.50
C3J	7.50	25T	7.50	804	15.00	5750/6BE6W	1.75	6896	350.00
3J21	35.00	26Z5W	1.50	805	7.50	5751WA	1.50	7391	47.50
3J31	100.00	28D7W	3.50	807	1.50	5755	5.00	7521	100.00
3K21	125.00	FG-32	10.00	807W	2.50	5763	1.75	7580	35.00
3K22	125.00	35T	7.50	808	2.50	5777	150.00	8000	20.00
3K23	200.00	35TG	3.75	809	4.75	5778	150.00	8002R	35.00
3K27	150.00	FP-54	150.00	810	17.50	5783	2.25	8008	6.00
3K30	100.00	FG-57	10.00	811	3.00	5787	2.50	8013A	5.00
3KP1	9.75	RK-60/1641	1.50	811A	4.75	5800	7.50	8014A	25.00
3RP1	7.50	HY-69	3.00	812A	4.75	5803	5.00	8020	6.00
3WP1	12.50	75TL	17.50	813	12.50	5814A	1.35	8025A	5.00
3X2500A3	150.00	KU-99	12.50	814	4.50	5819	40.00	9003	2.00
4-65A	12.00	HF-100	8.85	815	3.50	5829	1.00	9005	3.50

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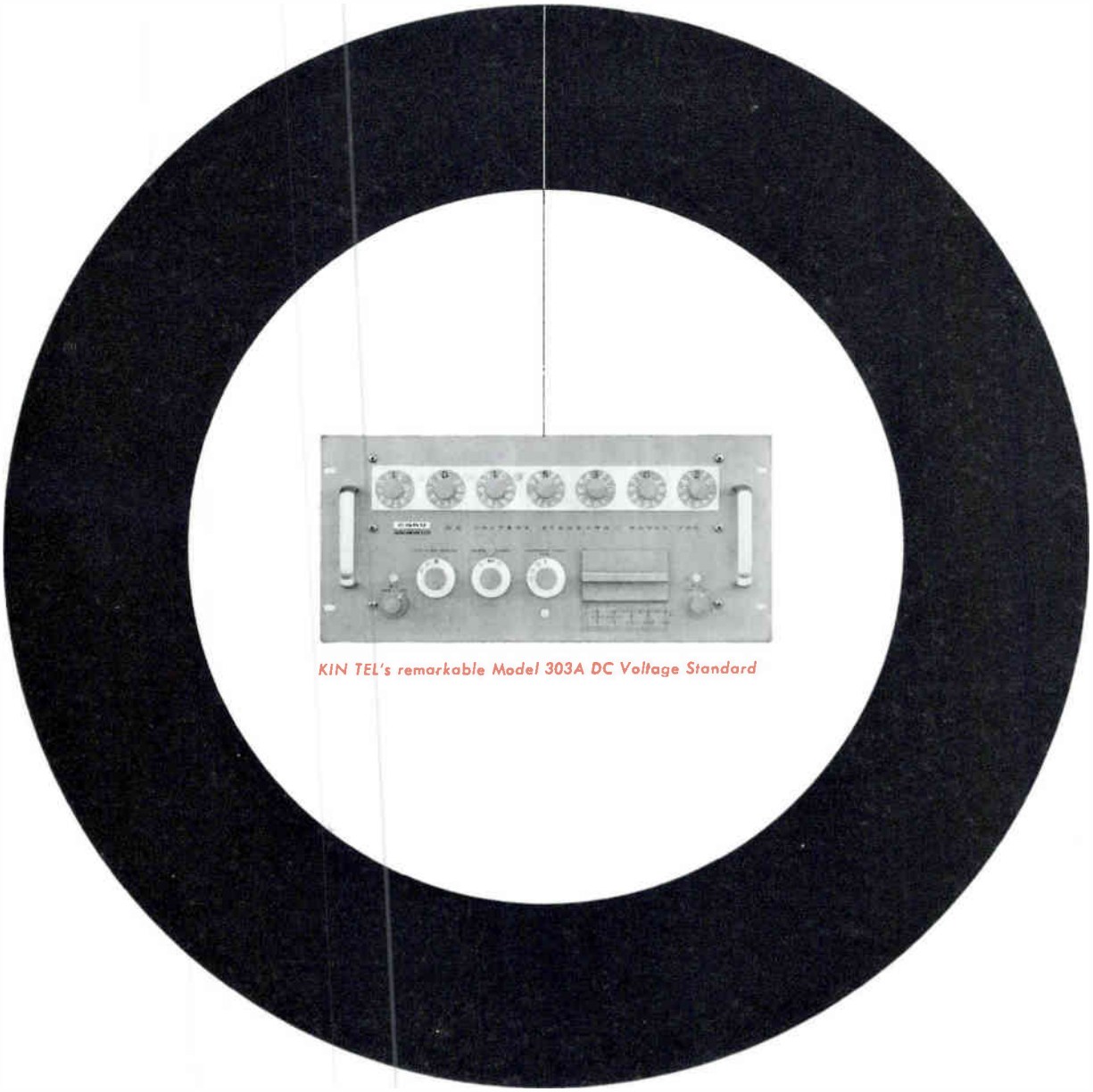

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0.01% accuracy, 0.005% stability. The output is accurate to within 0.01% of the dial setting, and is stable to within 0.0025% for over eight hours and to within 0.005% for over 30 days. Resolution is 0.1 part per million of full scale.

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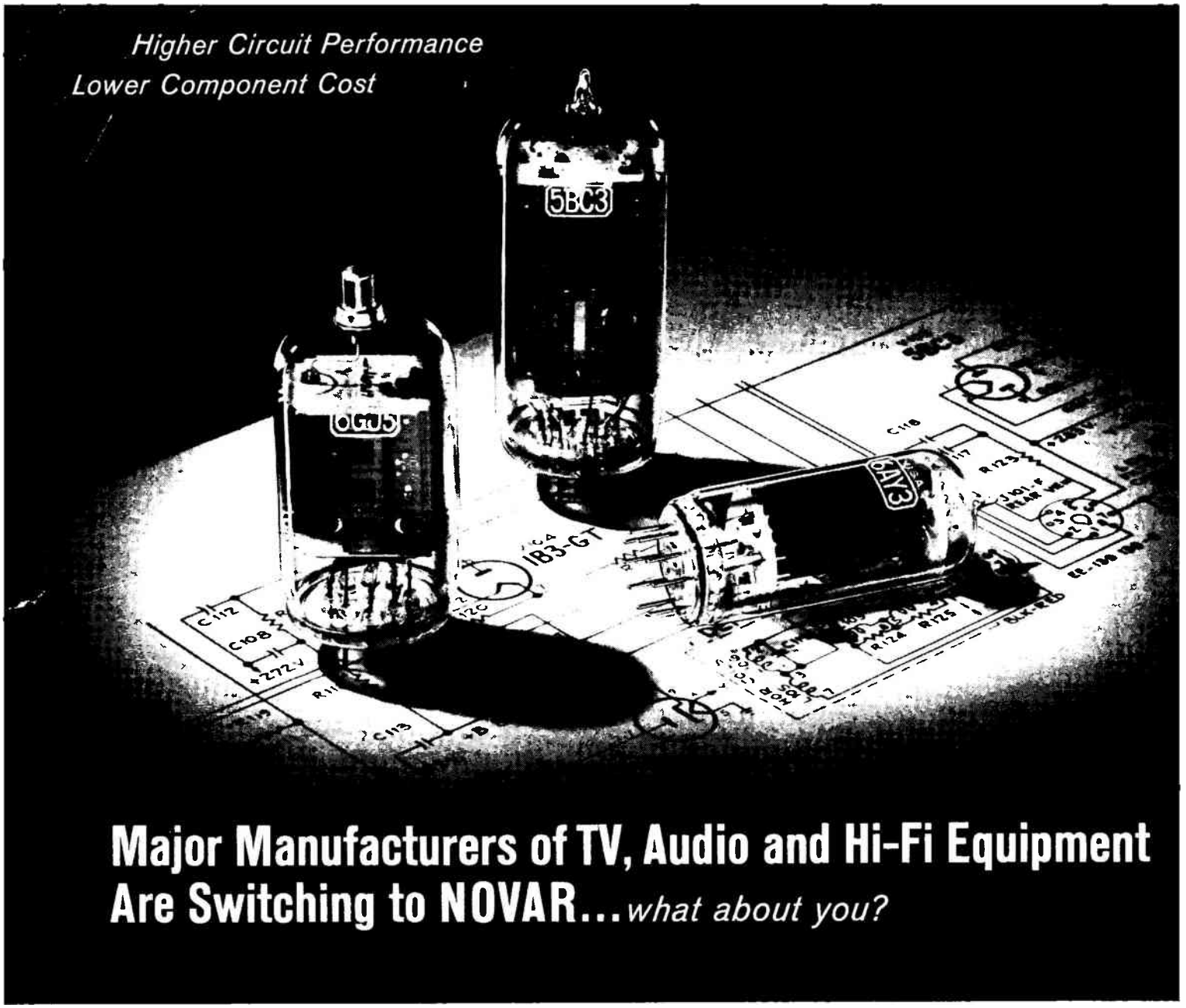

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14 MORE LEADING MANUFACTURERS WILL USE NOVAR TUBES IN THEIR NEW SET MODELS

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For TV horizontal-deflection amplifier service: RCA-6GT5, 12GT5 and 17GT5; RCA-6GJ5, 12GJ5 and 17GJ5.

For use in hi-fi amplifiers: RCA-7868.

For rectifier use in TV sets, hi-fi audio equipment and radio power supplies: RCA-5BC3.

For additional information on any novar tube type, call your RCA Field Representative or write Commercial Engineering, RCA Electron Tube Division, Section L-19-DE-2, Harrison, N.J.

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