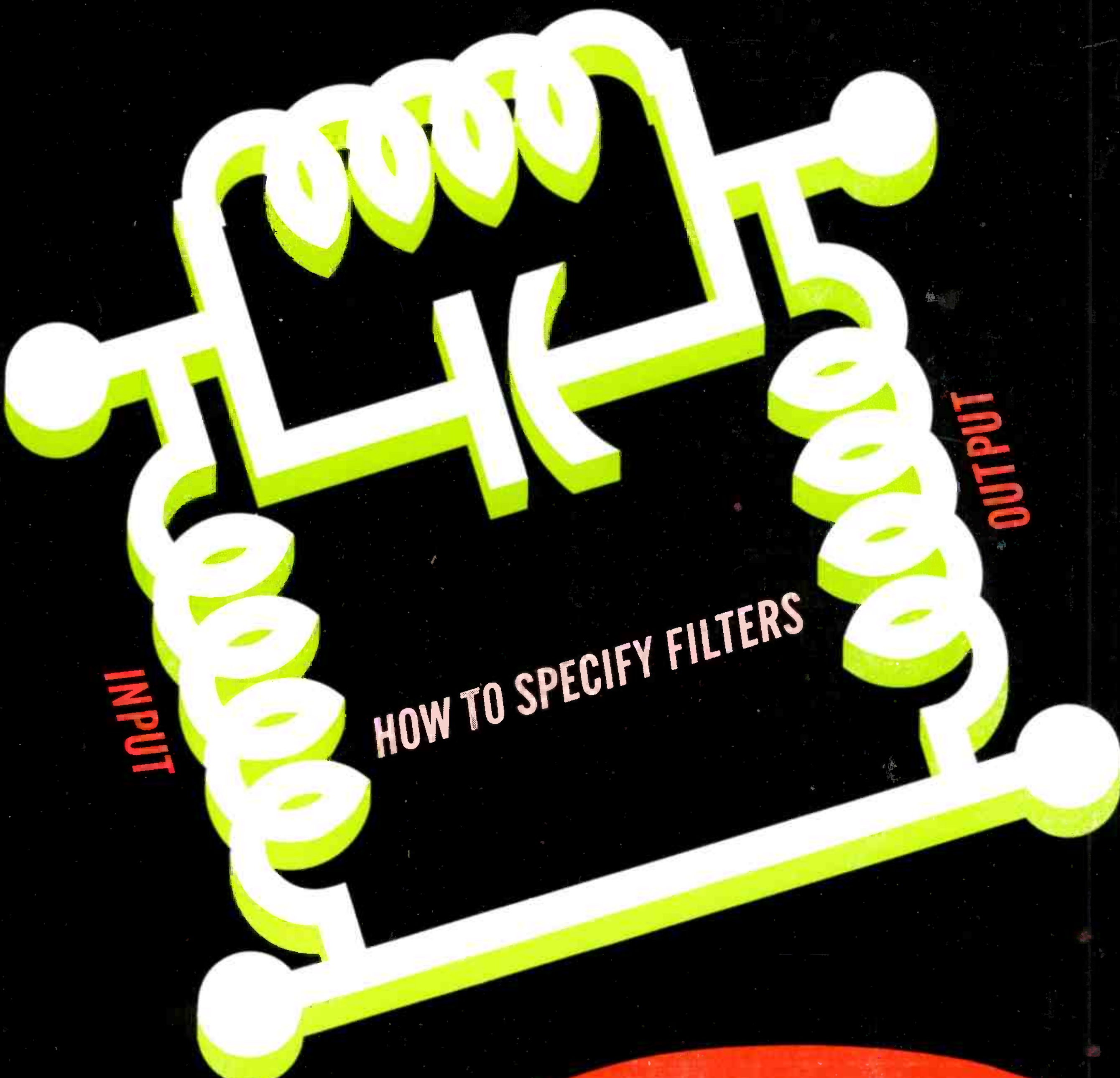
ELECTRONIC INDUSTRIES



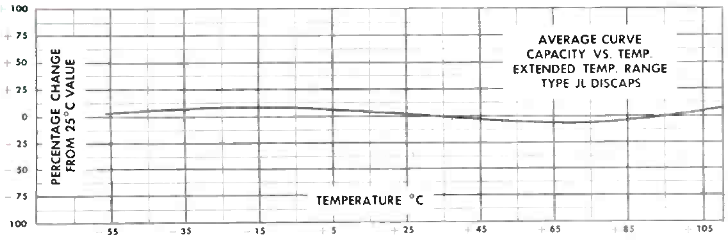
A Look At Network Synthesis . . .
Capacity Neutralization of Transistors
Testing Horizontal Deflection Tubes

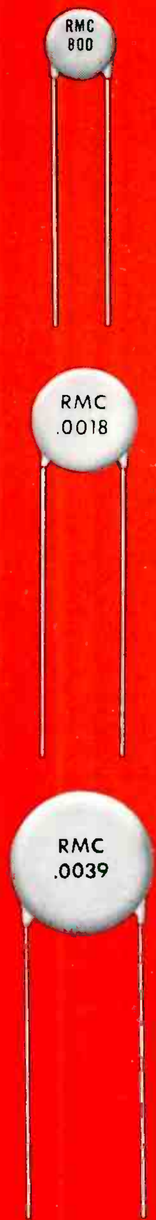
September • 1958
A Chilton Publication

RMC

brings you "temperature stable" Discaps

TYPE JL DISCAPS





Type JL DISCAPS are especially designed for applications requiring a minimum capacity change as temperature varies between −60°C and +110°C. The maximum change between these extremes is only ±7.5% of capacity at 25°C.

With a standard working voltage of 1000 V.D.C., Type JL DISCAPS are ideal cost saving replacements for paper or general purpose mica capacitors.

Write on your letterhead for additional data.

SPECIFICATIONS

LIFE-TEST: As per EIA-RS-198
POWER FACTOR: 1.5% Max. @ 1 KC (initial)
POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ±10% ±20% at 25°C

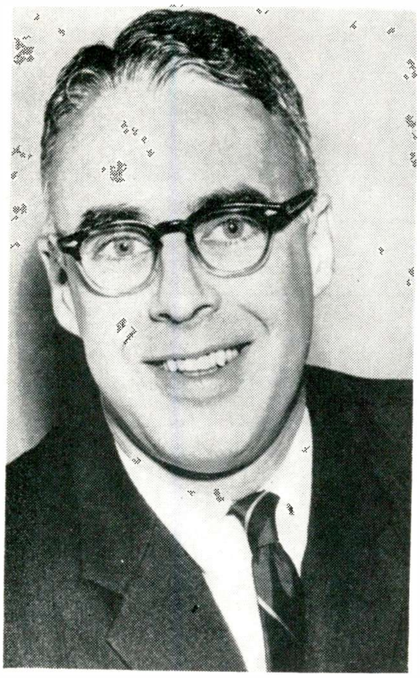
RMC uses the General Radio type 716-C Capacitance Bridge as the standard of capacity and power factor for all Hi K materials. The standard test frequency is 1000 cycles for all capacity and power factor measurements. Capacity and power factor readings at any other frequency can not be guaranteed.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card, page 101



ELECTRONIC INDUSTRIES

R. E. McKENNA, Publisher • B. F. OSBAHR, Editor

The Russian Menace

A Guest Editorial by **George F. Sullivan**

Editor—IRON AGE, A Chilton Publication

AN American steel and iron study group returned recently from Russia quite impressed by what they saw in the Russian mills. In the words of Edward L. Ryerson, chief of the delegation, "We did not quite appreciate how much they had done in a relatively short time in the development of steel."

The men who were impressed are not neophytes; theirs are some of the best known names in management, research, production and labor relations in the steel industry of the United States.

If their trip means only that we spread some good will and acquired some useful ideas in areas where Soviet technology is first-rate, then we as a nation will miss much of the potential value of the trip.

To understand the reason for this statement, please consider these questions. Fewer than one American in a thousand can answer them, but millions should be able to.

(1) WHY IS SOVIET TECHNOLOGY GOOD IN SOME AREAS? Because research is centralized, well paid, respected. In steel for instance, a large pilot plant checks out research ideas, develops working solutions for the entire industry to use. Experimentation with electronic controls is being pushed hard.

> In our May 1958 (p. 51) issue we presented an editorial entitled "Education in Communism." Here we pointed out that opposition to communism must be based on informed public opinion. In line with this, we offer here a guest editorial **entitled** "The Russian Menace." This is written by George Sullivan, editor of *The Iron Age*, another of the Chilton publications. George has just returned from an extended tour through Russia, and his comments are the result of first-hand observation and discussions with Russian industry people there. We believe that you, the readers of Electronic Industries will also find this information of interest and importance. Our editorial pages are open for your comments and suggestions.
>
> B. F. O.

(2) WHAT IS THEIR ATTITUDE ON REPLACEMENT OF OBSOLETE EQUIPMENT, ON CAPITAL EXPENDITURES? When a Soviet blast furnace operator learns that fully automatic control will increase output, he junks his existing controls to install the new system. Capital equipment cost and return on invested capital appear to be minor problems in Russia.

(3) WHAT IS THE ATTITUDE OF SOVIET LABOR? Once the Soviet worker has become convinced that he and the state are one and the same, it is perfectly legal and proper in Russian eyes to urge him to greater productivity by every possible means. This includes propaganda at every turn—in the plant by signs; in town by billboards; in the home through radio and TV; in the theater by the theme of the play or ballet; in the "Palace of Culture" by lectures and constant indoctrination.

(4) WHAT MAY THIS MEAN TO THE UNITED STATES? It is a serious economic and political threat to the Free World. Russia is improving housing for the masses; it plans some concessions in consumer goods. But it can set its own timetable; if something must be sacrificed for export propaganda purposes, it is sacrificed. The export problem is not primarily a question of whether the Free World loses markets; Russia used exports for political reasons—to make friends in the underdeveloped nations of the world.

The Soviet Union has a long way to go before it catches up with us in steel or electronics—and still longer before its standard of living approaches ours. But to the millions who live in abject poverty throughout the world, our standard of living is meaningless. And the Russian people don't know enough about it, or care enough about it right now, to stage a revolution over it.

(Continued on page 157)

ELECTRONIC INDUSTRIES, September, 1958. Vol. 17, No. 9. A monthly publication of Chilton Company, Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila., Pa. Accepted as controlled circulation publication at Phila., Pa. 75¢ a copy; Directory issue (June) $3.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $5.00; 2 yrs. $8.00. Canada 1 year. $7.00; 2 yrs. $11.00. All other countries 1 yr. $18.00, 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 17, No. 9 — September, 1958

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

Highlights

Of This Issue

How To Specify Filters! — page 55

Filter design is a highly specialized field, with its own nomenclature and test methods. When specifying filters the engineer should clearly understand how insertion loss is calculated and measured, the difference between insertion loss and attenuation, and the significance of impedance and phase-shift characteristics.

Reducing Spurious Radiation — page 59

Efficient r-f spectrum use requires radiation limits on microwave equipment. An experimental program, designed to extend existing limits to cover 1-10 KMC, has established measuring techniques to determine receiver susceptibility to interference and the magnitudes of radiated interference encountered in system operation.

A Look At Modern Network Synthesis — page 67

Synthesis provides a short cut to optimum results with many network problems. It is possible to reduce the findings of synthesis to handy tables which the engineer can use provided he has enough comparative data to allow him to choose intelligently among the various tables.

Why Dielectrics Break Down! — page 74

Many conflicting theories exist on the relative importance of ion and electron bombardment in causing failure of insulating material during sustained corona discharge. A series of tests have been conducted which demonstrate that electron bombardment is primarily responsible.

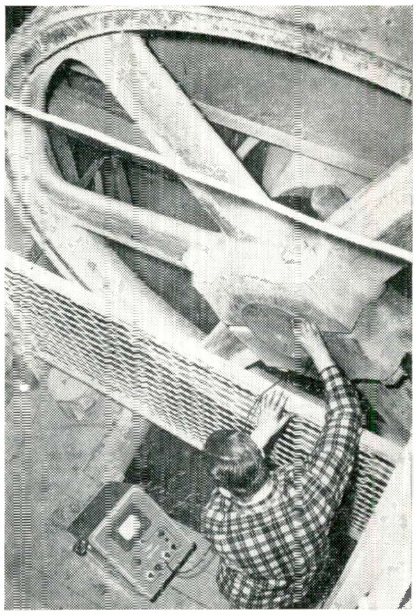
Capacity Neutralization of H-F Transistors — page 82

The stability and distortion considerations of i-f transistor amplifiers requires that the small signal, short circuit, reverse transfer admittance parameter be neutralized. The capacity needed for neutralization can be derived and its relation to the standard collector capacity outlined.

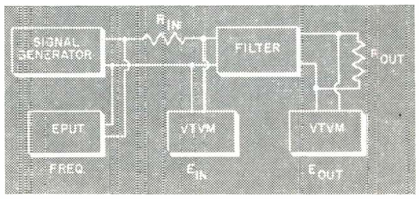
Engineering Education—Retrospect & Prospect — page 88

The past decade has seen more new concepts, new principles and new methods introduced to engineering education than during any comparable period in its history. Some radical changes are needed to meet this challenge. But in which direction?

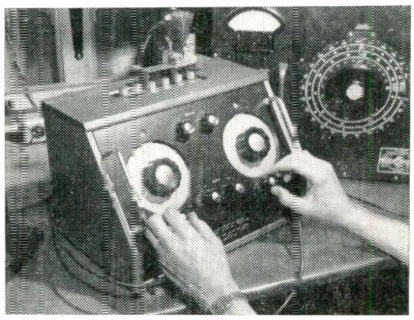
COMING NEXT MONTH—TRANSISTOR PARAMETER VARIATIONS IN THE L-F RANGE
Certain transitional changes in audio transistors in the low-frequency range have been investigated experimentally and theoretically and are generally attributed principally to feedback caused by collector-to-base capacitance. A set of general equations has been developed to predict the range of these parameters.
Also—"An Inexpensive Ultra-linear Output Stage." The husky audio output transformer, most expensive component in the hi-fi amplifier, can be replaced by a dual potentiometer, a twin triode vacuum tube and two resistors.



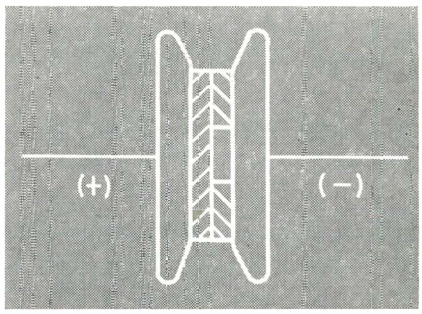
Engineering Education



How to Specify Filters?

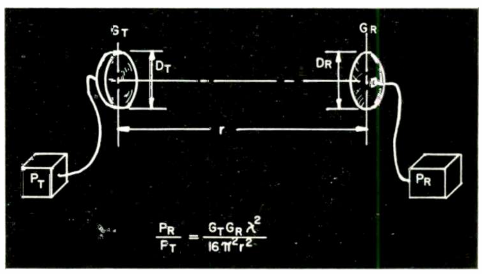


Neutralization of H-F Transistors

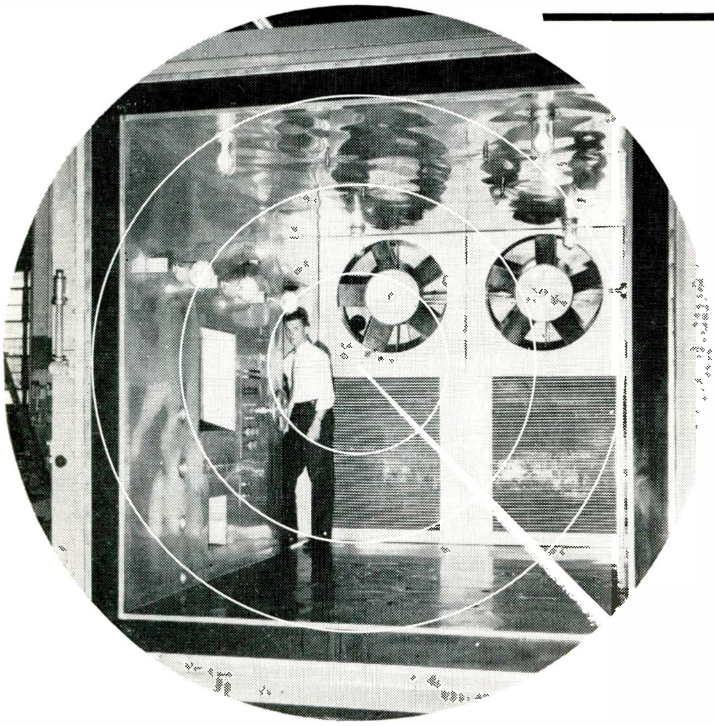


Why Dielectrics Break Down!

Reducing Spurious Radiation.



RADARSCOPE



TEST CHAMBER

This walk-in environmental test chamber installed at Stromberg-Carlson's Electronics Center by Tenney Engineering will accommodate a huge vibration machine under extreme altitude, temperature and humidity conditions. It is one of the very few in the country.

LOOK FOR either cancellation or drastic revision of the Renegotiation Act. While the primary objective of eliminating excessive profits from defense contracting is achieved the Act has also removed the incentive for increased efficiency and production short cuts. The complaint is not new, but only recently has the government shown signs that they recognize that something should be done about it.

THE CAA forecasts 55,000,000 air passengers for 1960 and 70,000.000 for 1970.

EDUCATIONAL RADIO network that would serve the 30,000,000 people living in New England, eastern New York state and New York City is now in the primary stages. Last month WEDK, Springfield, Mass. educational FM station began carrying some of the programs of Boston's WGBH, another educational FM station. It will also feed some local programs to the embryonic network. A third station, WAMC, Albany, N. Y. will join the network later this year.

PITCHED BATTLE looms between the independent mobile radio telephone companies and the Bell System. A petition presented to the FCC by two public mobile radio service operators and three radio maintenance organizations points out that the independents are severely handicapped by not being able to interconnect with the landline telephone exchanges as the Bell System mobile radio common carrier does. The independents are asking for equal privileges in order to permit fair competition.

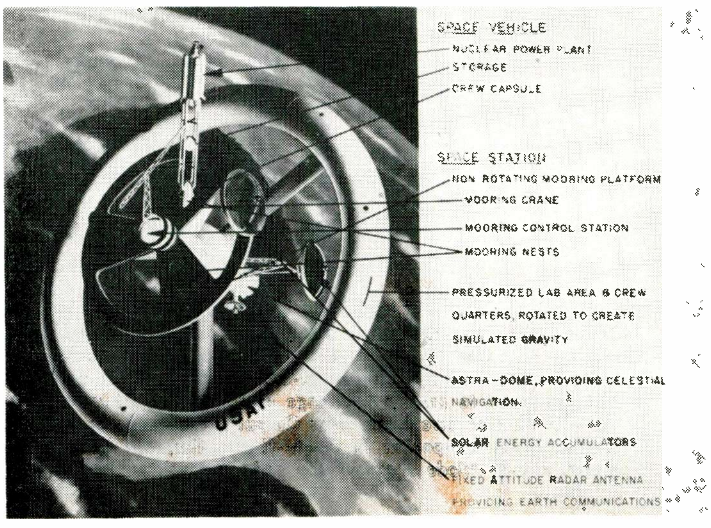
MINIMUM WAGE standards for the "electronic components" industry are being sought by the Dept. of Labor. The move is a resumption of the proceedings that were started in 1950 and suspended due to the Korean War. For purposes of the study the industry is being separated into three parts—tubes, parts and end-equipment. Separate standards will be set for each.

FM RADIO NETWORK — featuring fine music—went into operation last month with New York's WQXR as the key station and including 11 upstate New York affiliates. Five of the stations are operated by Northeast Radio Corp., Ithaca. All are FM. The network is 550-mi. long and covers 43 New York counties. Although operating as a network WQXR and affiliates will not go to the extent of implementing "network option time," though it will maintain certain "station time"—three 30-minute segments daily, plus time for regional and local newscasts to bolster the New York Times coverage.

IRBM DECISION will probably be made this month. Either Jupiter, or Thor—but not both—will be chosen for operational use with the services.

SHADES OF BUCK ROGERS!

No longer in the dreaming stage, this is the space station being planned by the U. S. Air Force. Last month Lear, Inc., delivered the mockup of the space ship cockpit, first step in its design.



Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation

NEW SEMICONDUCTOR MATERIALS for high-temperature transistors and rectifiers are being investigated in a new research program sponsored by seven manufacturers and industrial users at Battelle Memorial Institute. The Battelle scientists will study the properties of three semiconductor compounds—indium phosphide, gallium arsenide and aluminum antimonide. The companies behind the program are Erie Resistor Corp., G.E., IBM, Ohio Semiconductors, Philco, Sarkes Tarzian, and Texas Instruments.

FM MULTIPLEXING will come in for a re-examination by the FCC. In the three years since the Commission granted permission for "background music" transmission by FM outlets there have been numerous proposals to provide various other specialized radio communications services, such as price quotations, facsimile, stock market reports, paging services and traffic light control. Stereophonic broadcasting was another. The Commission is now looking for data and views from interested parties as to the feasibility of permitting these services in the FM broadcast band.

NO ANTI-COLLISION SYSTEM yet demonstrated can be considered a solution to the air safety problem, Elwood R. Quesada, Chairman of the Airways Modernization Board, told an Aviation Writers Association meeting recently. He said, however, that several programs are being tested to establish a system. He listed these as electronic, consisting mainly of a program with Bendix Aviation Corp., and a "light" and "colored smoke" program which gives "some hope" for the future.

TRANSISTORIZED PORTABLE COLOR TV SYSTEM has been developed by RCA for closed-circuit applications. The system consists of a 20-lb. camera and a 45-lb. monitor and control unit about the size of a suitcase—some several hundred pounds lighter than color equipment using tubes and conventional power sources. The unit will run with either batteries or fixed power supply.

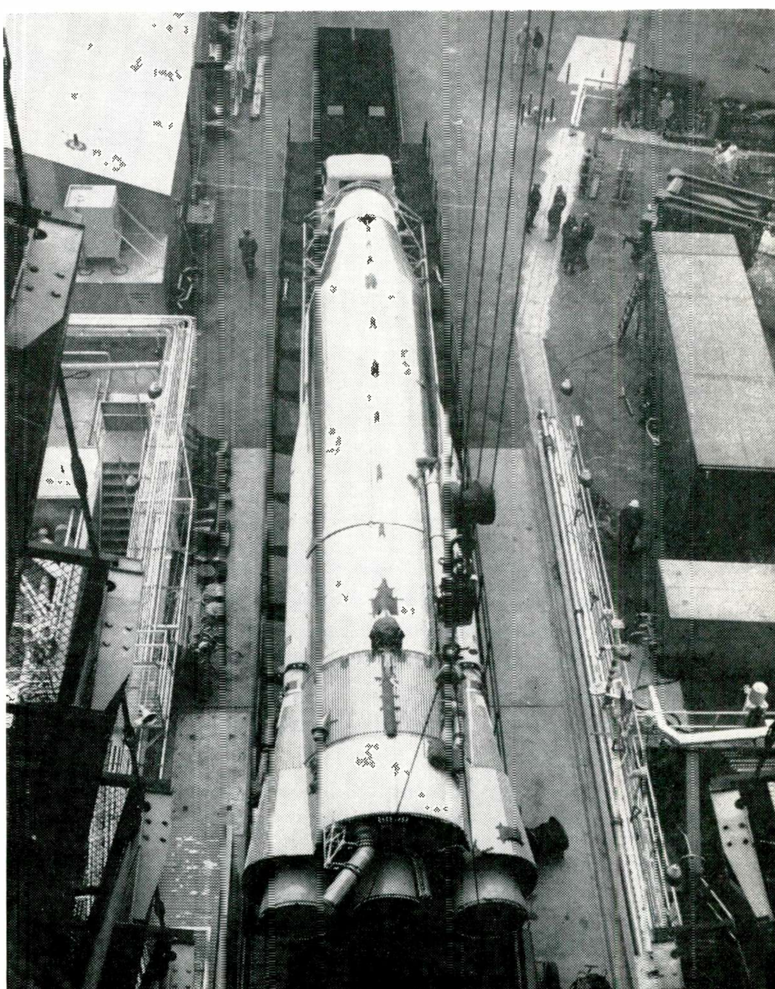
NEW RADIO SERVICES established by FCC, and now in operation, are: The Business Radio Service, for "any person engaged in a commercial activity, educational, or philanthropic institutions, clergymen or ecclesiastical institutions, and hospitals, clinics, and medical association: The Manufactures Radio Service, "with eligibility for manufactures": and The Telephone Maintenance Radio Service, for "Communications common carriers primarily engaged in rendering a wire-line and radio-communications service to the public for hire."

ENGINEERING EDUCATION

ENROLLMENTS in college-level engineering institutions last year reached an all-time high of 297,077, 79.4% above the low point established in 1951. The number of women entering engineering also increased markedly, from 625 in 1951 to a present total of 1,783. Part-time and evening undergraduate enrollment has now reached 38,365. Last year 31,211 first-level engineering degrees were awarded, a rise of 18.6% over 1956. The number of other pre-doctoral degrees were also up, by 10.8% over the previous year. But the number of doctoral engineering degrees declined, by 596, or 2.3% from 1956. However there was a very appreciable increase in the number of students seeking doctorates in evening schools. In 1957 there were 690, as compared with 528 the year before. This represents a jump of better than 30%. Evening students comprise 16.5% of the total enrollment.

FULLY-POWERED

Overhead view of Atlas lying on its handling carrier shows the added third engine that will give the big USAF ICBM a range of more than 6,000 miles. The new sustainer is in the center of the thrust section. The booster engines on either side are the same as earlier Atlas.



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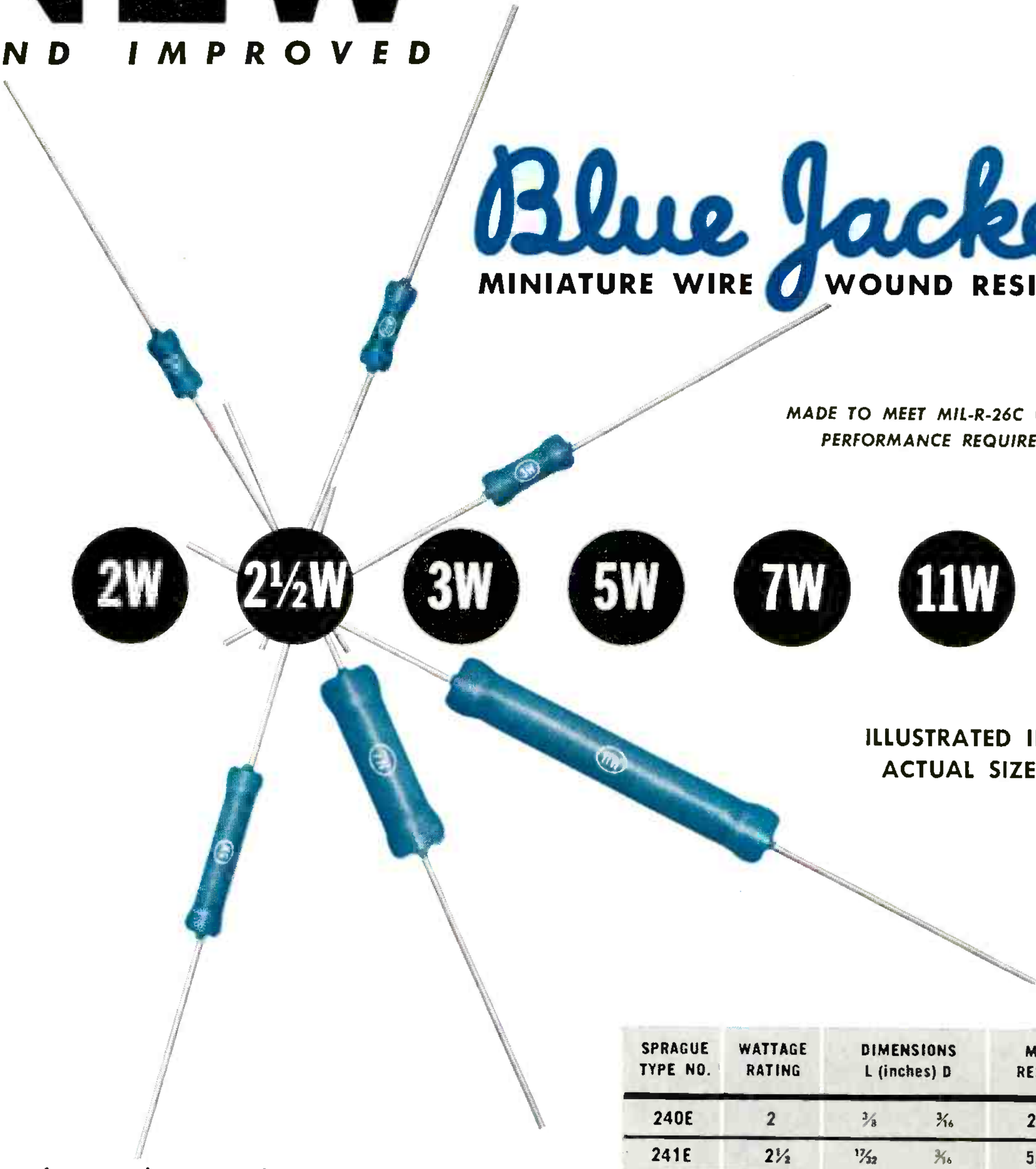
AND IMPROVED

Blue Jacket®

MINIATURE WIRE WOUND RESISTORS

MADE TO MEET MIL-R-26C CHAR. "V" PERFORMANCE REQUIREMENTS



ILLUSTRATED IN ACTUAL SIZE

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
240E	2	3/8	3/16	2,700 Ω
241E	2½	17/32	3/16	5,000 Ω
242E	3	17/32	13/64	10,000 Ω
243E	5	15/16	13/64	30,000 Ω
244E	7	1⅛	5/16	30,000 Ω
245E	11	1⅞	5/16	50,000 Ω

Now a new improved construction gives even greater reliability and higher wattage ratings to Sprague's famous Blue Jacket miniature axial lead resistors.

Look at the small sizes shown in the illustrations above and you will recognize how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

For the full technical story on these dependable miniaturized resistors, write for Engineering Bulletin 7410.

SPRAGUE ELECTRIC COMPANY • 233 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE®

THE MARK OF RELIABILITY

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

As We Go To Press . . .

Thor-Able Electronics Faced Stiff Challenge

By Walter M. DeCew

Cape Canaveral, Fla.—The first Air Force IGY lunar probe was attempted here on August 17th. The "shoot," given at best a 1 in 10 chance of succeeding, was unsuccessful. Interviews with engineers working on the project the following day revealed a number of interesting facts about the hectic preparations.

The engineers were working on such a "crash" schedule that on August 10th, only a week before firing, some of the electronic equipment in the payload capsule intended to circle the moon was still in the breadboard stage.

One of the principal technical accomplishments, in the opinion of the engineers interviewed, was in the packaging of the electronic equipment for the payload capsule. Transistorization of the Doppler receiver in the payload, for example, reduced to the size of a shoe box equipment previously the size of a trailer truck.

Besides the Doppler receiver, instrumentation in the payload capsule included a magnetometer, telemetering transmitter, inertial guidance and stabilization for the capsule, temperature gage, micrometeorite impact recorder, photo electric scanner and integrating accelerometer.

Among the many difficult problems solved were the successful modification of the Naval Ordnance Test Station television camera and transmitter to the requirements of the payload capsule, and the development of special paints for dissipation of heat from the surface of the payload capsule.

The addition of the second and third rocket stages, and technical vehicle (payload capsule) to the Thor IRBM meant that the aerodynamics previously worked out for the first stage Thor could not be used for the lunar probe. The extensive aerodynamic calculations carried out by STL for the larger vehicle would be of special interest to computer programmers.

Technical details on the aerodynamic calculations, and the other engineering accomplishments mentioned here, being part of the IGY program, are not to be treated as classified information. So said Maj. General Bernard A. Schriever, ARDC deputy commander for Ballistic Missiles, in response to direct questioning by your correspondent during a press conference following the unsuccessful launching.

Because of the urgency of the project, the prime contract was awarded to the Space Technology Laboratories of Los Angeles without competitive bids. Principal subcontractors to STL were Hallamore Electronics; Atlantic Research Corp.; Pacific Automation Products; Rantec Corp.; Reeves Instrument Corp.; Summit Industries; Western Electric; and Radio Corporation of America.

(Walter M. DeCew, sales promotion manager of EI was in Florida at the time of the "Moon Shot." He is a well-qualified technical observer, having previously worked as an AEC physicist, and editor of a leading nuclear trade journal.)

NO HANDS!

Giant Boeing 707 prepares to touch down while completely under the control of the Bell Aircraft automatic all-weather landing system at right. System picks up jet from 2 to 4 miles out, guides it to touchdown.

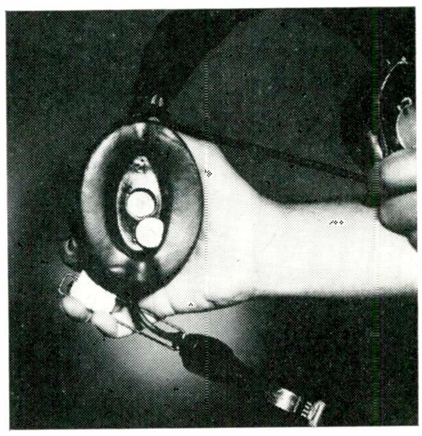
'Electronic Earmuffs' Developed By Army

Designed to create artificial quiet amid the roars of combat, new experimental earphones shut out loud noises that interfere with vital combat communications.

Developed by the U. S. Army Signal Research and Development Lab, Ft. Monmouth, N. J., and RCA, the earphones are expected to find wide use in tanks and Army planes, where noise is a major problem.

Paradoxically, the scientists created the artificial quiet by adding more noise. A miniature microphone in the special earpiece creates a second noise — just as loud, but opposite in phase. When the two sound waves meet in the earcup, they cancel out. The result is a greatly reduced noise level. A loud roar is muffled to a whisper.

The earpieces work in conjunction with a special electronic inverter and amplifier unit that in large-scale production could be made small enough to fit into a soldier's pocket. The electronic system cuts low-pitched sounds down to as little as 1/10th their original volume. Higher pitched sounds are trapped by special foam cushioning.



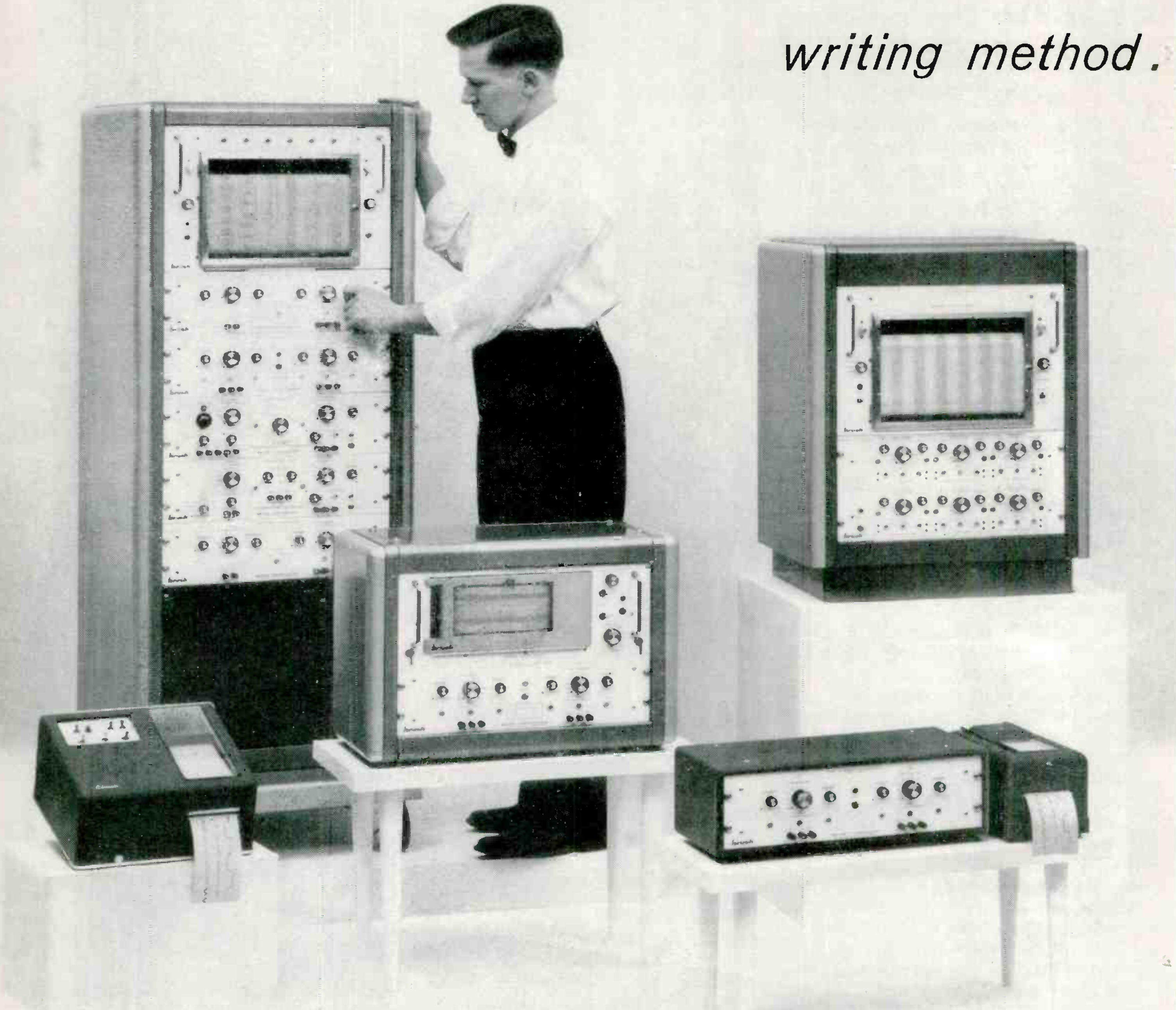
Earphone develops noise-cancelling signal.

More News on Page 12

In direct recording systems

ONLY—brush GIVES YOU

writing method.



When you need precise, permanently visible measurements of electrical or physical phenomena, make your logical choice of equipment from the newest Brush designs in *ultralinear* recording systems. For your specific application, now choose . . .

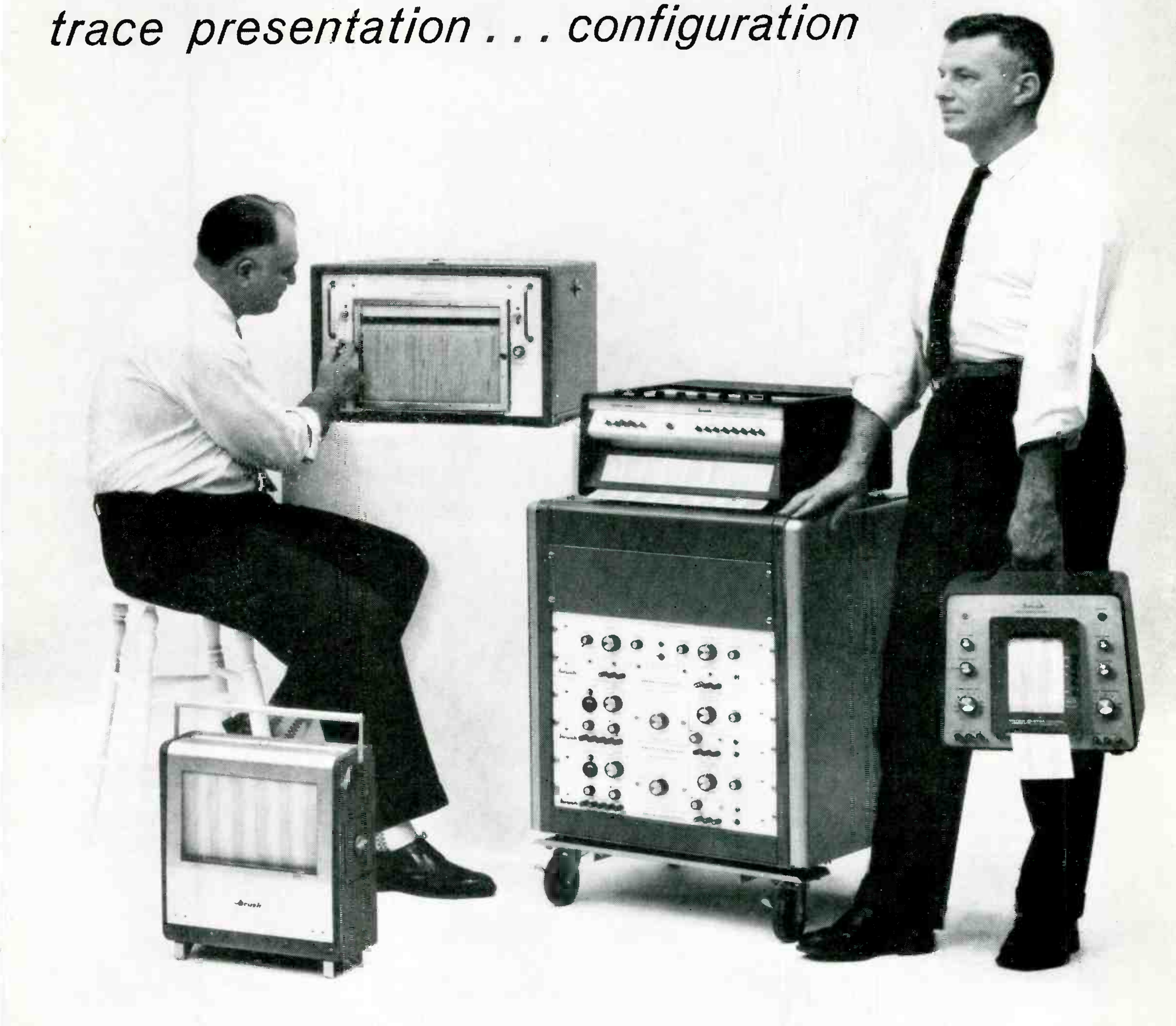
The writing method! Because different problems demand different writing methods, Brush gives you your choice . . . ink . . . electric . . . thermal writing.

The trace presentation! Brush offers curvilinear and rectilinear readout. Both methods produce *ultralinear* traces—clear . . . sharp . . . easy to read.

The configuration! Choose from vertical or horizontal writing tables, rack mounted or portable models, widest selection of chart speeds available from 50"/sec. to 10"/day, providing optimum resolution on all signals. Electrically controlled chart drive

FREEDOM OF CHOICE

trace presentation . . . configuration



transmissions permit instantaneous switching on the spot or by remote control.

New functionally designed control panels are clean, legible, easy to understand. All components are readily accessible for fast inspection and simple adjustment.

The most comprehensive operating manuals in the industry are included with every Brush product.

Factory branches, service and warehousing at Arlington, Va., Cleveland and Los Angeles; engineering representatives in all key locations.

brush INSTRUMENTS

DIVISION OF

3405 PERKINS AVENUE **CLEVITE** CORPORATION CLEVELAND 14, OHIO

Circle 4 on Inquiry Card, page 101

Quick facts about

ELECTRONIC INDUSTRIES

Editorial Concept

The design of electronic equipment results from the creative interplay of both technique and theory. The design articles in ELECTRONIC INDUSTRIES succeed in relating theory to technique, technique to theory. The editors do it by giving authorities 3, 4, 5, and 6 full pages for depth treatment of their engineering ideas.

The complex electronic technology demands this editorial formula. It attracts contributions of industry-wide importance, from engineering "celebrities," into the pages of the monthly ELECTRONIC INDUSTRIES. Every issue inspires hundreds, sometimes thousands, of letterhead requests for reprints. Among the men who develop and specify for electronic O.E.M.'s, ELECTRONIC INDUSTRIES wears the mantle of engineering authority.

Publishing Concept

Support of an editorial policy which earns engineering authority pays off for a magazine's advertisers. Readers' confidence in the magazine's technical authority carries over to its technical advertising, adding to its credibility and power. At the same time, ELECTRONIC INDUSTRIES produces for most advertisers even more inquiries than publications edited primarily to stimulate inquiries.

Market Research Services

ELECTRONIC INDUSTRIES Marketing Assistance Program is based on the new EIC code, industry census data on punched cards, and the publishers IBM, direct mail, and interviewing facilities. Contact your EI representative for details.

Advertising Research Services

EI is the only electronic publication to offer Starch ad readership studies, and conduct studies to determine the best copywriting techniques for electronic advertisers.

June Directory & All-Reference Issue

A major compilation of engineer's reference material, together with the most comprehensive product directory in the industry, assures 12 months of selling life for ads in this issue. Closing date for ELECTRONIC INDUSTRIES 17th annual Directory issue is May 1st, 1959.

ELECTRONIC INDUSTRIES

Chilton Company Executive Offices:
56th and Chestnut Sts., Phila. 39, Pa.

BPA NBP

the design engineers' dream becomes a reality—

AT LAST!

A CATHODE-RAY TUBE *with*

SPOT SIZE: .001″ MAX.*

...no frills

...no gimmicks

the

DU MONT K1725

cathode-ray tube

Here's super resolution for flying spot scanners and photo-recording—a cathode-ray tube with a spot size of less than .001″. And best of all, the Du Mont K1725 is no laboratory curiosity. It's a hard-working, practical, production component ready for the design engineer, requiring no super-size yokes and power supplies.

The K1725 cathode-ray tube is a five-inch, electromagnetically focused and deflected tube, utilizing the exclusive Du Mont Extra-Fine P-16 screen for high light output at fast writing rates.

- .001″ spot size over large range of currents.
- Uses standard-size yokes and power supply.
- A production component, ready for quantity delivery.

Another

**Measured by Shrinking Raster Method*

DU MONT® *AVAILABLE REALITY IN PRECISION PHOTOELECTRONICS*

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Circle 5 on Inquiry Card, page 101

ELECTRONIC SHORTS

▶ The Air Force is considering the adoption of the Navy's Bull Pup air-to-ground guided missile. The Navy has provided a limited number of Bull Pups for evaluation testing which is currently taking place at Edwards AFB, Calif. The missile is in production for the Navy at the Martin Co.s Orlando, Fla., missile plant, and is expected to be operational with both the Navy and Marine Corps some time this year.

▶ Sparrow II, U. S. air-to-air missile which will soon be built in Canada under license agreements, is being tested by Canadian pilots working with American missile experts. RCAF pilots are flying their own CF-100 jet interceptors at the Naval Air Missile Test Center at Point Mugu, California, while familiarizing themselves with Sparrow II and its fire control system.

▶ The National Warning System (NAWAS), capable of flashing an alert to 276 civil defense warning points in all parts of the United States in less than one minute, has added a fourth warning center to its nation wide network. The Office of Defense and Civilian Mobilization announced the new installation, at Richards-Gebaur AFB at Grandview, Mo., went into 24-hour operation on July 1, and will serve as the Central Warning Center.

▶ The USAF's newest bomber, the eight-jet B-52G stratofortress missile-platform will be equipped with GAM-77 air-to-ground "Hound Dog" missiles which are carried under each wing and designed for firing while the plane is still hundreds of miles from the target. The new bomber can fly at sustained speeds of more than 650 miles per hour.

▶ The FCC has told Congress that it will not make a final decision on making pay-TV tests until after the next session of Congress. The Commission said it would accept and process applications but it will approve none until the sine die adjournment of the first session of the 86th Congress, which would mean approximately August, 1959.

▶ To prevent aircraft from passing undetected through the gap in the coverage pattern provided by the basic long range radar screen guarding the United States against air attack, the Radio Division of Bendix Aviation Corporation has developed an automatic system called AN/FPS-14 gap-filler radar. It is interconnected via telephone lines with the prime radar site and with huge digital computers of the USAF defense complex, SAGE.

▶ A unique contract just awarded by the Airways Modernization Board to A. B. DuMont Laboratories, Inc. for the National Aviation Facilities Experimental Center at Atlantic City, New Jersey, points up the urgency of the problem of air traffic control to prevent mid-air collisions. DuMont's R & D Division will create a complete electronics laboratory for research and development leading to modernization of the national system of aviation facilities.

▶ To intensify development of the advanced forms of aircraft, missiles, and spacecraft called for in the aeronautical industry's transition to astronautics, the Republic Aviation Corporation is embarking on a $35-million research and development program. The four-year project will include erection of a $14-million Engineering R & D Center at the firm's main plant in Farmingdale, L. I., to house highly specialized research and development laboratories. It also calls for major expansion of the firm's technical personnel by the addition of scientists and engineers.

▶ The USAF has described as successful its use of the "Cat Eye" in obtaining previously impossible daylight photographs of planets and stars. "Cat Eye" is an electronic system that operates on principles similar to television but contains an optical amplifier that affords it a sensitivity of more than 1,000 times that of an ordinary TV camera. It is about 10,000 times faster than the best photographic film, and can literally see in the dark.

▶ The electronic countermeasure system developed by Sylvania Electric Products Inc. to protect the nation's first supersonic bomber, the B-58 Hustler, from enemy attack is being tested in actual flight as an integral part of the new bomber. It is "the first of its kind developed to meet the specific requirements and characteristics of a particular type of aircraft, in contrast to systems designed for use in more than one kind of plane," according to Henry Lehne, General Manager of Sylvania Electronic Systems.

As We Go To Press (cont.)

Visual Decoder For Air Traffic

An effort to combat the acute problem of air traffic control is taking shape through development of a new device suitable to the United States Air Force and the Civil Aeronautics Administration.

The device, known as a Visual Decoder, and developed by Burroughs Corp. Electronic Tube Division, automatically identifies by number or letter specific aircraft seen only as a blip on the controller's ground radar screen. This eliminates errors in the identification of flying aircraft in a crowded airport traffic pattern.

As search radar picks up the aircraft, the recognition radar interrogates the airborne transponders—small radar beacons considered standard equipment on most aircraft operating on a beacon-equipped range. Triggered by the interrogation signal, the transponder automatically transmits a binary-coded pulse train which has been pre-assigned to the aircraft. Received by the recognition radar, the pulse train is routed to the decoder.

To enable the controller to accept one binary-coded pulse train while rejecting all others, a "light gun," or electronic-eye, is placed against the face of the PPI scope over the target "blip." This opens the circuit to the decoder. Thus, an aircraft can be singled out by the controller, fed to the decoder, and displayed on a "Nixie" numerical indicator tube.

NEW TAPE RECORDER

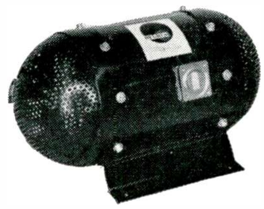
Consolidated Electrodynamics vice-pres. for marketing, R. L. Smallman (r), and engineer R. Heath look over a model of CEC's new Type 5-752 Magnetic Tape Recorder/Reproducer.

More News on Page 14

Hughes microwave tubes

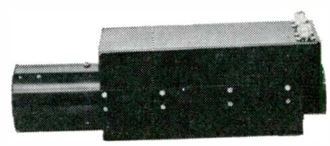
TOUGH ENOUGH FOR AIRBORNE RADAR

Rugged, compact, light in weight... all Hughes Microwave Tubes have withstood the most severe requirements of airborne radar systems and therefore can be applied in the most taxing of environmental problems.



KU BAND BACKWARD WAVE OSCILLATOR

The Hughes Type LOU-2 is a precision built oscillator which tunes over the frequency range of 12.4 to 18.0 kmc. Typical power output over band is 10 to 60 milliwatts. The tube is housed in a self-contained permanent magnetic focusing package so that a separate power supply for a focusing electromagnet is not required.



S-BAND TRAVELING WAVE AMPLIFIER

Periodically focused, the type MAS-1A has a peak power output of one kilowatt over a band of 2-4 kmc at duties up to 0.005. The tube has a gain of 30 to 33 db, giving an excess of one kilowatt over most of the band. When two tubes are operated in cascade, the one kilowatt output can be obtained with a drive on only one milliwatt.

S-BAND BACKWARD WAVE AMPLIFIER

The Hughes type PAS-2 is a narrow-band, voltage-tuned amplifier that is designed for use as an r-f preamplifier stage in contemporary radar communications and other microwave receivers. Features: frequency range 2.4-3.5 kmc, insertion noise figures on order of 4½ db, tube noise figures of less than 5 db, voltage-tuned, crystal protection, spurious input signal elimination, cold isolation greater than 80 db and image rejection.

For additional information please write: Hughes Products, Microwave Tubes, International Airport Station, Los Angeles 45, California. Or contact our local offices in Newark, Chicago and Los Angeles.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

Circle 6 on Inquiry Card, page 101

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period September & October that are of special interest to electronic engineers

Sept. 3-10: 2nd International Congress on Cybernetics, International Assoc. for Cybernetics; Namur, Belgium.

Sept. 8-10: 1st National Conf. & Exhibit on Application of Electrical Insulation, AIEE, Hotel Pick-Carter, Cleveland, O.

Sept. 8-13: First International Congress, Int'l Congress of the Aeronautical Sciences; Palace Hotel, Madrid, Spain.

Sept. 10-12: 4th National Conf. on Tube Techniques, Advisory Group on Electron Tubes; Western Union Auditorium, 60 Hudson St., New York, N. Y.

Sept. 12-13: Communications Conf., IRE; Sheraton Montrose Hotel, Cedar Rapids, Iowa.

Sept. 12-14: 7th Annual Chicago High Fi Show; Palmer House, Chicago.

Sept. 15-17: International Power Industry Computer Application Conf., AIEE; King Edward Hotel, Toronto, Canada.

Sept. 15-19: 13th Annual Instrument & Automation Conference & Exhibit, Instrument Society of America; Convention Hall, Phila., Pa.

Sept. 16-18: Fall Quarterly Conference. EIA; St. Francis Hotel, San Francisco, Calif.

Sept. 22-24: Symposium & Exhibit on Telemetry & Remote Control, IRE; American Hotel, & Patrick AFB, Miami Beach, Fla.

Sept. 24-25: Industrial Electronic Conference, IRE & AIEE; Rackham Memorial Bldg., Detroit, Mich.

Sept. 28-Oct. 2: Fall Meeting, Electrochemical Society; Chateau Laurier, Ottawa, Canada.

Sept. 29-Oct. 3: 10th Annual Conv. & Non-Consumer Sound Equipment Exh., Audio Eng'g Society; Hotel New Yorker, New York.

Sept. 29-Oct. 4: High Fidelity Show, Institute of High Fidelity Mfrs.; New York, N. Y.

Oct. 1-2: 4th Conf. on Radio Interference Reduction, Armour Research Foundation; Museum of Science & Industry, Chicago, Ill.

Oct. 1-2: Engineering Writing & Speech Symp., IRE; New York City.

Oct. 2: Section Meetings Calendar-Wichita Sect., Institute of Aeronautical Sciences; Innes-Colonial, Room 121 S. Broadway, Wichita, Kans.

Oct. 2: Section Meetings Calendar—Phila. Sect., Institute of Aeronautical Sciences; Penn-Sherwood Hotel, Phila., Pa.

Oct. 6-7: Symp. on Extended Range & Space Communications, IRE & G. Washington Univ.; Lisner, Washington, D. C.

Oct. 7-10: Industrial Film & A-V Exh.; Trade Show Bldg., New York City.

Oct. 8-10: 14th Annual Mtg., Canadian Electrical Manufacturers Assoc.; Sheraton Broch Hotel, Niagara Falls, Canada.

Oct. 8-10: Canadian IRE Conv. & Exposition; Automotive Bldg., National Exhibition Grounds, Toronto.

Oct. 13-15: National Electronics Conf., IRE, AIEE, & EIA; Hotel Sherman, Chicago, Ill.

Oct. 13-15: International Systems Mtg.; Penn-Sheraton Hotel, Pittsburgh, Pa.

Oct. 19-24: 84th SMPTE Conv.; Sheraton-Cadillac Hotel, Detroit, Mich.

Oct. 20-22: URSI Fall Mtg., IRE; Penna. State Univ., University Park, Pa.

Oct. 14-17: Midyear Mtg. of Recorder-Controller Sect., SAMA; Seaview Country Club, Absecon, N. J.

Oct. 20-22: 4th Annual Symp. Aeronautical Communication, IRE; Utica Hotel, Utica, N. Y.

Oct. 20-23: Annual Conf. of Int'l Municipal Signal Ass'n; Sheraton Hotel, Philadelphia, Pa.

Oct. 23-25: Fall Mtg. of Nat'l Society of Professional Engineers; San Francisco, Calif.

Oct. 23-25: Nat'l Simulation Conf., IRE; Dallas, Tex.

Oct. 26-27: Fall Mtg. of AIEE; Pittsburgh, Pa.

Oct. 27-29: East Coast Conf. on Aero & Navigational Electronics, IRE; 7th Regiment Armory, Baltimore, Md.

Oct. 27-28-29: Radio Fall Meeting, EIA; Sheraton Hotel, Rochester, N. Y.

Oct. 28: Ultrasonic Mfrs. Ass'n Annual Mtg.; Hotel Cleveland, Cleveland, O.

Oct. 30-Nov. 1: Electronic Devices Mtg., IRE; Shoreham Hotel

Dec. 3-5: Eastern Joint Computer Conference, IRE, AIEE & ACM; Bellevue-Stratford Hotel, Phila., Pa.

Abreviations:

ACM: Association for Computing Machinery
AIEE: American Inst. of Electrical Engrs.
EIA: Electronics Industries Assoc.
IAS: Inst. of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
WCEMA: West Coast Electronic Manufacturers Assoc.

As We Go To Press (cont.)

UK Instrument Maker OrganizesUSSubsidiary

Recognizing the need for closer support of its American distributors, Wayne Kerr Co., Ltd., of Chessington, Surrey, England, designer and manufacturer of instruments for the electronic, chemical and related industries, has organized Wayne Kerr Corp., 2920 N. 4th St., Phila. 33, to handle distribution, sales and service of its products in the U. S.

Boyce Adams, formerly with the Instrument Div., Robertshaw-Fulton Controls Co., Philadelphia, has been elected President of the subsidiary, it was announced by Richard Foxwell, Managing Director of the parent firm.

The British firm is one of the prominent producers of instruments in Europe. Their instruments offer unique measuring capabilities through ratio-arm impedance bridges, in which two transformers form two arms of bridge network. This type of design, developed by Wayne Kerr's technical director, Raymond Calvert, contrasts with the conventional methods of using standards of resistance capacitance and inductance.

The basic difference is one of varying voltages and currents, rather than building up cumbersome and involved decade standards to vary impedance.

Measurement of impedances *in situ* (in its undisturbed position) can be determined regardless of other impedances between either or both terminals and a third point.

1959 COMING EVENTS

Jan. 12-13-'59: 5th National Symposium on Reliability & Quality Control, IRE, AIEE, ASQC & EIA; Bellevue-Stratford Hotel, Phila., Pa.

Mar 2-6: Western Joint Computer Conf., IRE, AIEE & ACM; at Fairmount Hotel, San Francisco, Calif.

March 23-26: IRE National Convention, IRE; New York City.

Apr. 5-10: 5th Nuclear Congress, IRE & EJC; Cleveland, Ohio.

May 4-6: National Aeronautical Electronics Conference, IRE; Dayton, Ohio.

May 6-8; Electronic Components Conf., IRE, AIEE, EIA & WCEMA; Ben Franklin Hotel, Philadelphia, Pa.

NEW OHMITE®

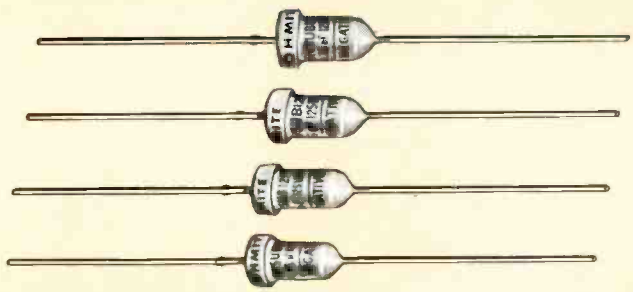
Series TS
Porous
Slug Type

"TAN-O-MITE®" TANTALUM CAPACITORS

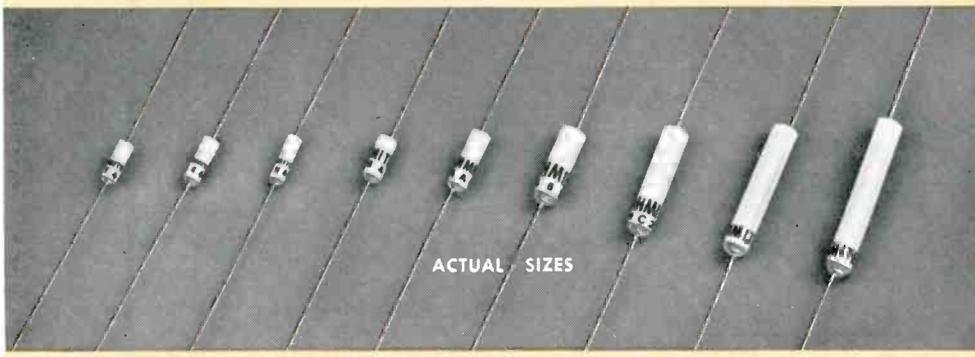
...The third in a variety of Ohmite Tantalum Capacitors

Ohmite offers you a *complete line* of quality tantalum capacitors including three types . . . all available from stock in reasonable quantities. New slug-type units employ a porous anode of sintered tantalum sealed into a fine silver case, externally uninsulated. Their stability of performance is unexcelled, with indefinitely long shelf life and exceptionally long operating life. Size "U" unit illustrated at right offers a range of 1.75 microfarads to 30 microfarads. Working voltages to 125 are available, depending upon capacity. These capacitors are polar units intended for d-c applications.

BULLETIN 159



- High Capacity, Small Size
- Extremely Low Leakage Current
- Long Shelf and Operating Life
- Normal Temperature Range is —55°C to +85°C



SERIES TW WIRE-TYPE TANTALUM CAPACITORS These Mylar® insulated, subminiature, wire-type units feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperatures as compared to other kinds of electrolytics. Ultrasmall for low-voltage, d-c, transistorized electronic equipment, these tantalum capacitors have high stability, high capacitance, long shelf life, and excellent performance under temperature extremes of —55°C to +85°C. Available in nine subminiature sizes; .01 to 80 mfd. over-all capacitance range. Smallest size is .080 x .203 inch; largest is .134 x .812 inch. Six most popular sizes are recommended for distributor's stock.

BULLETIN 148

SERIES TF FOIL-TYPE

These capacitors are tantalum foil, electrolytic units for low-voltage, a-c and d-c applications where top performance and stability of electrical characteristics are required. Units feature unusually long shelf and operating life. Three sizes now available; .25 to 140 mfd. over-all capacitance range. Standard tolerance is ±20%. Working voltages up to 150. Polar and nonpolar units available.

BULLETIN 152

OHMITE® QUALITY Components

RESISTORS RELAYS TAP SWITCHES
RHEOSTATS TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

Circle 7 on Inquiry Card, page 101

Electronic Industries' News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

FEDERAL ELECTRONIC PRODUCTS, INC., has been formed for the manufacture of gun mounts for TV and industrial tubes, such as radar, oscilloscope, storage, and pick-up tubes. The firm is located at 1380 Pompton Ave., Cedar Grove, N. J.

BERKELEY DIV., BECKMAN INSTRUMENTS, INC. has opened a new Eastern sales office for its analog computers on U. S. Highway 22 at Summit Rd., Mountainside, N. J. The Manager of the computer office will be Austin F. Marx.

RAYTHEON MFG. CO. has been awarded a CAA contract for $5.8-million for long range air traffic control radars and associated equipment.

SPERRY GYROSCOPE CO. has inaugurated a unique program enabling business and corporate aircraft users to secure immediate, permanent replacement of important flight equipment. The new program is called SPEX —Sperry exchange.

PHILCO CORP.'S G & I DIV. has received a contract for installation of 2 inter-battery microwave communication systems between Nike missile sites and anti-aircraft operation centers (AAOC) in Alaska. The contract is valued at over $1-million.

WESTINGHOUSE ELECTRIC CORP. has set up a Long Island sales office for its Defense Products Sales. It is located in the new Franklin National Bank Bldg. at 600 Old Country Rd., Garden City, N. Y.

RADIO CORP. OF AMERICA has received a $1.4-million contract for production of experimental equipment capable of obtaining flight information from up to 500 aircraft in 2 min. This is 25 to 50 times the present voice-channel capacity. Airways Modernization Board awarded the contract.

GE's WIRE & CABLE DEPT. has been notified that its silicone rubber insulated aircraft wire, SI-57421B, has received product qualification approval under Federal Specification MIL-W-7139A.

CORNING GLASS WORKS has been awarded a $400,000 contract by the Naval Bureau of Ordnance to add to its facilities for production of Pyroceram missile radomes.

SYLVANIA ELECTRIC PRODUCTS INC. has been awarded a USAF contract for the production of electronic countermeasure subsystems for radar target simulators. Number of units and sum were undisclosed.

A. B. DU MONT LABORATORIES, INC. has received an order for 80 MCA-101-E transistorized mobile radio units from the Connecticut State Police Dept.

GENERAL CERAMICS CORP. will discontinue the manufacture of low temperature Alumina solderseal terminals in favor of steatite solderseal terminals.

GENERAL CHEMICAL DIV., ALLIED CHEMICAL CORP. has developed a special line of extremely high-quality solvents for use by the electronics industry. The products included acetone, methyl alcohol, absolute, isopropyl alcohol, carbon tetrachloride, anhydrous ether, and trichloroethylene.

AMPEX CORP. opened the first of its new Professional Products Div. parts and service depots at 345 E. 48th St., New York City.

MID-WEST

BURROUGHS CORP. has installed its first high speed electronic bank proof machines at the National Bank of Detroit. They will be used to sort, list, and total the amounts of checks drawn on other banks but cashed and processed by NBD.

GATES RADIO CO. now has available a complete "package" of studio and transmitter equipment for FM broadcasting of stereophonic sound.

MAGNECORD DIV., MIDWESTERN INSTRUMENTS, INC. has received a Government contract for $739,000.

INTERNATIONAL TELEPHONE & TELEGRAPH CORP. has established an Astrionics laboratory for research and development of systems and techniques at the Ft. Wayne, Indiana, branch of the company's Missile Systems Laboratory.

INTERNATIONAL RESISTANCE CO. has relocated its Chicago Sales office to 5243 W. Diversey Ave., Chicago 39. Phone remains TUxedo 9-5800.

SEMICONDUCTOR DIV., HOFFMAN ELECTRONICS CORP. has acquired a 40,000 sq. ft. neighboring plant which will help triple production. Situated on a 2-acre plot, the 3-year old, one story brick structure is located at 2205 Lee St., Evanston, Ill.

POTTER & BRUMFIELD, INC. has announced a new 6PDT miniature latching relay that remains operative under 30g shocks and 10g vibration at 55 cps. The KE requires only a 1.5 w. pulse for 10 msec. to transfer the contacts.

P. R. MALLORY & CO., INC. suppliers of the tiny mercury batteries used in the Explorer I satellite reveal that the units have significantly exceeded their life expectancy.

CHICAGO TELEPHONE SUPPLY CORP. now has available through its industrial distributors a complete line of military and industrial variable resistors.

FOREIGN

ALLIED CONTROL CO. OF CANADA, LTD. has been formed with offices at 1500 St. Catherine St., West, Montreal, Que., by Allied Control Co., Inc., N. Y. The initial purpose of the new company is to facilitate supply of Allied Control and Siemens & Halske relays and other components. Construction of manufacturing facilities is also under consideration.

INTERNATIONAL ELECTRONIC RESEARCH CORP. has completed licensing agreements with Europelec, Les Clayes, Sous-Bois, Paris, France. The European firm will manufacture and sell IERC heat-dissipating tube shields.

STANDARD TELEPHONES & CABLES, LTD., London, an affiliate of IT&T, has installed a new system known as STRAD (switching, transmitting, receiving, and distribution system) at Gatwick Airport, near London, England. The system sharply reduces the time required to handle telegraph messages for control of aircraft.

WEST

TEXAS INSTRUMENTS INC. has disposed of its panel instrument manufacturing facilities and product line to the Sun Electric Corp. of Chicago, Ill.

LOCKHEED MISSILE SYSTEMS DIV. has developed a highly refined nose cone for the Navy's fleet ballistic missile, Polaris.

ELECTRONIC ENGINEERING CO. OF CALIF. has completed delivery of a $3-million project Datum centralized data processing facility to the USAF Flight Test Center, Edwards AFB, Calif. Consisting of 123 7-ft cabinets of equipment, the complete system is one of the largest military-type data processing facilities in the U. S.

SIERRA ELECTRONIC CORP., a Philco subsidiary is ready to introduce three new waveguide water loads. They provide a convenient and accurate means of measuring microwave power when used with a calorimeter and thermopile.

CANOGA CORP., Van Nuys, Calif., specialists in missile ranging and tracking, has been purchased by the Underwood Corp.

PACIFIC SEMICONDUCTORS, INC. has opened new Western Regional Sales Offices at 8271 Melrose Ave., Los Angeles.

LOCKHEED MISSILES SYSTEMS DIV.'s Space Communications Laboratory has almost doubled in size by the addition of 8000 sq. ft. The new unit will be used mainly for offices and permit needed expansion of laboratories in the present 10,000 sq. ft. building.

ELECTRO INSTRUMENTS, INC. has opened a new sales office at 496 Sherwood Way, Menlo Park, Calif. Phone: DAvenport 6-9120. Ted Lawson is in charge.

PACKARD-BELL ELECTRONICS CORP. has added 20,000 sq. ft. of leased space to its expanding Technical Products Div. The new facility located at 1905 Armacost Ave. in West Los Angeles will house engineering and administrative personnel of the Missile Equipment Section and the engineering staff of Packard-Bell Computer Corp.

GOOD-ALL ELECTRIC MANUFACTURING CO. has opened its fifth separate manufacturing plant in Ogallala, Nebr.

INTERNATIONAL BUSINESS MACHINES CORP. opened a new regional headquarters in Los Angeles serving 12 western states, Hawaii and Alaska. The manager of the regional office is Leonard E. Clark, whose headquarters will be temporarily located at 3275 Wilshire Blvd.

ARNOUX CORP. has just established a new facility for low-temperature calibration of temperature transducers. For the LOX range, service is provided in any desired increments from —300°F to —285°F, with an accuracy of 0.1°F at any point.

CONSOLIDATED ELECTRODYNAMICS CORP. has received contracts totaling $1.5-million from the Convair Astronautics Div. for the design, development, and production of ground-support equipment for the Atlas ICBM program.

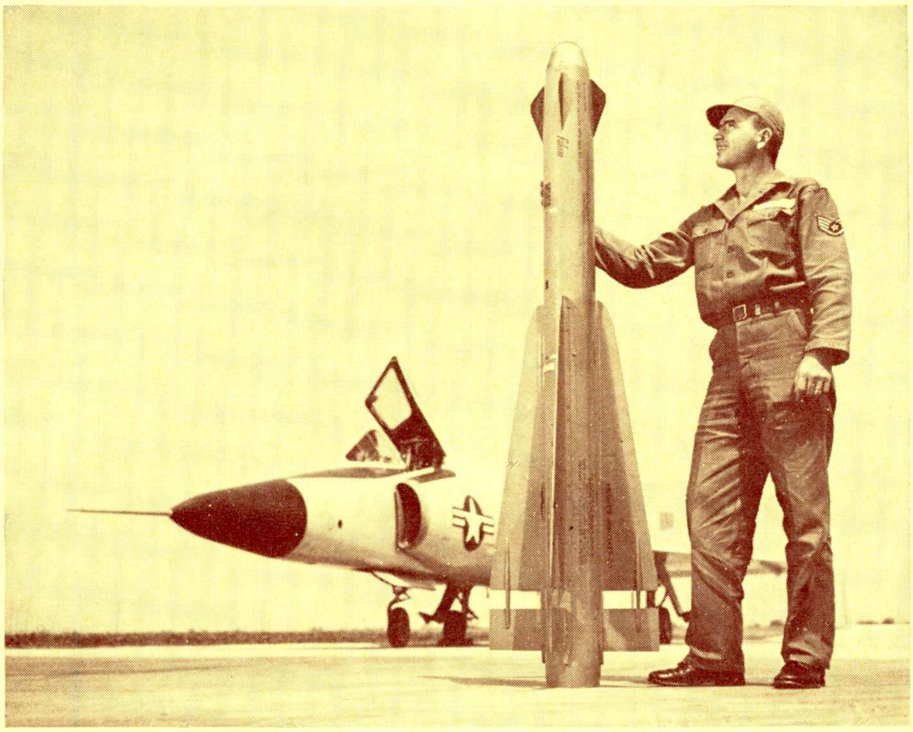
TELECOMPUTING CORP. has been awarded a USAF contract totaling over $3.5-million. Contract calls for the manufacture of valve equipment for the USAF's Oklahoma City and San Antonio Air Materiel Areas.

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

Deadly Hughes GAR-2A Falcon Missile Employs Six G-E 5-Star Subminiatures in Vital Control Sockets!



General Electric 5-Star high-reliability subminiature tubes help give dependable striking power to Hughes Aircraft Company's GAR-2A air-to-air missile, which seeks out its target by means of infra-red guidance.

Six 5-Star subminiatures are employed: Types 5899, 5902, 6021, 6111, 6112, and 6205. The Hughes Type GAR-2A missile complements the GAR-1D Falcon, which relies on radar guidance. Eight 5-Star subminiatures are used in the GAR-1D.

Tubes and other electronic components in Falcon missiles are compactly mounted on plug-in etched circuit boards. Miniaturization has been carried to a point roughly equivalent to compressing two television sets into a space no larger than a football.

Cold, Heat, Acceleration, Vibration—All Are Environmental Hazards

The tiny 5-Star Tubes that guide Falcons to their explosive destinations, must withstand the extreme cold of high altitudes, the heat of skin friction, the acceleration and vibration of launching and flight.

Dependable service under these conditions calls for special rugged qualities which General Electric has designed into all 5-Star subminiatures. These tubes, moreover, are built with extra care in a lint-free, dust-free factory, and undergo 100% tests that accurately reflect airborne and missile operating requirements.

On the next page will be found suggestions on how to conserve tube life and obtain top performance, when applying high-reliability tubes in compact circuits where temperatures may run high, as with missiles.

7077 UHF Triode Tests Prove Tube's Versatility, Show Low Noise Figure at 30–60 MC

Recent tests have confirmed that General Electric's new 7077 ceramic UHF-amplifier triode has an extremely low noise figure in the 30–60 megacycle region, and is well suited to IF-amplifier applications.

For receivers operating at microwave frequencies, 30–60 megacycles is an area of prime importance in the IF-amplifier circuit. Minimum noise here is essential, if the full potentialities of a low-noise microwave crystal mixer are to be realized.

Low shot-noise resistance and negligible transit-time loading help make Type 7077 an ideal choice for the cascode input stage of an IF-amplifier circuit. Besides the tube's electrical advantages, its physical features—small size, ruggedness, and high heat resistance—add to the 7077's value in military applications.

Complete data on IF-amplifier tests of the 7077 at varying band widths, may be obtained from any G-E office listed on the next page. Also, ask for information about sockets for the tube, already developed and available, and for noise, gain, and other performance characteristics at frequencies from 30 to 1000 megacycles.

Tear off and keep this sheet for reference. It contains useful tube-application data.

FOR MAXIMUM TUBE LIFE, AVOID HIGHER-THAN-RATED TEMPERATURES!

Promote Dependable Performance by Keeping Bulb Temperatures And Dissipation Levels within Published Tube Limits!

Sharp penalties in shortened life can result from tube operation which is in excess of rated limits for bulb temperature and dissipation. See life-test curves at right for evidence that high temperatures and high dissipation levels cut the number of operative tubes—the percentages dropping rapidly as heat and dissipation go up.

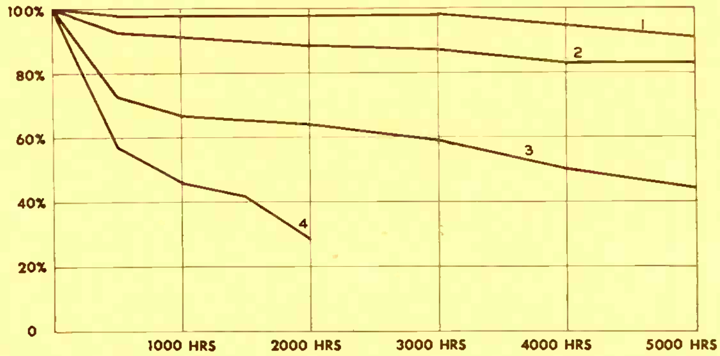
Excessive temperatures in tubes can cause reverse grid currents, loss of emission, shorted elements, glass-envelope failures, and other faults.

Ambient Heat Level, Internal Element Dissipation, Both Influence Tube Temperature

How hot a tube will run, is a joint result of the ambient temperature and the dissipation of the internal elements of the tube. Designers can reduce bulb temperatures mechanically, by using improved tube shields which permit the heat to flow by conduction to a heat sink—have good radiation efficiency—and allow free air circulation.

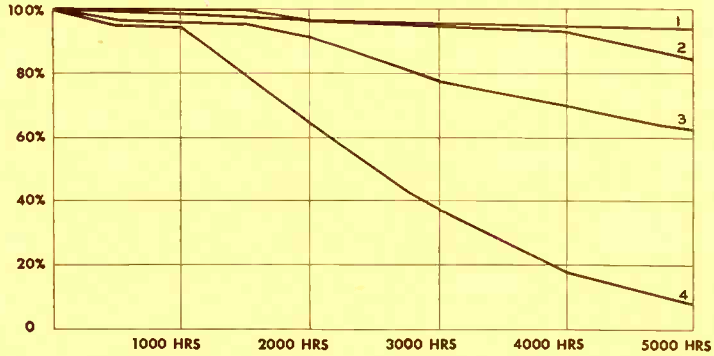
Normally, however, tube shields do not significantly lower the temperature of the internal tube elements. Here the circuit designer's control must be electrical—i.e., he should strive to avoid dissipation levels in excess of rated limits.

Observing these limits will increase tube reliability and greatly extend the span of tube life. More specific and detailed facts about tube operating temperatures can be obtained from any General Electric office at the bottom of this page.



TYPE 5654 HIGH-RELIABILITY MINIATURE

Life test results at varying temperatures. (Vertical scale shows percentage operative* tubes remaining. Horizontal scale, time.) Ambient temp for Curve 1 was 100 C, bulb temp was 125 C . . . Curve 2, 175 C and 192 C . . . Curve 3, 250 C and 263 C . . . Curve 4, 300 C and 312 C. Plate dissipation was maintained at 1.5 watts. The max rated bulb temperature of Type 5654 is 165 C.



TYPE 6005 HIGH-RELIABILITY MINIATURE

Life test results at varying dissipation levels. (Vertical scale shows percentage operative* tubes remaining. Horizontal scale, time.) Dissipation level, P_p+P_c2, for Curve 1 was 10.0 w. . . . Curve 2, 13.5 w. . . . Curve 3, 15.4 w. . . . Curve 4, 20.0 w. Bulb temperature was allowed to increase with dissipation. The max rated dissipation of Type 6005 is 13.2 w.

**By "operative tubes remaining" is meant tubes without any short, open, air leak, or heater-cathode leakage in excess of 100 microamperes.*

Tubes for the above tests were taken in lots of 200 or more from the production of all manufacturers with qualification approval. Accordingly, results are a composite for the industry.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION	CENTRAL REGION	WESTERN REGION
200 Main Avenue, Clifton, New Jersey	3800 North Milwaukee Avenue	11840 West Olympic Boulevard
Phones: (Clifton) GRegory 3-6387	Chicago 41, Illinois	Los Angeles 64, California
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8	Phone: SPring 7-1600	Phones: GRanite 9-7765; BRadshaw 2-8566

Progress Is Our Most Important Product

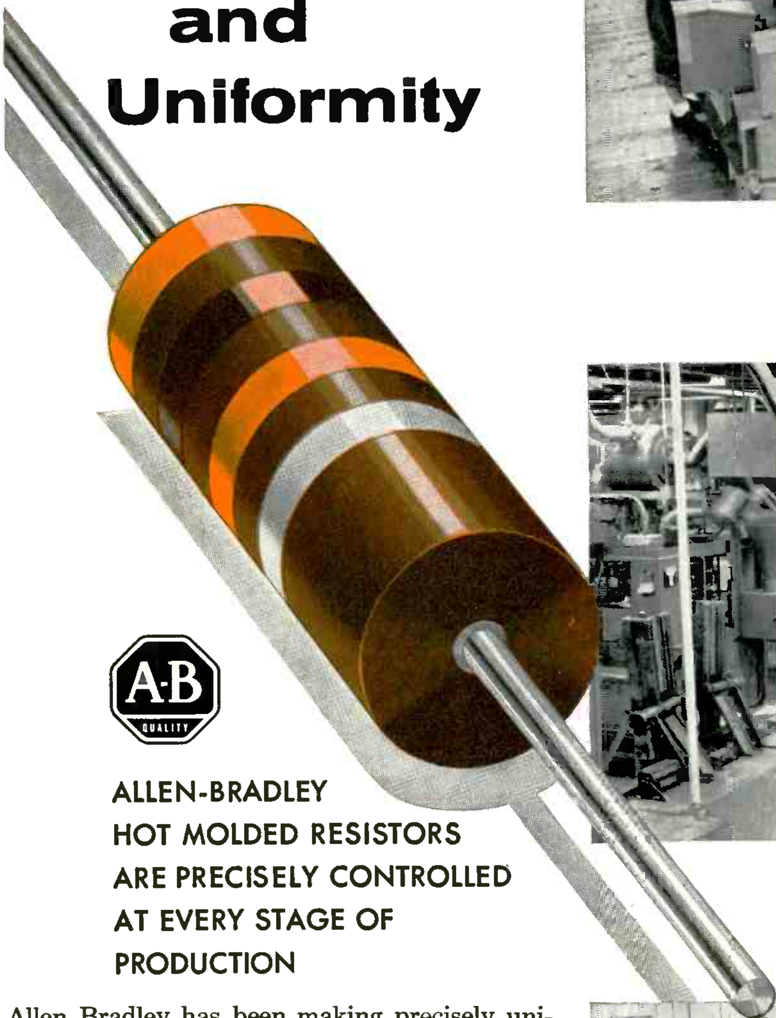
GENERAL ELECTRIC

12-11-205

← Circle 8 on Inquiry Card, page 101

Circle 9 on Inquiry Card, page 101

Miracle of Precision and Uniformity



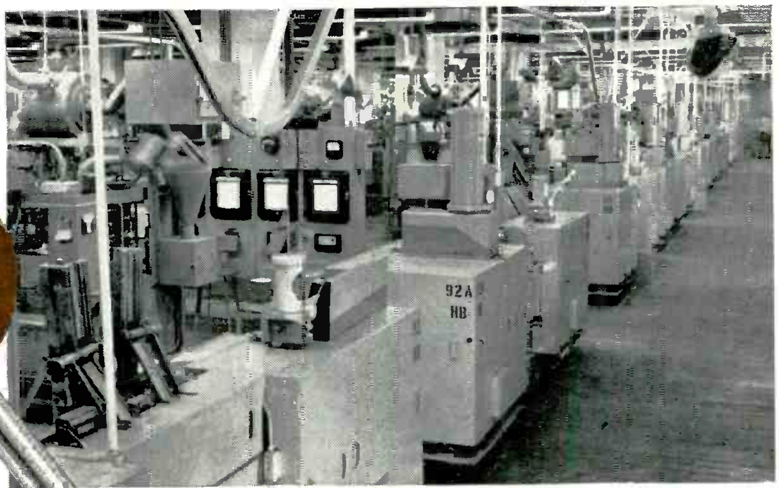
ALLEN-BRADLEY
HOT MOLDED RESISTORS
ARE PRECISELY CONTROLLED
AT EVERY STAGE OF
PRODUCTION

Allen-Bradley has been making precisely uniform resistors—not by the millions *but by the billions*—over the years. The *exclusive* hot molding process—developed and perfected by Allen-Bradley—uses specially designed automatic machines that incorporate precision control at *every* step of production. Shown here are a few of the special machines that make possible the amazing uniformity—from resistor to resistor, year after year—for which Allen-Bradley composition resistors are famous.

Allen-Bradley Co., 1342 S. Second St.
Milwaukee 4, Wisconsin
In Canada: Allen-Bradley Canada Ltd.
Galt, Ontario

ALLEN-BRADLEY
QUALITY
Electronic Components

AUTOMATIC HEADING MACHINES form heads on the end of lead wires to make sure they will be solidly anchored in the resistor body. Wire has been previously tinned for easy soldering.



AUTOMATIC MOLDING MACHINES take the resistance powder, insulation powder, and lead wires, and hot mold them under closely controlled high temperature into one integral unit.

AUTOMATIC COLOR CODING MACHINES apply color bands and oven-bake the enamel at high temperatures to assure that the color coding will withstand the maximum operating temperatures of 150°C and all types of cleaning solvents.

Circle 96 on Inquiry Card, page 101

Circle 11 on Inquiry Card, page 101 →

For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS

All types for frequencies from .1 cycle to 400 MC.

400 ∼ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ∼, ⅝ x 1¼ x 2″.

15 ∼ BP filter, 20 db at 30 ∼, 45 db at 100 ∼, phase angle at CF less than 3° from —40 to + 100° C.

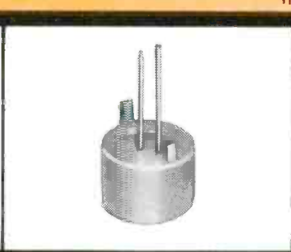
LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

HIGH Q COILS

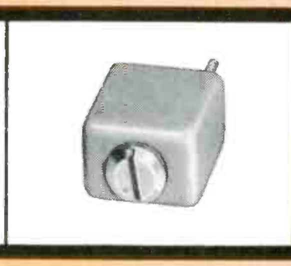
Toroid, laminated, and cup structures from .1 cycle to 400 MC.

Tuned DO-T servo amplifier transformer, 400 ∼ .5% distortion.



Toroid for printed circuit, Q of 90 at 15 KC.

Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.



HVC tapped variable inductor for 3 KC oscillator.

SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.

RF saturable inductor for sweep from 17 MC to 21 MC.

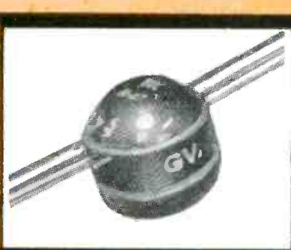
Voltage reference transformer .05% accuracy.

Multi-control magnetic amplifier for airborne servo.

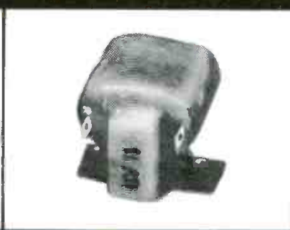
Input, output, two tuned interstages, peaking network, and BP filter, all in one case.

PULSE TRANSFORMERS

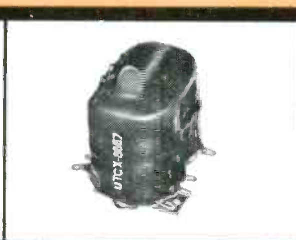
From miniature blocking oscillator to 10 megawatt.



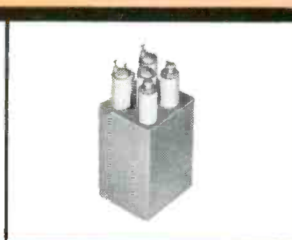
Wound core unit .01 microsecond rise time.



Pulse current tansformer 100 Amp.



Pulse output to magnatron, bifilar filament.



Precise wave shape pulse output, 2500 V. 3 Amps.

POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.

Multi-winding 140 VA, 6 KC power transformer 1⅛ x 1⅛ x 1″

200° C. power transformer, 400 ∼, 150 VA.

400 ∼ scope transformer, 20 KV output.

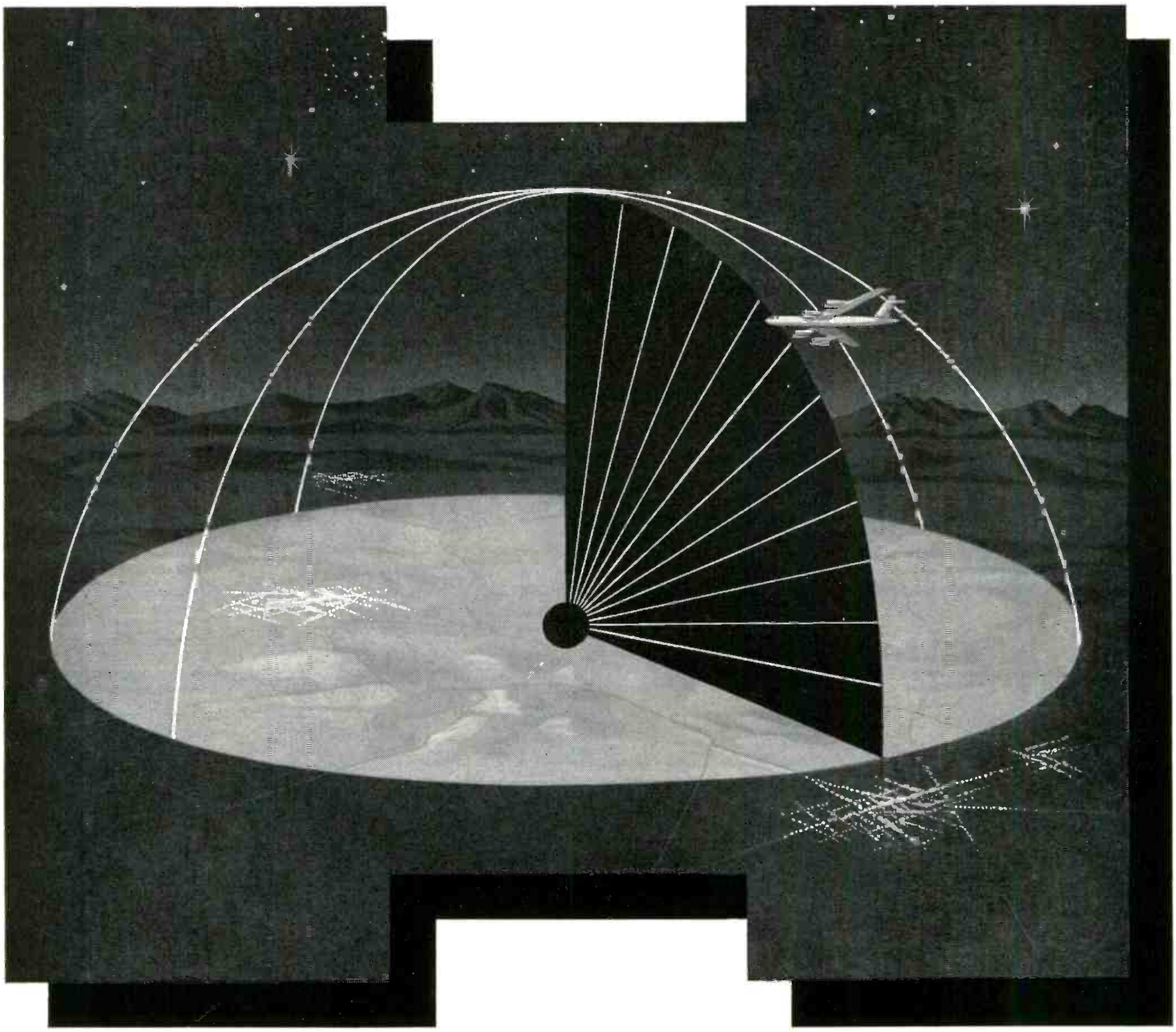
60 ∼ current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y., CABLES: "ARLAB"

PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

THE UMBRELLA



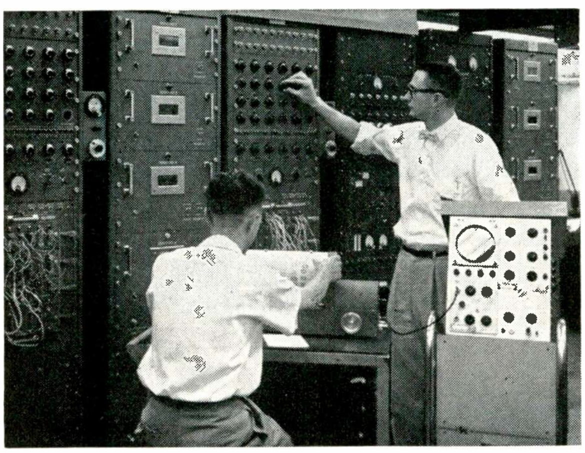
THAT NEVER LEAKS

To achieve umbrella-like radar protection Hughes engineers at Fullerton, California, have developed systems which position radar beams in space by electronic rather than mechanical means. These unique three-dimensional radar systems are digitally programmed to instantaneously detect high-speed enemy aircraft, even at low altitude.

Other defense systems under development at Hughes in Fullerton are Data Processors which monitor the movement of hundreds of aircraft, store the information and assign defense weapons; radars with beams capable of detecting and tracking missiles; and new radar systems for installation on surface and subsurface naval vessels.

Other Hughes activities are delving into similarly advanced areas of electronics. Engineers at Hughes Research & Development Laboratories are probing into the effects of nuclear radiation on electronic equipment, studying advanced microwave theory and applications, and examining communication on a spatial scale. Applying this advanced type of creative engineering to commercial projects is the task of engineers at the Hughes Products activity.

The highly advanced and diversified nature of Hughes projects offers creative engineers and physicists the opportunity to build a rewarding career in a progressive and expanding environment.



Research & Development Engineers use REAC computing equipment as an aid in such complex problems as systems simulation.

Reliability of the advanced Hughes Electronic Armament systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.

An immediate need now exists for engineers in the following areas:

Electron Tubes	Radar
Industrial Systems	Communications
Semiconductors	Circuit Design
Field Engineering	Microwaves
Computer Engineering	Systems Analysis

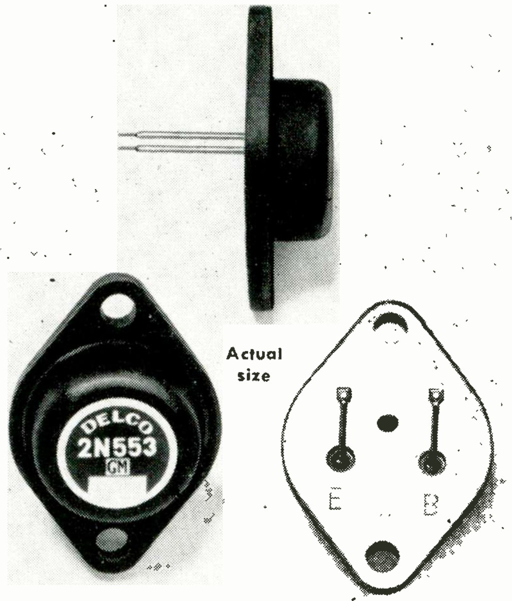
Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-F-1, Culver City, California.

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

Circle 501 on "Opportunities" Inquiry Card, page 103



ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS $T = 25°C$ unless otherwise specified

Collector diode voltage V_{CB} ($V_{EB} = -1.5$ volts)	80 volts maximum
Emitter diode voltage V_{EB} ($V_{CB} = -1.5$ volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} ($V_{CB} = 2$ volts)	12 μa
Collector diode current I_{CO} ($V_{CB} = -60$ volts)	0.5 ma
Collector diode current I_{CO} ($V_{CB} = -30$ volts, 75°C)	0.5 ma
Current gain ($V_{CE} = -2$ volts, $I_C = 0.5$ amp.)	55
Current gain ($V_{CE} = 2$ volts, $I_C = 2$ amps.)	25
Saturation voltage V_{EC} ($I_B = 220$ ma, $I_C = 3$ amps.)	0.3
Common emitter current amplification cutoff frequency ($I_C = 2$ amps. $V_{EC} = 12$ volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

DELCO RADIO

Division of General Motors
Kokomo, Indiana

Circle 14 on Inquiry Card, page 101

Tele-Tips

"HAM TV" is now a reality. Electron Corp., Dallas, Tex. subsidiary of Ling Electronics, Inc. is introducing a new "ham" tv transmitter that operates in the 420-450 MC band allocated to amateurs. The price is "under $2,000."

SIMULATED COLOR TV system was patented last month by two Austrian scientists. It employs a principle called the Fechner-Benham effect, and uses three discs divided into black, white and shaded areas. They give impressions of red, green or blue, depending on the relative size and order of the areas and the speed of rotation. According to the inventors the impressions of color can be given without any changes in the ordinary black-and-white receiver and with relatively little effort in the television studio.

SALARIES of the "average" business executive increased 4.8%—from $11,240 a year to $11,800 a year—from last year to this. This compares with a 5.8% increase during the same period a year ago.

STEREO MANUFACTURERS are brewing a hot argument over whether the stereo effect is possible from just one cabinet. Classical theory says that speakers should be spaced 7 to 10 ft, but can the effect be "gimmicked"?

THE HIGH COST of aircraft is dramatically emphasized by these figures from Douglas Aircraft Co. Though the firm already has over $700 million in orders for their DC-8 jetliner they are not even close to writing off the $250 million development costs that went into the aircraft.

THE VA is underwriting the costs of an experiment in Long Island, N. Y. in which a polio-stricken vet is "attending" college courses through a 2-way telephone hook-up. While confined to his home in a wheelchair the vet can listen to lectures and take part in classroom discussions, the same as any student.

Tele-Tips

THE PULL OF GRAVITY is due for a re-measurement. Scientists at the National Bureau of Standards have been using the figure of 32.155 ft/sec/sec. But there is an uncertainty there of at least 8 parts in a million. That's not good enough, says the Bureau. They will attempt to make an absolute determination to an accuracy of 1 part in a million.

COMPUTERS are being used by traffic engineers to predict highway traffic loads up to 20 years in the future. Samplings of traffic at various points—information on where the driver wants to go and where he came from—is translated into formulas that are fed into the computers together with the population growth curves for various areas and population saturation.

THE FCC received a complaint of a "garbled voice" on the programs of a radio broadcast station in Georgia, and another in Alabama, which are jointly owned. The management at first denied knowledge of the mystery voice, but later admitted it was a stunt to arouse interest in a certain program. It dropped the idea when it boomeranged to cause annoyance to listeners and gave the FCC field engineers unnecessary work.

OVERSEAS RADIO traffic, from New York to Frankfurt, Germany, was recently suffering from a severe interference that neither the German nor British monitoring services were able to identify. FCC monitoring observations and direction findings bearings placed it as coming from a commercial telegraph transmitter of a company in New York.

TOP HONORS as the East Coast's champion predicted-log yachtsman again goes to Dr. Allen B. DuMont. Winning the trophy has almost become automatic to "Doc;" he's taken it 5 times since 1953. Predicted-log races call for the skipper to estimate the exact time that he will pass certain markers, given only the current, tide, wind and boat's characteristics.

Letters

to the Editor

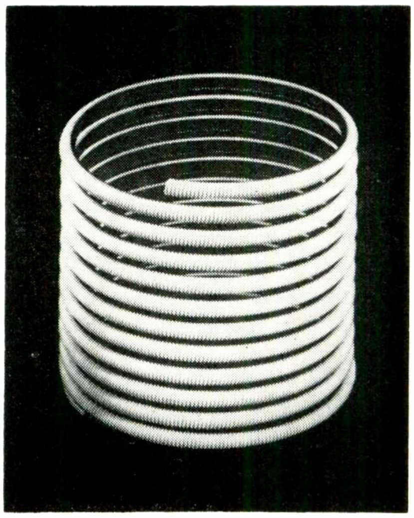
"Making Precision Pots"

Editor, ELECTRONIC INDUSTRIES:

On page 90 of the July issue of ELECTRONIC INDUSTRIES you described a process, using ultra-violet light, by which precision potentiometer resistance elements can be inspected. The process was accredited to Shannon Luminous Materials Company.

We at Spectrol Electronics Corporation developed the process for incorporating luminous tracers in bonding materials to facilitate accurate inspection on the dispersion of the bonding materials used in the manufacture of resistance elements. Shannon Luminous Materials Company was the vendor who worked with us to determine the optimum type of luminous material used in the mix.

The photograph you showed on page 90 to illustrate the use of this inspection technique is not a good example of the correct dispersion of the bonding material. The ultra-violet light shows, in that photograph, the bonding material to be non-uniform and incorrectly applied. It will not produce a good device.

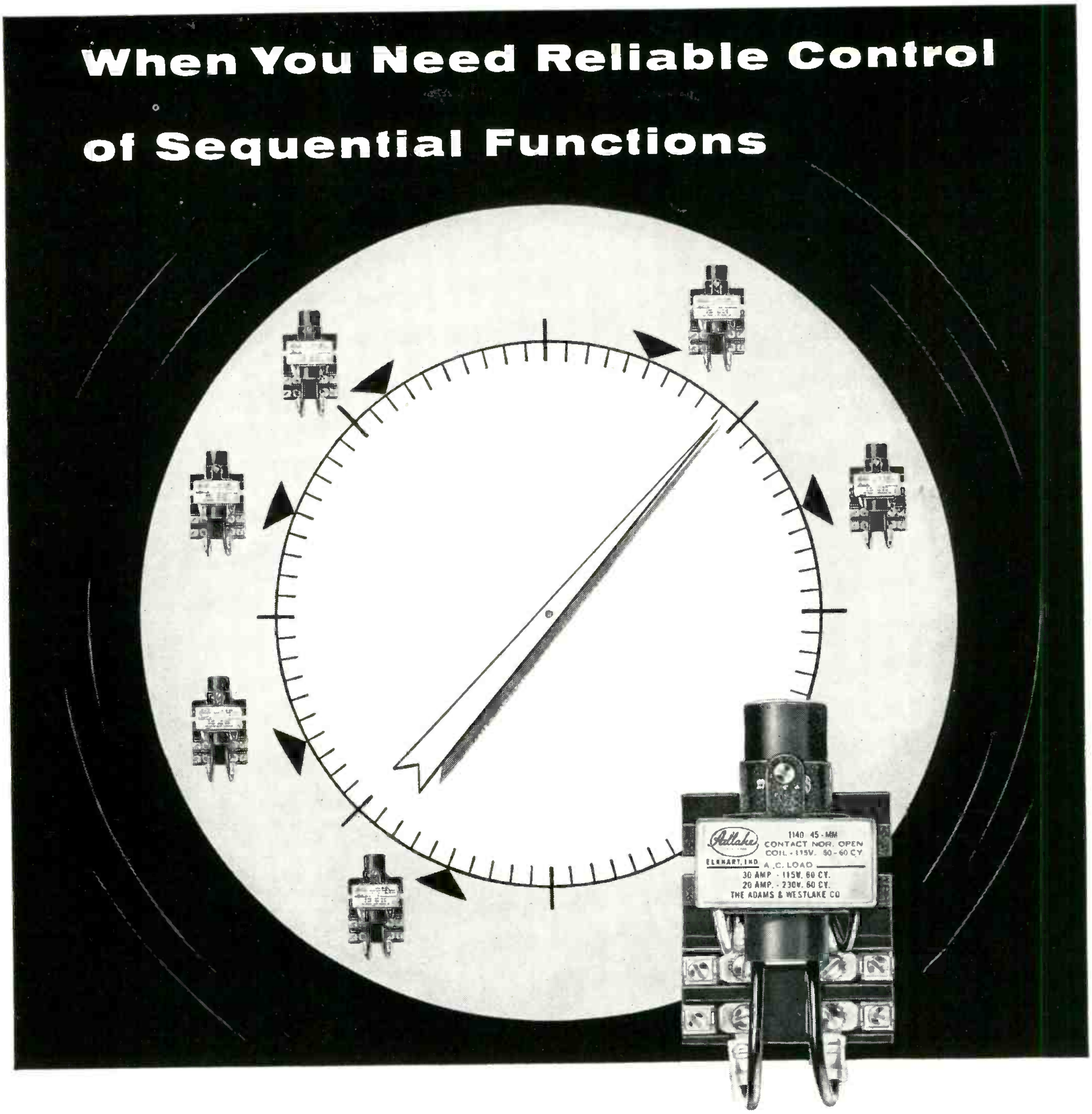


Properly bonded resistance element.

Here at Spectrol Electronics we have developed many manufacturing and inspection techniques that enable us to produce highest possible quality precision potentiometers. Enclosed is a photograph which shows a properly bonded resistance element under ultra-violet light. Please note the difference. We hope your readers will be as interested in the difference as we know you are.

R. K. BURTNER
Sales Manager
Spectrol Electronics Division
of Carrier Corporation
1704 South Del Mar Avenue.
San Gabriel, Calif.

More "Letters" on page 36



you need Adlake *mercury-to-mercury* relays

From sensitive laboratory use to rugged locomotive application, Adlake relays have proved their dependability and versatility. Here's why:

- **Perfect snap action—no pitting, burning or sticking**
- **Hermetically sealed at the factory—no intrusion of dust, dirt or moisture**
- **Fixed, tamper-proof time delay characteristics**
- **Quiet, chatterless operation. No maintenance whatever.**

Our engineers will gladly help you solve your control problems—no obligation. Just write The Adams & Westlake Company, 1182 N. Michigan, Elkhart, Indiana... New York... Chicago

The Adams & Westlake Company

NEW YORK ELKHART, INDIANA CHICAGO

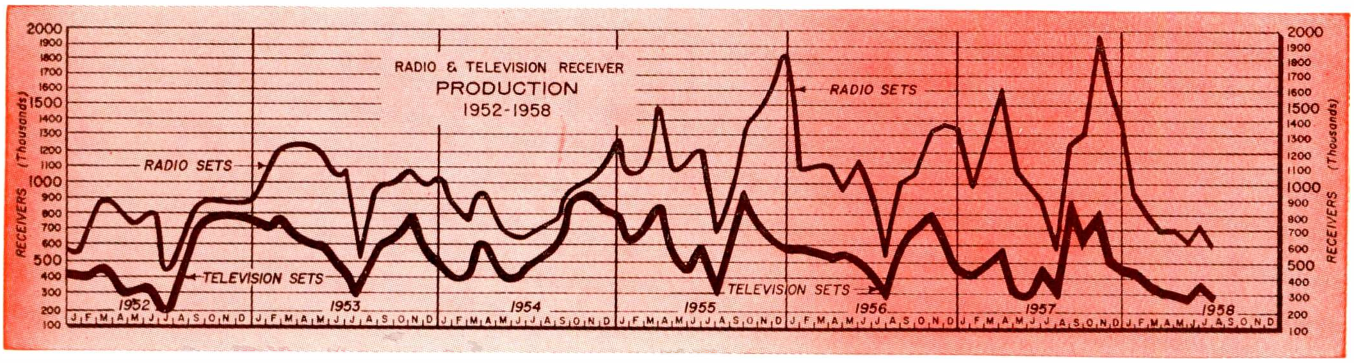
Established 1857

Circle 16 on Inquiry Card, page 101

Facts and Figures Round-Up September, 1958

ELECTRONIC INDUSTRIES

TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in July, 1958.

Accelerometers	33,775
Amplifiers	820,482
Amplifiers, audio	110,951
Amplifiers, r-f	41,799
Amplifiers, synchro	37,000
Analyzers	260,032
Analyzers, spectrum	65,550
Antennas & accessories	1,450,687
Antenna towers & supports	2,080,882
Battery chargers	1,318,928
Batteries, dry	1,060,019
Batteries, storage	1,403,830
Beacon equipment, radar	511,610
Beacon equipment, radio	202,090
Cable assemblies	250,850
Cable sets, interconnecting	204,426
Calibrators	39,771
Capacitors	61,871
Circuit breakers	95,601
Coder-decoder	594,462
Communications systems	114,194
Computers & accessories	18,580,271
Computers, airborne	14,465,978
Connectors	136,472
Countermeasures equip.	346,572
Crystal units	136,000
Electronic equipment	30,750
Fire control equip.	3,240,000
Generators, signal	2,139,426
Handsets	46,633
Headsets	45,305
Headset-microphone	254,024
Identification sets	41,625
Indicators	4,911,268
Indicators, radar	425,250
Intercom. equipment	152,142
Isolators	27,945
Kits, modification	2,176,640
Kits, radar installation	182,678
Kits, radar modification	1,022,896
Meters, frequency	903,669
Meters, frequency power	42,510
Meters, r-f watt	73,198
Meters, volt	507,779
Microwave equipment	155,934
Mine detectors	1,341,026
Modulators	49,500
Monitors	130,562
Multimeters	512,039
Multiplexer equipment	670,371
Navigational systems & equip.	4,434,517
Networks	30,030
Oscillators	311,282
Oscilloscopes & accessories	238,157
Potentiometers	181,779
Power supplies	767,733
Power units	47,151
Radar equipment	29,003,897
Radiac equipment	819,076
Radio direction finders	505,981
Radio equipment	115,754
Radio receivers	3,512,434
Radio receivers-transmitters	1,675,512
Radio set controls	1,366,611
Radio sets	8,268,161
Radio transmitters	13,416,632
Radiosonde equipment	69,000
Radomes	849,255
Recorders & accessories	2,747,735
Relays	439,616
Resistors	161,869
Semiconductor diodes	143,543
Simulators, target	1,629,911
Single sideband equip.	7,507,662
Sonar equipment	3,723,810
Spare parts	130,415
Standards	35,896
Switches	141,811
Synchros	2,092,861
Tape, recording	195,869
Telemetering equip.	403,998
Telemetering ground stations	130,530
Teletype equipment	3,014,500
Television equipment	662,547
Test bridges	262,800
Test equipment (various)	1,696,971
Testers	281,553
Testers, tube	230,277
Test sets	462,047
Test sets, power	40,710
Test sets, radio	355,450
Transformers	65,900
Transistors	257,477
Transponder sets	1,369,277
Tubes, electron	6,592,884
Wire & cable	1,692,058
X-ray equipment	196,420

BUSINESS EXPECTATIONS 4TH QUARTER 1958

			Total Mfrs.	Manufacturers Durable	Non-durabl
Net Sales	No. Companies Reporting		774	410	364
	Per cent Expecting	Increase	59	60	58
		No Change	30	26	34
		Decrease	11	14	
Net Profits	No. Companies Reporting		702	375	327
	Per cent Expecting	Increase	43	44	41
		No Change	43	38	50
		Decrease	14	18	9
Selling Prices	No. Companies Reporting		757	400	357
	Per cent Expecting	Increase	14	15	14
		No Change	81	80	82
		Decrease	5	5	4
Level of Inventories*	No. Companies Reporting		771	408	363
	Per cent Expecting	Increase	22	24	20
		No Change	62	56	69
		Decrease	16	20	11

*End of Quarter

—*Dun & Bradstreet*

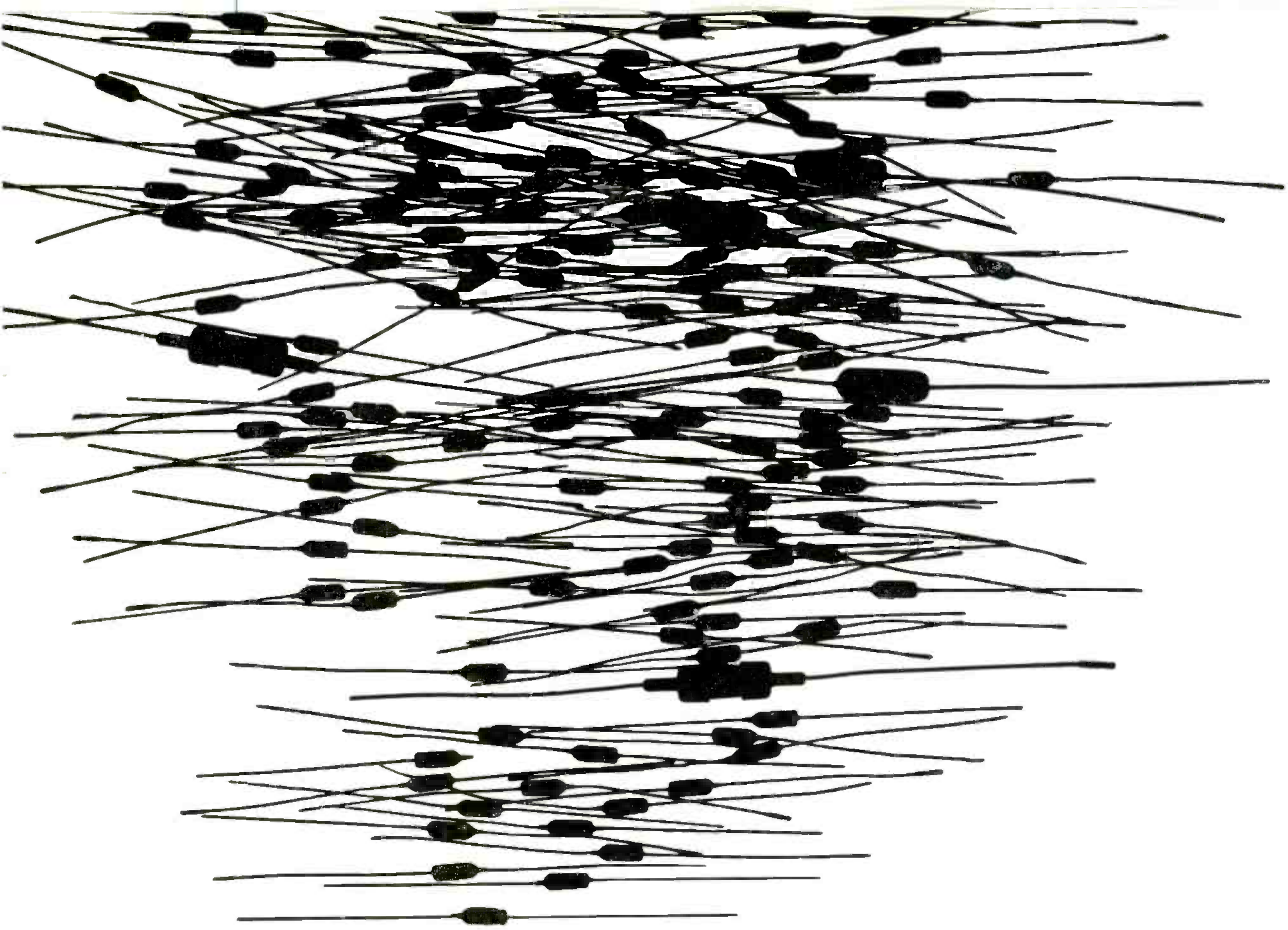
TUBE SALES

	TV Picture Tubes Units	TV Picture Tubes $ Value	Receiving Tubes Units	Receiving Tubes $ Value
January	621,910	$12,341,927	26,805,000	$23,264,000
February	556,136	11,210,527	29,661,000	25,650,000
March	634,779	12,643,404	28,548,000	25,716,000
April	590,357	11,591,733	32,582,000	28,788,000
May	560,559	11,237,147	36,540,000	31,406,000
June	725,846	14,203,381	36,270,000	31,445,000
TOTAL	3,689,587	$73,228,119	190,406,000	$166,269,000

RADIO & TV PRODUCTION

	Television	Automobile Radio	Total Radio
January	433,983	349,679	1,026,527
February	370,413	268,445	876,891
March	416,903	234,911	931,341
April	302,559	190,435	697,307
May	266,982	185,616	654,803
June	377,090	235,433	774,424
TOTAL	2,167,930	1,464,519	4,961,293

—*Electronic Industries Association*

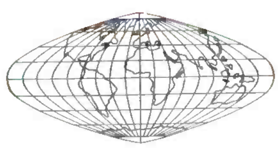


MINIATURE *all-glass technique . . . point-contact or gold-bonded construction . . . available with solder-in leads or clip-in studs.*

SUBMINIATURE *all-glass technique . . . copper-heat-sink . . . available on standardized tape for automatic insertion.*

AVAILABLE TYPES *standard EIA or to your own specifications.*

FOR QUALITY IN QUANTITY ASK AMPEREX



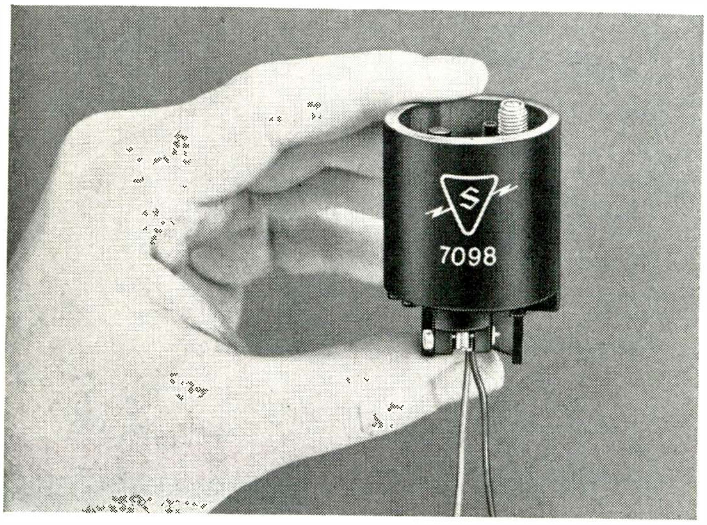
the industry's reliable source of germanium and silicon diodes for computers, radio . . . tv . . . hi-fi and other professional or consumer applications

Amperex® electronic corp.
230 Duffy Avenue, Hicksville, L. I., New York
IN CANADA:
ROGERS ELECTRONIC TUBES & COMPONENTS
11-19 Brentcliffe Road, Leaside, Toronto 17, Ont.

Circle 12 on Inquiry Card, page 101

MICROWAVE AND SPECIAL TUBE NEWS from SYLVANIA

Six-Ounce Missile Magnetron Withstands 500 g

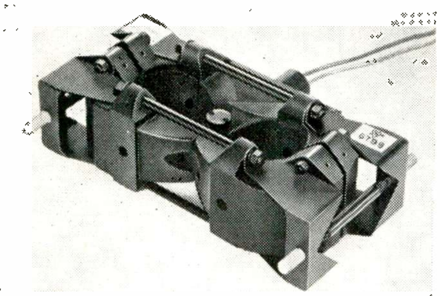


Miniature magnetron, type 7098, for missile and beacon applications, meets extra severe environmental tests

Palm-sized, mechanically tunable magnetron, designed to operate in the frequency range from 9300 to 9500 mc at 60 watts minimum peak power output, is now available from Sylvania. The rugged unit meets some of the military's toughest environmental requirements. Here are some of the tests that every 7098 must pass:

- Vibration of 10 to 60 cps at 0.08 inch total excursion and 60 to 2,000 cps at a constant acceleration of 15 g in each of three mutually perpendicular planes.
- Centrifuge test of 500 g acceleration.
- Linear shock test of 500 g for 1.0 ms.
- Rotation at 300 rps. without a shift in frequency greater than plus or minus 1.25 mc.

New Ka Band Magnetrons specially designed for missile applications



Light weight and extra ruggedness make Sylvania's new Ka band magnetrons ideal for high and low altitude pinpointing applications

Four Ka Band magnetrons — types 6799, M 4064, M 4063 and M 4155 (ruggedized 5789), covering a power range from 20 KW to 100 KW, are now available from Sylvania. Particularly adaptable to high resolution applications, such as cloud finding, mapping and missile guidance, the three new types meet and surpass current missile vibration and shock requirements.

Type	Peak Power Output	Weight (Approx.)
6799	100 KW	33 lb
M 4064*	70 KW	13 lb
M 4155*	40 KW	11 lb
M 4063*	20 KW	9 lb

*ruggedized

Sylvania develops and produces Backward-Wave Magnetrons

BWM's in L, S and X Bands develop output powers as high as 600 Watts

Sylvania, one of the pioneers in Backward-Wave Magnetron development, now has several types in pilot production and late development. The new units exhibit extremely low frequency drift and nearly flat power versus frequency characteristics. Used principally in electronic countermeasure applications for barrage jamming, BWM's offer high reliability and require less associated circuitry and equipment than other power sources.

Today, 75 percent of the engineers and technicians employed at Sylvania's extensive magnetron facilities in Williamsport, Pa. are engaged in development work. For full particulars on how these outstanding facilities can help you, contact your Sylvania representative or write Sylvania direct.

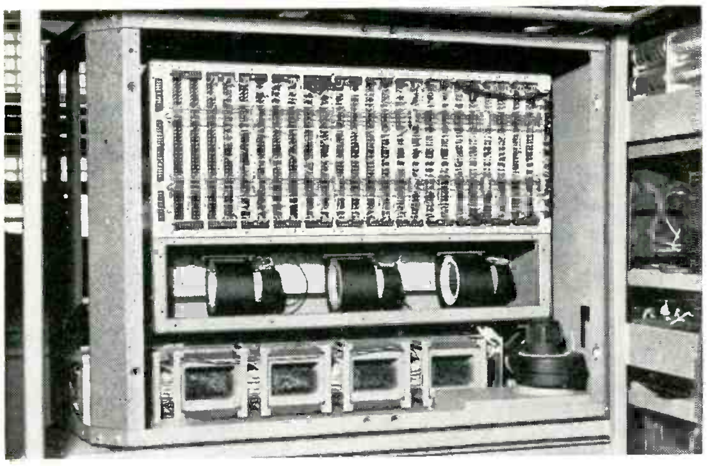
SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.

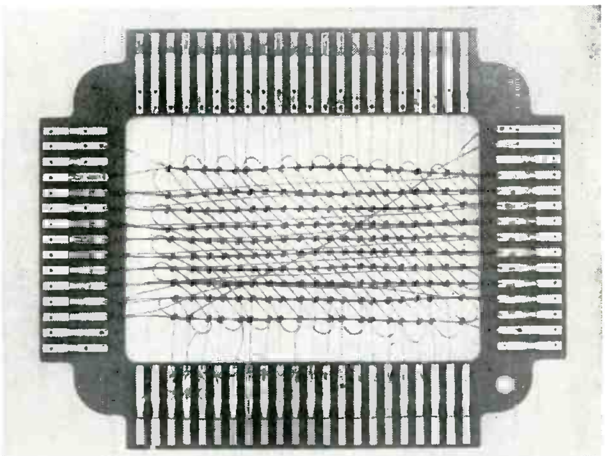
LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

THE NATIONAL SCENE

KEEPING "ELECTRONIC BRAINS" FROM LOSS OF MEMORY. One of science's greater marvels is IBM's 705 Electronic Data Processing Machine—which makes intricate calculations and logical decisions in millionths of a second. Heart of this electronic "wizard" is its main magnetic core memory. Designed for use with the machine's high-speed printer is the IBM 760 Control and Storage Unit containing its own core memory of 1,000 positions which allows central processing to continue in the 705 while other data are being printed. Helping the 760 remember what information is to be printed is a job for PHENOLITE® Laminated Plastic. PHENOLITE's unique combination of properties makes it ideal for this application.



MOST ADVANCED FORM OF ELECTRONIC STORAGE. The 1,000-position core memory for the IBM 760 Control and Storage Unit—a portion of which is shown here—consists of pinhead size cores strung on copper-wired frames of PHENOLITE. Electrical impulses, passing through wires, alter the magnetic state of cores so that a group of them stands for a word or figure. Reversing the process recalls information from storage. PHENOLITE frames safeguard the circuit and permit stacking of core planes as shown.



PHENOLITE MEETS CRITICAL STANDARDS. Core frames like the one shown are punched out of laminated PHENOLITE by IBM. Each frame has printed circuit type terminal strips and soldered connections. PHENOLITE proves an ideal material for this application because it is mechanically strong and stiff, punches cleanly, etches well, remains flat, has high dielectric properties and withstands the heat of dip soldering.

NATIONAL CAN HELP YOU reduce unit product cost or improve product performance at no added cost. Here's why . . . You can select the "one best material" from over 100 grades of PHENOLITE, Vulcanized Fibre and National Nylon—without compromise in properties or cost. You can simplify production and purchasing with the timed delivery of 100% usable parts—from a single reliable source. You gain competitively with National's new materials and grades—the direct result of programmed materials-research.

You benefit by calling National first. Check Sweet's PD File 2b/Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware. Dept. F12.

NATIONAL
VULCANIZED FIBRE CO
WILMINGTON 99, DELAWARE

In Canada:
NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

Letters

to the Editor

"June All-Reference Directory Issue"

". . . This has been a publication of outstanding value and has been widely used in our organization since its release. We are in the process of conducting some market surveys on new items, and this particular directory has been a major source for our survey section in determining the potential users of products under consideration."

K. M. SCHAFER
Manager
P. R. Mallory & Co. Inc.
Vibrator Division
Du Quoin, Ill.

". . . A directory of this nature is considered indispensable to the industry. Yours has been put to good use a number of times already. I would like to compliment you on the excellent coverage you have produced."

B. CREW
Project Engineer

". . . In my opinion the Products Finding Index provides a very fast and thorough method of locating desired products.

"In addition I was very pleased to see your sections on New Electronic Text Books. This information is very important to us."

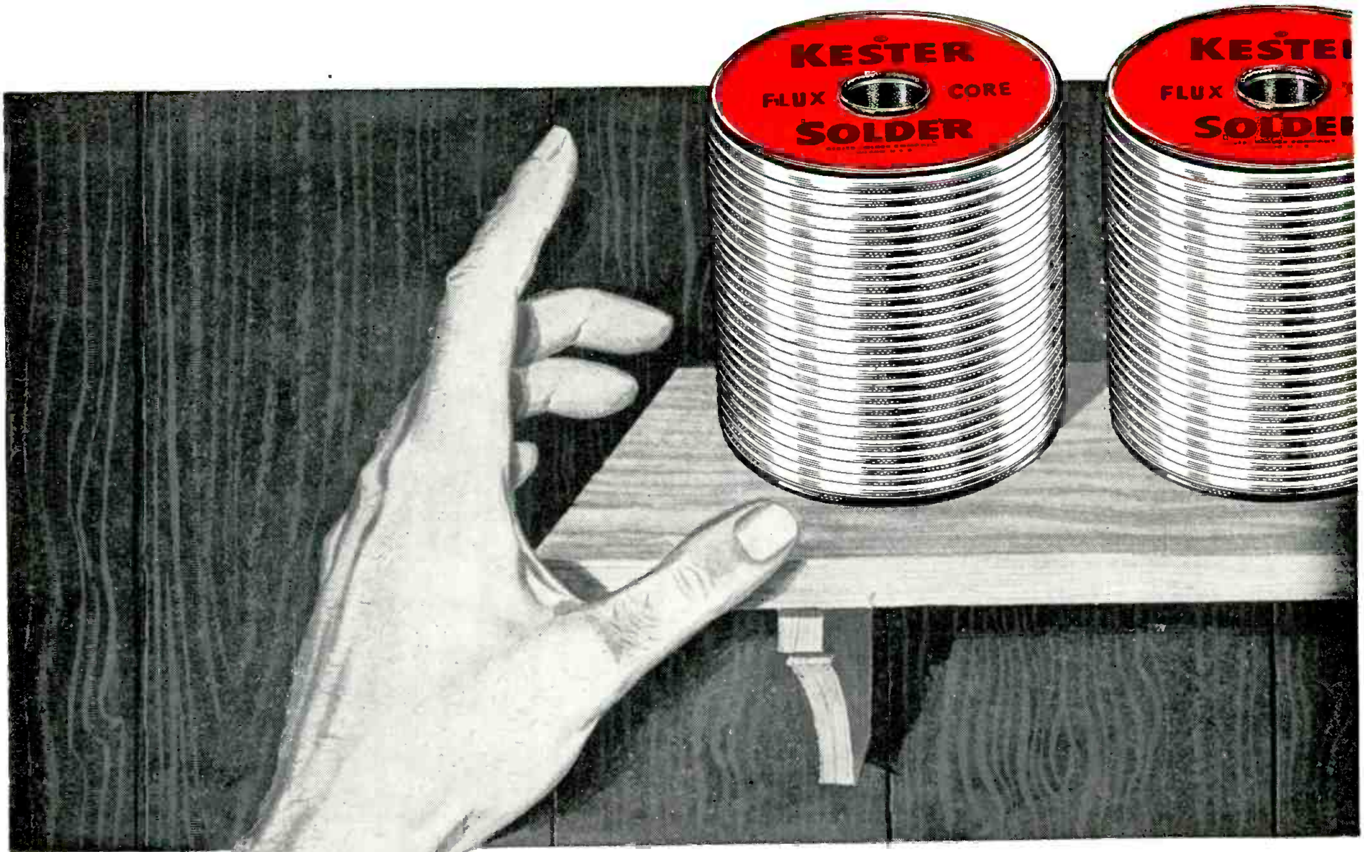
D. D. CHAFFEE
Project Engineer
Haller, Raymond, and Brown, Inc.
Science Park, State College, Pa.

"The Directory and Reference issue of ELECTRONIC INDUSTRIES is most comprehensive. I have found the specifications, color codes and graphical symbols most helpful in design considerations."

EARLE S. JOHNSON
Engineer
Flight Refueling Inc.
Friendship Int'l Airport
Baltimore, Md.

"Regarding your June directory and reference issue, let me add my appreciation for a very valuable text. For my purposes, as a supervisor in the electronics research business, I found the reference material of even greater value than the directory material. Thus far, the diode and transistor listings have proven most useful; it is certainly a help to have both

(Continued on page 40)



THERE'S NO SUBSTITUTE FOR EXPERIENCE..

YESTERDAY - TODAY - TOMORROW

JUST ONE QUALITY...THE FINEST!

KESTER SOLDER

INDUSTRY-TESTED AND PROVED FOR OVER 50 YEARS...

You hear a lot about the remarkable showing of "Johnny-come-lately" solders from that second source of supply, based only upon test samples or short production runs. But there's no real substitute for regular on-the-job applications to prove the actual merits of a product like solder. That's why Kester Solder is the preferred choice of wise solder buyers and users everywhere; they know it has over half a century of genuine experience and unqualified production approval behind every spool.
Write today for complete details.

YOUR COPY FREE! Kester's 78-page manual "SOLDER . . . ITS FUNDAMENTALS AND USAGE." Send today.

KESTER SOLDER COMPANY

4210 Wrightwood Avenue, Chicago 39, Illinois
Newark 5, New Jersey, Brantford, Canada

Circle 20 on Inquiry Card, page 101

Simply slide together
and lock with thumbscrew on back.

New Triplett Unimeters

Decrease Inventory Cost . . . Increase Flexibility

With the New Select-Your-Range Triplett Unimeters two basic meter movements can be combined with any number of Dial-Component units for a wide variety of panel meter ranges—you can even create your own ranges with available dial blanks by following simple instructions furnished.

Since the basic movement accounts for the greater part of the meter cost—you can have a much more flexible inventory by stocking the minimum number of basic meter movements and a large variety and maximum quantity of the inexpensive Dial-Components.

Unimeter features are: self-shielded Bar-Ring movements: AC and DC linear scales • extreme accuracy • dustproof construction • error proof assembly • instant conversion • standard mounting.

For complete details see your Electronic Parts Distributor, or write

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

Three Standard Kits, too. Kit A (makes 8 ranges), Kit B (makes 12 ranges), Kit C (makes 23 ranges).

MODEL 372 SLIDING COAXIAL TERMINATIONS

This equipment, available only from Narda, provides the most convenient means for evaluating the residual VSWR of coaxial slotted lines. VSWR of the element is 1.05 or less; covers range from 2000 to 12,400 mc.

N Connector, male or female **$110** C Connector, male or female **$116**

MODEL 371 FIXED COAXIAL TERMINATION

This Narda coaxial termination is the first and only to cover the entire frequency range from S to X band. Same range and element VSWR as above.

N Connector, male or female **$55** C Connector, male or female **$58**

3, 6, 10 and 20 DB

40 DB HIGH POWER

HIGH DIRECTIVITY COUPLERS

The 40 db High Power Coupler is another exclusive Narda product. Similar to standard types, except that coupling irises are in the narrow wall, it may be used at full rated power of the waveguide size. Nominal coupling value is 40 db; directivity 40 db. Directivity for 3, 6, 10 and 20 db couplers is also 40 db. Standard cover flanges on primary line; low VSWR termination and standard cover flange on secondary. All bands covering frequencies from 2600 to 18,000 mc.

STANDARD REFLECTIONS

Narda offers five values of reflections for each of six different waveguide sizes . . the most complete choice we know of! Provides calibrated reflections or VSWR's for use in standardizing reflectometers or calibrating slotted line impedance meters.

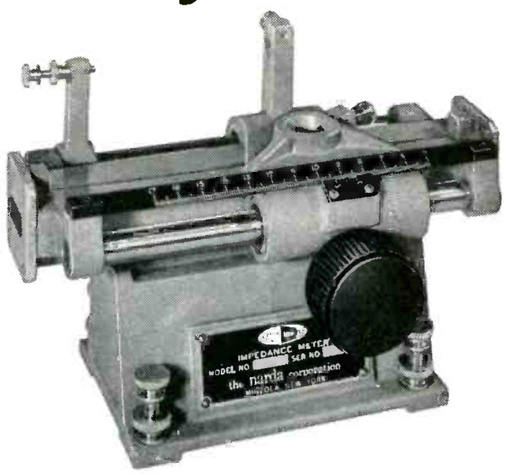
SPECIFICATIONS

Reflection Coefficient	0.00	0.05	0.10	0.15	0.20
Accuracy	0.002	0.0025	0.0035	0.0045	0.007
VSWR Equivalent	1.00	1.105	1.222	1.353	1.50

Models for 2.60 to 18.0 kmc, from $125 to $300

Microwave engineers–

Where can you use these exclusive features offered by narda?



Waveguide and Coaxial IMPEDANCE METERS

Exclusively in Narda Waveguide and Coaxial Impedance Meters, the carriage mounting and drive mechanism are integral with the precisely machined transmission line casting. This insures permanent accuracy and freedom from slope errors—no more tedious adjustment or possibility of misalignment.

Other features include angle-mounted scale and vernier for optimum visibility; readily removable supporting pedestal; and smooth carriage travel action. Waveguide models, accurate for VSWR's of 1.01, are available for complete coverage from 2600 to 18,000 mc; N or C Connector coaxial models, from 1500 to 12,400 mc.

WAVEGUIDE IMPEDANCE METERS

Frequency (kmc)	Narda Model	Residual VSWR	Price
2.6 — 3.95	224	1.01	$425
3.95— 5.85	223		350
5.3 — 8.2	222		325
7.05—10.0	221		270
8.2 —12.4	220		250
12.4 —18.0	219		270

COAXIAL IMPEDANCE METERS

Frequency (kmc)	Connectors (One Male, One Female)	Narda Model	Price
1.5 to 12.4	Series N	231	$360
1.5 to 12.4	Series C	232	390

Complete Coaxial and Waveguide Instrumentation for Microwaves and UHF—including:

DIRECTIONAL COUPLERS
TERMINATIONS
FREQUENCY METERS
HORNS
TUNERS
ECHO BOXES
SLOTTED LINES
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ATTENUATORS
STANDARD REFLECTIONS
BOLOMETERS
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the narda microwave corporation

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MAIL COUPON TODAY FOR FREE CATALOG AND NAME OF NEAREST REPRESENTATIVE

The Narda Microwave Corporation
160 Herricks Road
Mineola, N. Y.
Dept. EI-1

NAME____________________

COMPANY____________________

ADDRESS____________________

CITY__________ZONE____STATE________

Letters

to the Editor

(*Continued from page 36*)

these lists in one issue rather than in separate ones as in the past. In addition, I can certainly see the value in certain of the other sets of reference material which were included."

JAMES B. ANGELL, Sc.D.
Manager, Circuit Research
Solid-State Research Dept.
Philco Corp.
Phila., Pa.

"Your June Directory and Reference Issue of E. I. occupies a conspicuous place on my desk. This is so it is readily available for my reference—when its there. Others in my department have discovered that it is a central fact finder also. It has a lot of characteristics of a master catalog and address index to manufacturers which we correspond with.

"We have added index tabs which quickly locate the various sections such as the Diodes, Transistors, Batteries, etc.

"I deeply appreciate this and every issue I receive, as in many ways it is superior to publications which I must pay for a subscription from my own pocket."

G. E. BOLDMAN
Electronic Test Engineer

". . . I take pleasure in informing you that this issue is one of the most comprehensive and informative trade publications I have encountered. The broad scope of reference data included makes it so useful that I keep it at arm's reach at all times."

F. M. TORRE
Electrical Engineer

"Your June Directory and Reference Issue of ELECTRONIC INDUSTRIES is most interesting and useful. I really appreciated my copy. Your editors have done a remarkable job in compiling the information."

C. F. DER
Westinghouse Electric Corp.
Friendship Int'l Airport
Baltimore, Md.

Move To Arizona

About 50 key personnel of the total 300 employed by Talco Engineering Co. at their three plants in Hamden, Conn., will be moved to Talco's new 110,000 sq. ft. plant in Meza, Ariz.

The firm is a producer of cartridge actuated devices for missiles and aircraft.

THEY MAY LOOK ALIKE—BUT

there is a difference... and the difference is inside, where it counts.

All Hughes diodes resemble each other—externally. Germanium point-contact or silicon junction, they are all glass-bodied* and tiny (maximum dimensions: 0.265 by 0.107 inch). But minute, meticulously controlled variations in the manufacturing process impart individual characteristics to the diodes, make them just right for specific applications. This gives you the opportunity of selecting from a line which includes literally hundreds of diode types.

So, when your circuitry requires varying combinations of such characteristics as... high back resistance...quick recovery... high conductance...or high temperature operation, *specify Hughes.* You will get a diode with mechanical and electrical stability built in. You will get a diode which was manufactured first of all for reliability.

*Nowhere else have glass packaging techniques been developed to a comparable extent, for the Hughes process has many unique aspects. They are difficult to duplicate, yet are instrumental to the manufacture of diode bodies which are completely impervious to contamination and moisture penetration.

For descriptive literature please write: HUGHES PRODUCTS, SEMICONDUCTOR DIVISION
International Airport Station, Los Angeles 45, California

HUGHES SEMICONDUCTORS

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

Circle 24 on Inquiry Card, page 101

FREQUENCY STANDARDS

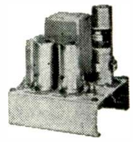
*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L



Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

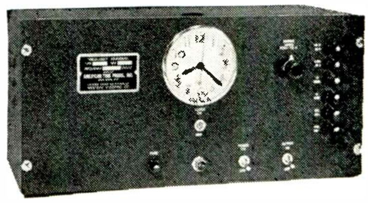
Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD **NEW**
TYPE 2007-6
TRANSISTORIZED, Silicon Type

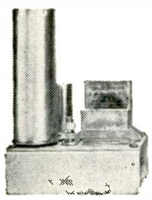
Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007–6 (± .02% at —50° to +85°C)
R2007–6 (±.002% at +15° to +35°C)
W2007–6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A



Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

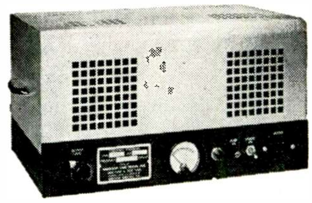


FREQUENCY STANDARD
TYPE 2001-2

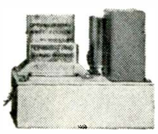
Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C



Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430 **580 Fifth Ave., New York 36, N. Y.**

Type WL-7228 is the first to offer write-through plus high voltage selective erase

The new WL-7228 is a two-write gun storage display tube developed by Westinghouse for such applications as fire control radar, weather radar, data transmission and half-tone storage requiring a bright, stored, scintillation-free display.

Either write gun can be used for write-through, to display non-stored information. Also, either write gun can be used to selectively erase with very high selectivity and erase speed. Unusually high writing speeds under practical writing conditions.

Typical operating characteristics: Electrostatic focus and deflection for both write guns. **Screen voltage:** 10,000 volts. **Resolution:** 250 lines/diameter. **Brightness:** 2800 foot-lamberts.

Sample orders are invited or write for technical data to Westinghouse Electric Corporation, Elmira, N. Y.

YOU CAN BE SURE...IF IT'S **Westinghouse**

Circle 26 on Inquiry Card, page 101

Books

Electronic Designers Hand Book

By Robert W. Landee, Donovan C. Davis, and Albert T. Albrecht. Published 1957 by McGraw-Hill Book Co., 330 W. 42nd St., New York 36. 1016 pages. Price $16.50.

The entire electronic field is covered in 23 big sections ranging from a vacuum tube fundamentals and voltage and power amplifiers to such topics as computer and servomechanism techniques and waveform and network analysis.

The Solid State for Engineers

By Maurice J. Sinnott. Published 1958 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 533 pages. Price $12.50.

This book deals with the features of solid materials that are of special interest to the engineer. The author sets forth a series of fundamental principles which provides an accurate and convenient reference to problems concerning the choice and use of materials.

In developing these principles, the author surveys the basic concepts of various sciences which bear on the behavior of the solid state of material. Each chapter represents condensation of an entire field of investigation. The sciences are discussed in the light of their contribution to the study of material, and the author includes information previously available only in specialized higher level text.

Physics and Mathematics in Electrical Communication.

By James O. Perrine, PhD. Published 1958 by John F. Ryder Publisher, Inc., 116 W. 14th St., New York 11. 268 pages. Price $7.50.

This is an explanation of what happens in electrical circuits that contain resistance, inductance and capacitors. While it is a penetrating analysis, it is presented in an unusually lucid manner.

The author demonstrates a talent for selecting that avenue of approach to analysis which leads to utmost clarity. On a foundation of associated mathematics, made completely understandable and replete with numerical examples, the author ties together physical concepts and electrical communication.

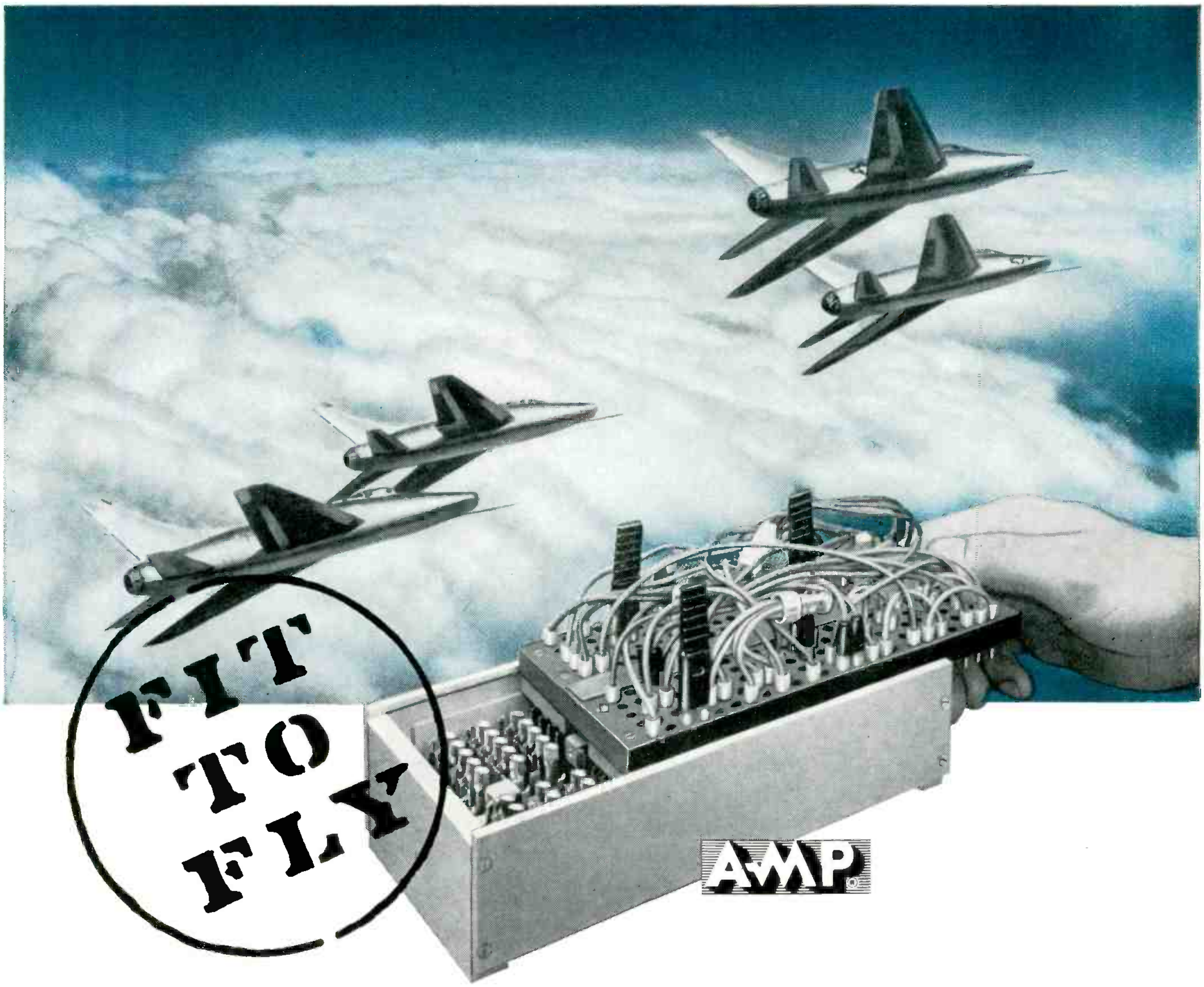
An entirely new approach is used in analyzing hyperbolic functions, exponential equations, and related functions.

Introduction to Electromagnetic Fields

By Samuel Seely. Published 1958 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 308 pages. Price $8.50.

This introduction to Maxwell's equations and electromagnetic field theory serves as the foundation on

(*Continued on page* 48)



THE NEW LIGHTWEIGHT A-MP "240" PATCHCORD PROGRAMMING SYSTEM

. . . means lightning fast in-flight reprogramming of airborne electrical/electronic circuitry . . . obsoletes fixed circuit connectors and other systems requiring hours or days to rewire . . . and offers these unusual features:

- removable patchboards to permit complete reprogramming in seconds
- 3 1/4 pounds to minimize weight . . . miniaturized to conserve space
- rugged shock and vibration-resistant construction with high strength aluminum alloy
- shock-resistant seating of patchcord plugs in removable board
- AMP's patented wiping action that pre-cleans contacts for top electrical performance
- 240 contacts for greatest versatility in circuit combinations or program arrangements

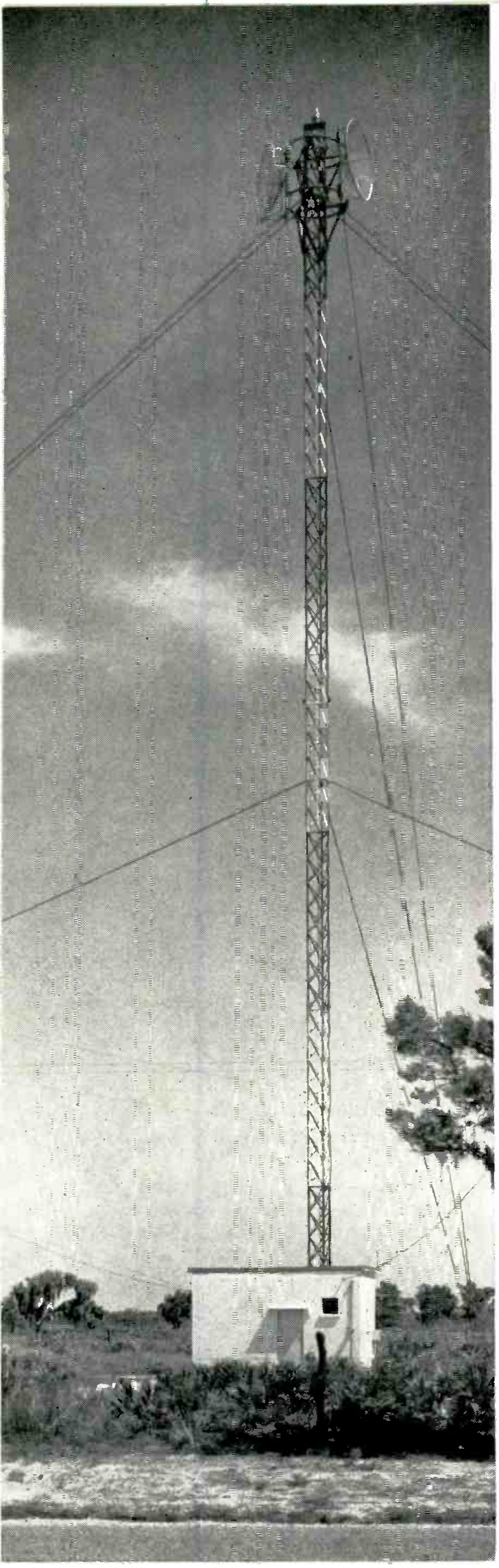
For more information on this new airborne wiring technique, AMP's Patchcord System Catalog is available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

Circle 28 on Inquiry Card, page 101



Guyed tower was designed and built by Blaw-Knox to meet the needs of a southern microwave system.

the towers that simplify microwave expansion

Microwave is set for a big future. More and more progressive companies choose microwave to improve service and lower operating costs. And they're looking for the towers that can keep pace with their expanding microwave plans. Here's how Blaw-Knox microwave towers provide the answer.

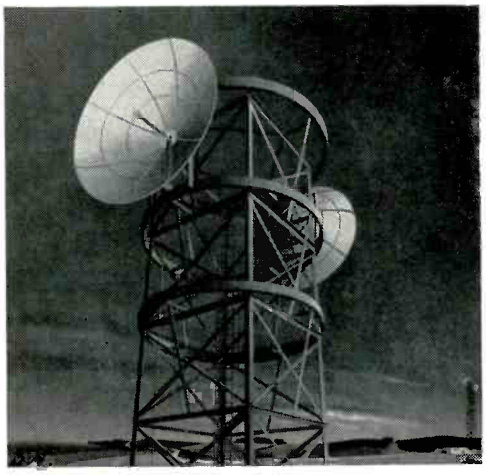
designed to established specifications

Blaw-Knox towers provide the positive dependability that only exacting engineering can deliver. All standard towers *meet or surpass* standards and recommendations of the Radio-Electronic-Television Manufacturers Association for safety, wind loading and quality of construction. By maintaining rigid requirements for torque and deflection, these durable towers pay off with trouble free service in the toughest weather and roughest terrain.

360 degree orientation

Even mounting a single dish antenna can cause a problem. But Blaw-Knox towers can be equipped with ring mounts to simplify precise orientation, and to permit future changes in signal path with minimum effort. Then as the system grows, two or three more dishes can be installed and orientated with less work and less cost.

Whether your installation calls for ring or fixed mounts, self-supporting or guyed towers, Blaw-Knox has the experience and the know-how to build the tower system to fulfill your present needs . . . and effectively meet your future needs.



Ring mounts simplify orientation, make future antenna installation easier and less costly.

For details on Blaw-Knox tower design, engineering and fabrication service, send for Bulletin 2538.

BLAW-KNOX

BLAW-KNOX COMPANY
Equipment Division
Pittsburgh 38, Pennsylvania

MICROWAVE TOWERS
Guyed and self-supporting towers for Microwave, AM, FM, TV, Radar, Communications . . . Transmission Towers . . . Parabolic Antennas . . . Special Structures. All custom built to meet your requirements.

Circle 30 on Inquiry Card, page 101

Books

(Continued from page 44)

which to develop later works in field operated devices, such as transducers and rotating machinery, and the important problems of electromagnetic field theories.

Automatic Process Control

By Donald P. Eckman. Published 1958 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 375 pages. Price $9.00.

Written for all engineers who are concerned with instrumentation, this book treats the important principles of automatic control, emphasizing block diagrams and frequency techniques in process control. It begins with process analysis and carries on into the generalized behavior of closed-loop systems. System problems are given a great deal of study.

The techniques of analysis are used to the fullest extent, and enough detail is carefully presented so that some of the more difficult problems in automatic process control may be inspected rather closely. The author incorporates numerous problems with answers and nine detailed experiments including the analog computer.

Books Received

The Direction of Research Establishments

Published 1957 by Philosophical Library, Inc., 15 E. 40th St., New York 16. Price $12.00

Proceedings of a symposium held at the National Physical Laboratory, Teddington, England, on 26, 27, and 28 of September, 1956.

Automation Systems

Published 1958 by Engineering Publishers, Div. of the AC Book Co., Inc., New York. 180 pages. Price $5.00.

Proceedings of the 2nd EIA Conference on automation systems sponsored by the EIA Engineering Dept.

Zone Melting

By William G. Pfann. Published 1958 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 252 pages. Price $7.50.

Modern Computing Methods

Published 1958 by Philosophical Library, Inc., 15 E. 40th St., New York 16. 135 pages. Price $8.75.

F. M. Radio Servicing Handbook

By Gordon J. King. Published 1958 by The Macmillan Co., 60 Fifth Ave., New York 11. 192 pages. Price $5.00.

Impedance Matching

Edited by A. Schure, PhD. Published 1958 by John F. Ryder Publisher, Inc., 116 W. 14th St., New York 11. 128 pages, paper bound. Price $2.90.

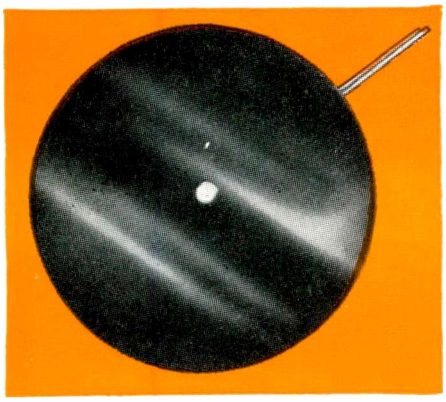
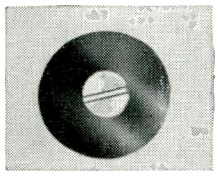
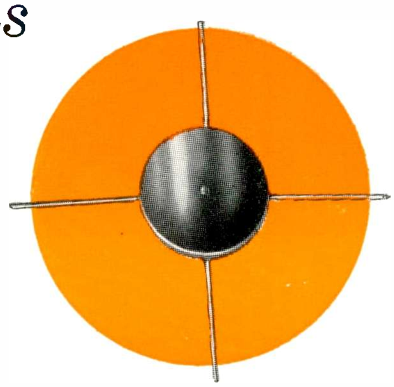
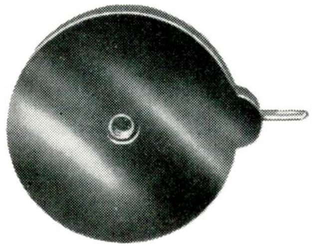
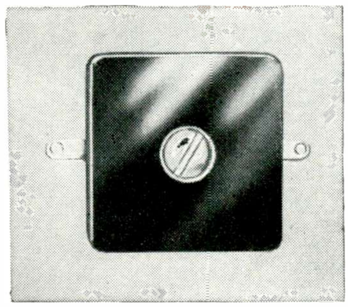
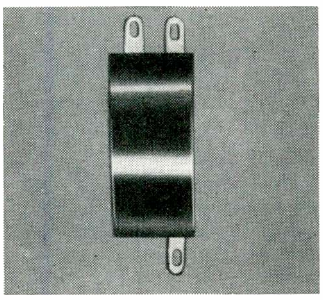
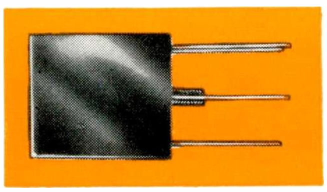
Electrostatics

Edited by A. Schure, PhD. Published 1958 by John F. Ryder Publisher, Inc., 116 W. 14th St., New York 11. 72 pages, paper bound. Price $1.35.

Burnell offers

THE MOST

complete line of encapsulated toroids to meet your circuit needs

All components shown actual size.

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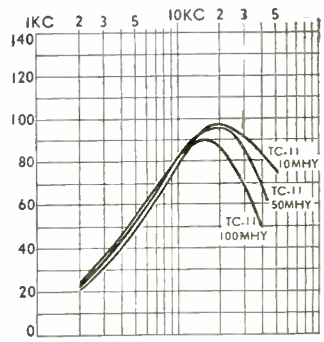
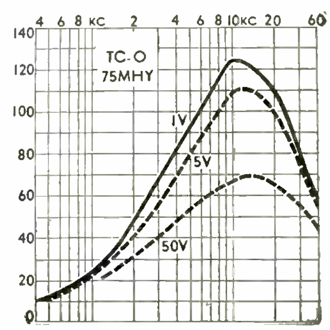
TC 0	1"x13/32"	5/8	1 1/16" OD x 1/2" H
TC 1	1 5/8"x5/8"	less than 3	1 3/4" OD x 3/4" H
TC 2	2 9/32"x15/16"	10	2 3/4" OD x 1/8" H
TC 3	1 1/2"x5/8"	2 1/2	1 3/4" OD x 3/4" H
TC 4	1 7/32"x19/32"	less than 2	1 5/16" OD x 23/32" H
TC 5	1 7/32"x19/32	less than 2	1 5/16" OD x 23/32" H
TC 6	1"x13/32"	5/8	1 1/16" OD x 1/2" H
TC 7	1"x13/32"	5/8	1 1/16" OD x 1/2" H
TC 8	1 9/16"x5/8"	less than 2	1 3/4" OD x 3/4" H
TC 9	1"x3/8"	less than 1/2	1 1/16" OD x 1/2" H
TC 10	1 3/32"x15/32"	1	1 1/4" OD x 5/8" H
TC 11	5/8"x9/32"	1/4	3/4" OD x 1/2" H
TC 12	5/8"x9/32"	1/4	3/4" OD x 1/2" H
TC 13	5/8"x9/32"	1/4	3/4" OD x 1/2" H
TC 14	5/8"x9/32"	less than 1/4	3/4" OD x 1/2" H
TC 15	1 7/8"x7/8"	5	2" OD x 1" H
TC 17	1 3/32"x15/32	less than 1	1 1/4" OD x 5/8" H
TC 20	1 3/32"x15/32"	1	1 1/4" OD x 5/8" H
TC 27	1 9/16"x11/16"	2 1/4	1 3/4" OD x 3/4" H





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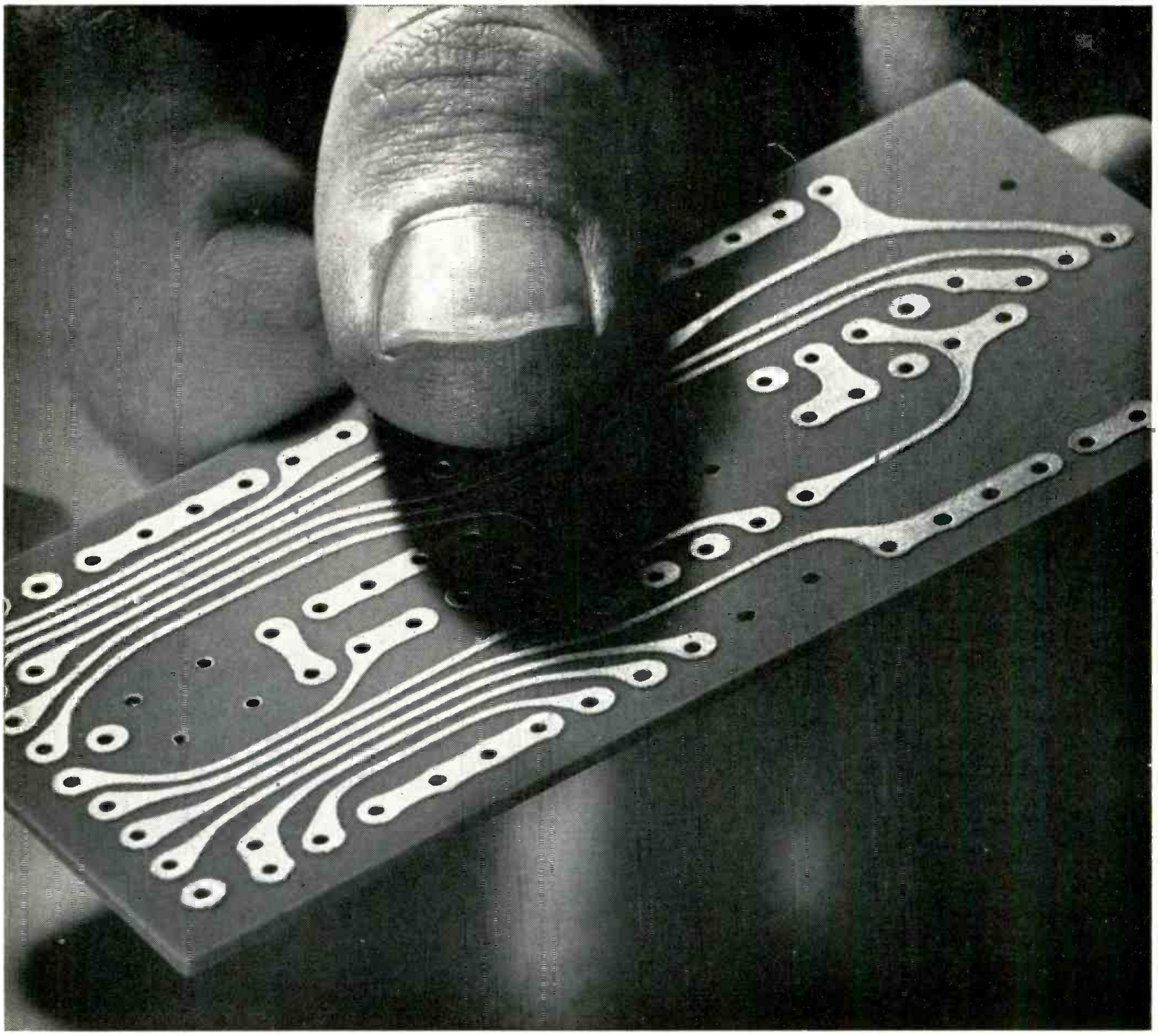

FOTOCERAM circuit board blanks are made photographically. All holes and shapes are produced by simple exposure to light, heat, and an etching operation.

This is a FOTOCERAM printed circuit

. . . an unusual new type of printed circuit board

Reliable through-plate holes • The good adhesion of the circuit runs applies also to the through-plate holes because both are produced with one plating operation.

Excellent resolderability • We have removed and resoldered components over twenty times on a FOTOCERAM board without damage to circuit runs or through-plate holes. And this is *without* using adhesives to bond the copper to the board.

Dimensional stability • Rigid structure of FOTOCERAM prevents unusual design considerations—eliminates problem of warp and twist.

Good adhesion • It takes 12-25 pounds to peel a one-inch copper strip from a FOTOCERAM board.

Exceptional pull strength • 1400 pounds per square inch.

No water absorption • FOTOCERAM's nonporous—zero water absorption.

Non-flammable

No blisters • FOTOCERAM never blisters. We put it through repeated 15-second cycles of copper metallizing at 500°F. and could not find a single blister or sign of peeling or failure.

Other properties:

Dissipation factor			
	1mc @	20°C.	0.006
	@	200°C.	0.014
Dielectric constant			
	1 mc @	20°C.	5.6
	@	200°C.	6.3
Loss factor	1mc @	20°C.	0.034
	@	200°C.	0.088

For more information, write for our Data Sheet on FOTOCERAM.

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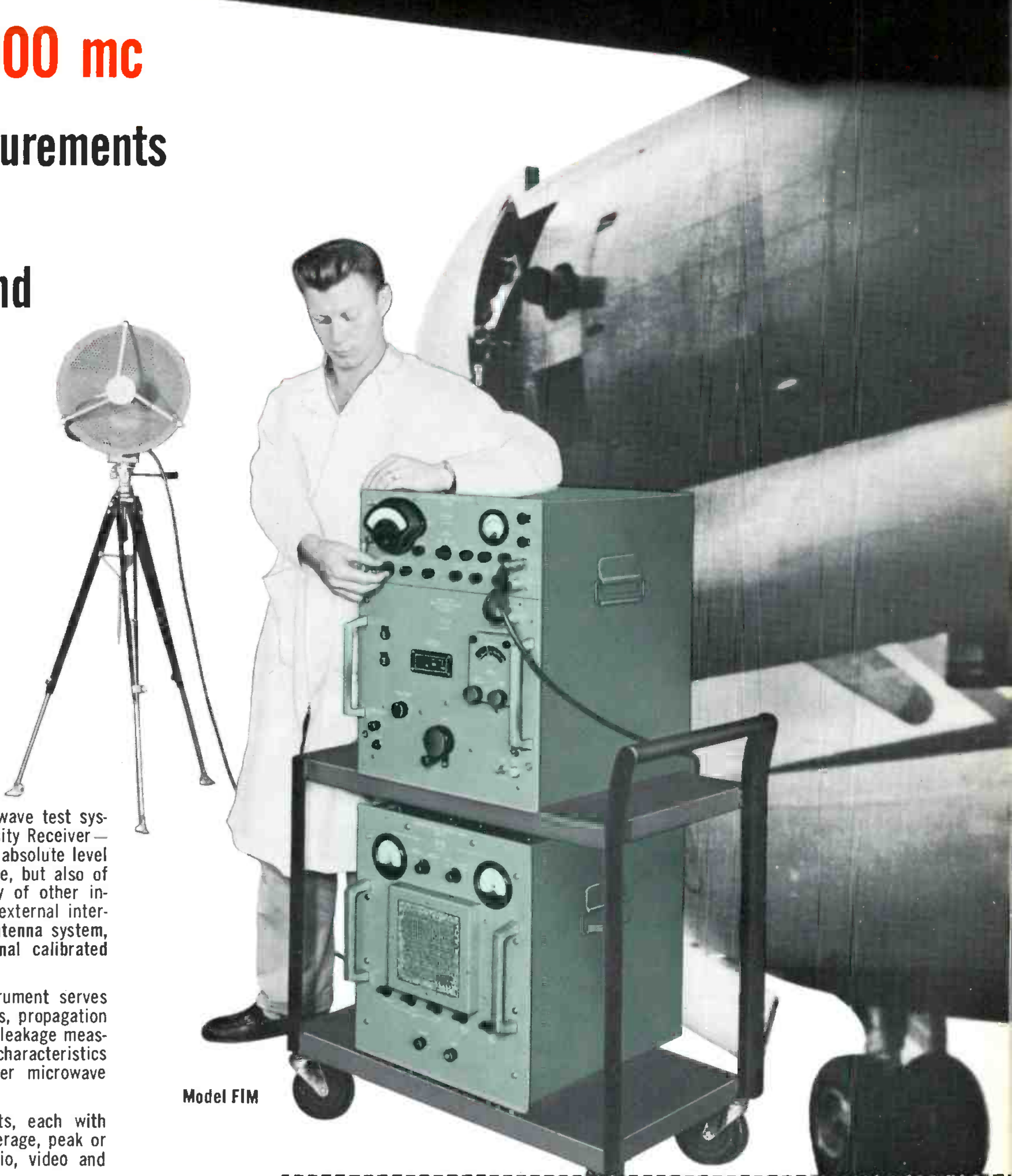
CALIBRATED MICROWAVE FIELD INTENSITY RECEIVER

1000 to 10,000 mc

Absolute measurements of microwave interference and susceptibility



Model FIM

POLARAD

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For the first time, one single microwave test system—Polarad Model FIM Field Intensity Receiver—is capable not only of measuring the absolute level of radiated or conducted interference, but also of determining the signal susceptibility of other instruments and components to such external interference. It combines a **calibrated antenna system, a calibrated receiver** and an **internal calibrated signal generator.**

This versatile precision test instrument serves also for field intensity measurements, propagation studies, antenna pattern analysis, r-f leakage measurements, analysis of r-f signals—and characteristics of transmitters, receivers, and other microwave components.

Four sensitive plug-in tuning units, each with UNI-DIAL control. Meter indicates average, peak or quasi-peak value of r-f signals. Audio, video and recorder outputs.

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Please send me information and specifications on:

- ☐ Model FIM Calibrated Field Intensity Receiver
- ☐ Model K-200 Microwave Tube Tester*
- ☐ Model P-3 Transistorized Power Meter*

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My application is:__________

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PORTABLE TRANSISTORIZED MICROWAVE POWER METER

- 10 to 39,000 mc
- Battery or line operated
- Light and rugged
- Measures absolute r-f power instantly without tuning

Used for: field or laboratory measurement of absolute r-f power levels; testing and calibration of signal generators, attenuators, traveling wave tubes; testing coax and waveguide systems; measurement of power at locations where AC power lines are not available.

Thermistor elements make the unit safe from accidental overload. Thermistor mounts available in coaxial and waveguide sizes.

Model P-3

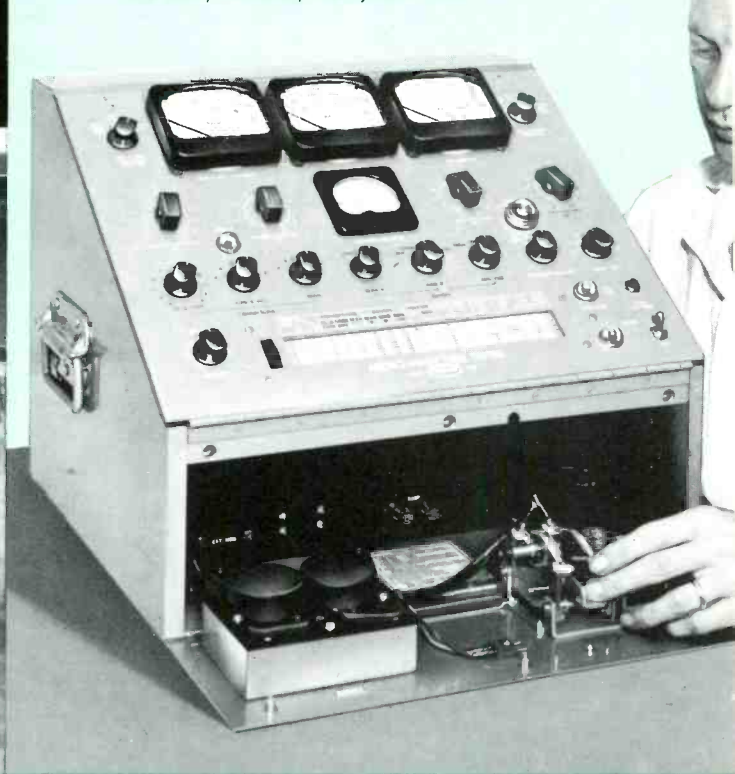
MICROWAVE TUBE TESTER

Simplified Test Saves Engineering Man Hours

No guesswork. No need to fire up complete equipments to determine microwave tube performance. Model K-200 gives rapid, positive decision on costly microwave tubes. Quickly pays for itself by enabling you to reclaim questionable tubes from salvage. Allows Incoming Inspection to check tubes upon receipt and throughout warranty period, without tying up expensive personnel.

Tests all microwave tubes including internal and external cavity types, pencil triodes, rocket and lighthouse tubes. A scroll indicates quick setups to test for filament continuity, short circuits, static d-c tests, life tests, and dynamic tests.

Model K-200



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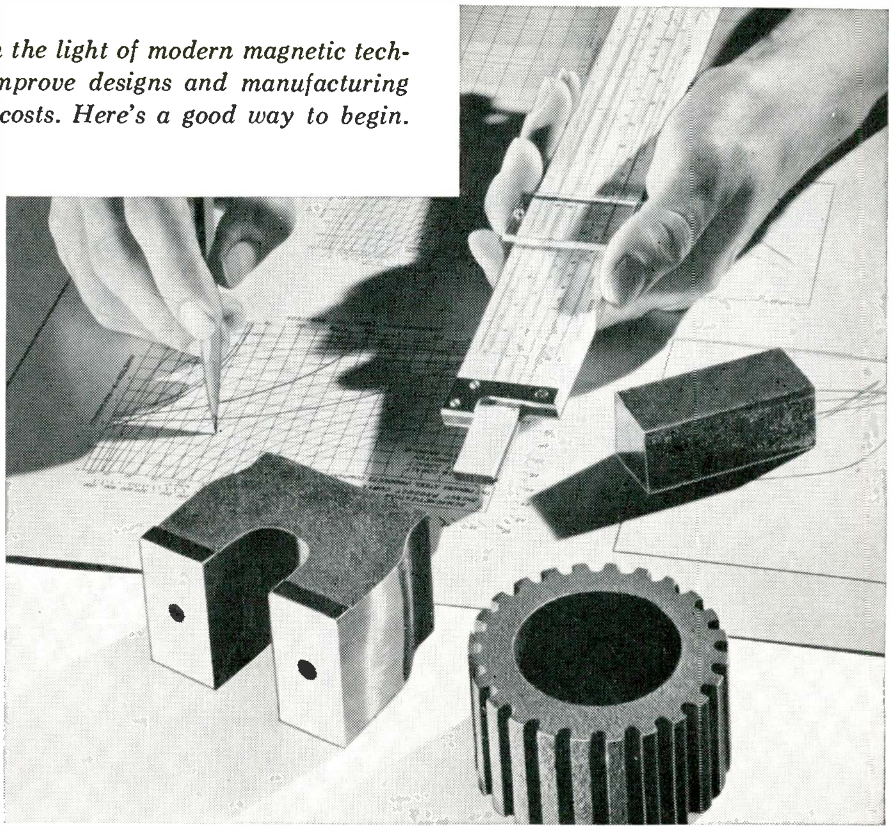
How Magnet Specialists Can Help Improve Your Product, Cut Design and Production Costs

A close look at your product in the light of modern magnetic technology may reveal ways to improve designs and manufacturing methods with resulting lower costs. Here's a good way to begin.



STUDY THE MAGNETS YOU'RE USING

If your product now employs a permanent magnet, review these considerations:

1. Is the magnet right for the job?
2. Would a larger or smaller magnet improve the design, permit larger physical tolerances, etc?

Example: A manufacturer was using Alnico V magnets in a high-quality intercom unit. Magnetic experts studied the design and found that 83% of the energy of the magnet was nullified in actual operation of the unit. Equivalent results could be obtained with a smaller Alnico magnet or lower cost magnetic materials.

3. Are all close tolerances in the design essential to the performance of the product?

Example: A radar manufacturer — to meet required tolerances—specified an I.D. grind on a permanent magnet used in conjunction with a magnetron assembly. Cost of the magnet was $2.26. Study showed that the I.D. grind was not necessary, and the new magnet price is 81.7¢ each.

4. Would a different magnet material perform more efficiently in this application?
5. Can the design of the magnet itself be modified for greater efficiency, lower cost?

Example: A manufacturer of small electric motors used two Alnico V magnets and two pole pieces in a motor assembly. These four elements have been eliminated in a design that uses one Indox ring magnet — a multiple saving in material, parts and labor.

TOOLING WITH MAGNETS

Literally thousands of manufacturers have cut factory costs with permanent magnets in tooling, processing, material handling and production devices. A partial list of the most common applications will indicate the wide range of jobs a permanent magnet can do effectively and at low cost.

PARTS CONVEYOR
Magnets eliminate clamps and hooks, simplify loading and removal of parts.

CHIP RETRIEVER
Collects chips and other iron particles from coolant, lubricant, etc.

PIPE ROLL
Handles ferrous pipe and tubing at high speed without slippage.

SHEET FANNER
"Fans" sheet steel in stacks to simplify pickup and handling.

FLOOR SWEEPER
Picks up iron scrap, tools, etc. from plant floors, drives and parking lots.

TOOL HOLDER
Keeps tools handy and orderly, speeds work.

SEPARATORS
Magnetic pulleys, plates or drums remove tramp iron from non-ferrous materials in every industry.

RESEARCH AND DEVELOPMENT

Magnetics is a highly specialized science. Too often, competent engineers who are without the required testing facilities and experience will spend months studying a magnetic circuit for a proposed product, finalizing a design that could have been completed in a few weeks with the help of specialists.

Nobody knows magnetics like Indiana Steel Products...and Indiana makes all kinds of magnet materials, can recommend exactly the *right* magnet for your specific application. You are invited to consult with our engineers and scientists on any problem involving permanent magnets. Write today for new free catalog, "Cast and Sintered Alnico Permanent Magnets." Ask for Catalog No. 19-N9.

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Circle 34 on Inquiry Card, page 101

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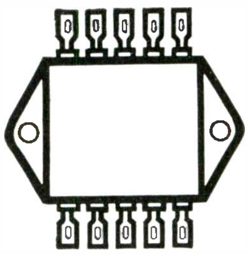
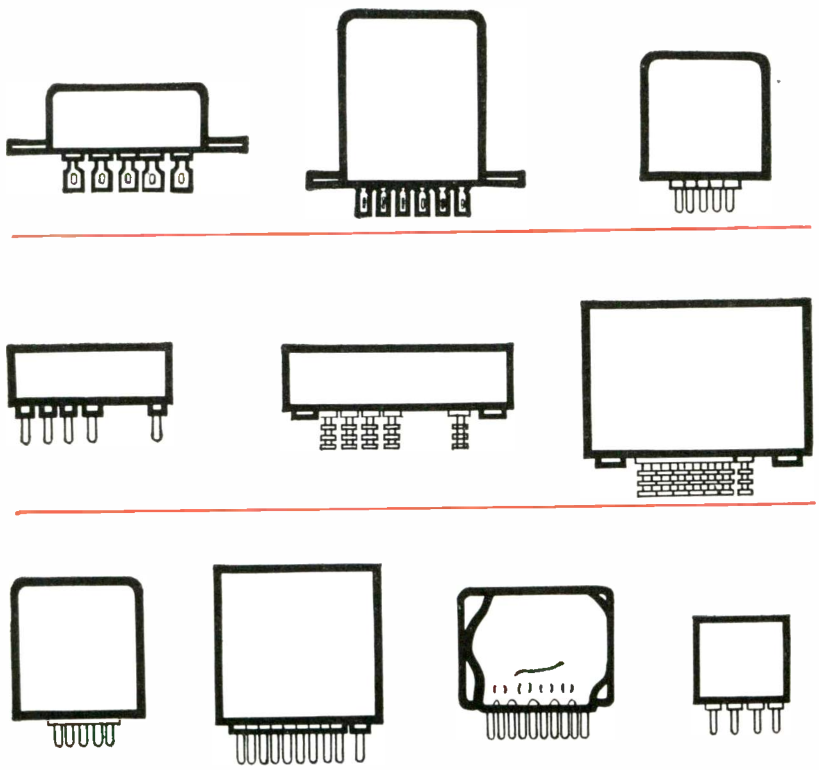
for missiles
for computers
for controls





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Circle 35 on Inquiry Card, page 101

Filter nomenclature and specifying has been confusing. This article describes the nomenclature and procedure for ordering or specifying filters. It gives the test standards for filters to aid in their selection.

How to Specify Filters

By STANLEY BOYLE
Group Supervisor
RF & Electronic Test
Radioplane Co.
8000 Woodley Ave.
Van Nuys, Calif.

WITH the advent of Systems Enginering and the specialization of electronic firms in particular equipment, engineers find it necessary to know how to use, describe and order various items that they will not design but will use in a total system. Filters fall in this category.

Because filter design is a highly specialized field, the nomenclature associated with it is not widely known amongst engineers. This causes much confusion when ordering a specific filter, and considerable consternation when it arrives because it is found to have properties different than those expected. Another problem of equal magnitude is the unfamiliarity with proper filter test and circuit operation. This again causes lost time while trouble-shooting systems having incorrect frequency or phase shift characteristics.

It is the purpose of this report to explain filter nomenclature, test methods and use in order to eliminate these previously stated problems.

Nomenclature and Definitions

One property exhibited by all filters is Insertion Loss or the Voltage Transfer Constant. This is the ratio of filter output voltage to input voltage expressed in db. If the filter contains active elements, such as amplifying stages, or if it is a passive network consisting of L, C and R but has a higher output impedance than input impedance, it may exhibit a gain. Then the insertion loss is referred to as a voltage transfer constant, also expressed in db.

In a bandpass or band rejection filter, the insertion loss is measured at the center frequency. In a low pass filter it is measured at one-half the cut-off frequency, $F_c/2$. In a high pass filter it is measured at twice the cut-off frequency, $2F_c$. At extremely high frequencies it may be difficult to find signal generators that cover the $2F_c$ requirement. In these cases a very close approximation can be obtained by measuring the insertion loss at not less than $1.2F_c$.

Fig. 1 is a test circuit for measuring insertion loss.

$$\text{Insertion Loss} = 20 \text{ Log } \frac{E_{out}}{E_{in}}$$

Where:

R_{in} = Filter input impedance or driving circuit impedance.

R_{out} = Filter output impedance or output circuit impedance.

Fig. 1: Diagram shows insertion loss test circuit.

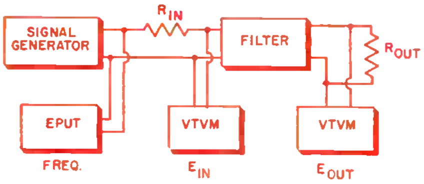
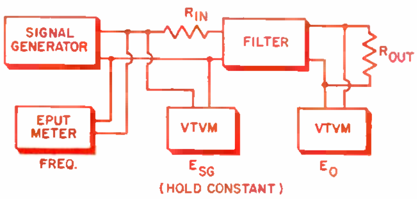


Fig. 2: Test circuit for measuring attenuation or response.



Filters *(Continued)*

Frequency Response Characteristic

A great deal of confusion exists about the difference if any, between insertion loss and attenuation. A plot of attenuation vs. frequency is the frequency response characteristic of a filter. It differs completely from insertion loss because it involves only the filter output voltage.

Unless specifically designated on a particular filter, the attenuation reference level is taken at the point of maximum output level. The only exception is band rejection filters where it is at the point of minimum output level. Usually in bandpass and band rejection filters this point occurs at the center frequency. In low pass filters it occurs at zero frequency, or dc, and in high pass frequencies it is at infinite frequency. Again in the latter case, it may be taken with good approximation between 1.2 and $2F_c$.

Fig. 2 is the best circuit for measuring the attenuation or response characteristic. It is very important to use values of R_{in} and R_{out} that accurately simulate the actual circuit conditions. Also, the output voltage of the signal generator, E_{sg}, must be kept constant at each point of measurement. A simple analysis of the input circuit mesh, using Kirchoff's equations will prove that keeping the voltage constant is equivalent to using a zero impedance source. This will eliminate the effect of the signal generator impedance upon the frequency response of the filter under test.

$$\text{Attenuation } f_n = 20 \text{ Log } \frac{E_o f_{max}}{E_o f_n}$$

Where (Fig. 2):

R_{in} = Input circuit impedance.

R_{out} = Output circuit impedance.

E_{sg} = Signal generator output voltage.

E_o = filter output voltage.

f_{max} = frequency of maximum output voltage.

f_n = frequency of measurement.

Pass Band—3db Points

Although the pass band is one particular part of the frequency response curve, it is the most important characteristic and therefore, should be specifically defined.

The pass band of a filter is that portion of the response characteristic confined between frequencies of 3 db attenuation. In other words, the filter bandedge is 3 db down from the zero reference level.

In a low pass filter, the 0 db reference is at zero frequency. Therefore, the cutoff frequency is 3 db down and the low pass filter pass band is between zero and the cutoff frequency.

In a high pass filter the cutoff frequency is similarly defined but the reference level is at infinite frequency. Thus the high pass filter pass band is between the cut-off frequency and infinite frequency.

A band pass filter has two cutoff or bandedge frequencies that are 3 db below the center frequency zero reference level. The pass band is between these 3 db points. Should the maximum output of a band pass filter occur at a frequency other than the center, then the 3 db points are still measured from this reference frequency.

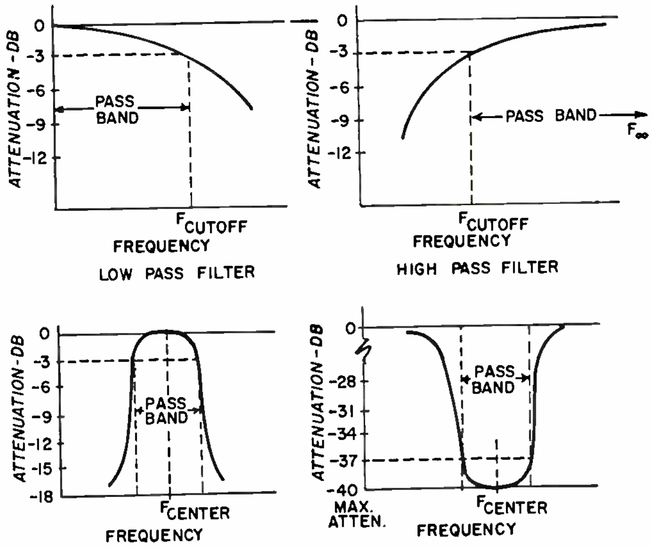


Fig. 3: Graphs show low and high filter pass bands.

In a band rejection filter the attenuation curve is inverted. The frequency of minimum output (usually the center frequency) is taken as the maximum attentuation point. The bandedge frequencies are 3 db less attenuation.

Fig. 3 illustrates the pass band characteristics as described above.

Impedance

Filters exhibit a characteristic impedance that is normally measured within the pass band. To obtain the normal frequency response of the filter, it is important to drive the filter with a circuit whose impedance matches that of the filter (Fig. 4). Likewise, the filter output circuit should terminate the filter properly.

The filter impedance is not constant over the entire response characteristic. It is most constant within the pass band and generally changes radically at frequencies of maximum attenuation and outside the pass band. In these instances, if the driving circuit impedance matches the nominal filter input impedance, the input voltage will rise and fall in accordance with the changes in filter impedance. This situation will produce a filter response that differs from the original filter response curve. The change in response may or may not be advantageous, depending upon the circumstances.

Phase Shift Characteristics

By their basic nature filters are a phase-shift device. Often, the term "zero phase-shift" is applied to filters. Actually the zero phase-shift will occur at only one frequency. A constant value of phase-shift may be approached beyond the cutoff frequencies.

Fig. 5 indicates the approximate phase-shift characteristics of the various types of filters, and its relationship to the filter response curve. Note that the phase-shift in all cases approaches $\pm \pi$ radians or $\pm$ 180° phase-shift outside the pass band of all the filters.

Compatibility Requirements

Usually a filter has to accomplish a specific job in unison with another filter or component. If more than one filter is to be used in parallel, the number of filters and their impedance and frequency responses must be stated. In these cases, adjacent channel attenuation is an important factor. If the filter attenuation is to be a certain value at the adjacent channel, it is best to stipulate the value at the bandedge of the adjacent channel instead of the center frequency. Doing this will greatly aid in the elimination of adjacent channel interference problems.

Fig. 4a: Circuit for measuring filter input impedance.

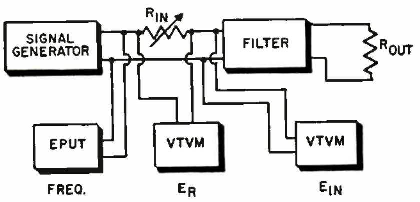
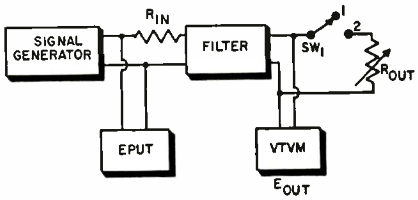


Fig. 4b: Circuit measures output filter impedance.



Referring to Fig. 4a:

R_{out} = Filter output impedance.

adjust R_{in} until:

$E_R = E_{in}$

Then: Filter input impedance $= Z_F = \dfrac{R\,E_{in}}{E_R}$

Referring to Fig. 4b:

R_{in} = Filter input impedance.

adjust R_{out} until:

E_{out} with SW_1 in position 1 $= 2E_{out}$ with SW_1 in position 2

If temperature and humidity environment is of consequence, the degree of required stability should be stipulated. Also, it should be stated whether shift of a single frequency must be held to a minimum or, if the width of the pass band is the critical factor.

Using and Ordering Filters

Make certain that circuit impedances are the same as those used to test the filter, if identical response characteristics are to be obtained. Terminate the filter in its proper output impedance. In some instances, filters are purposely mismatched in output impedance. This is done to obtain a special response characteristic. Again, it is imperative to use the value of resistance in the circuit to obtain the correct mismatch. Sometimes the manufacturer may include the input or output resistor in the filter container. This procedure establishes correct circuit parameters. Use a driving circuit that is five or more times the filter input impedance value, and use a series resistor to match the differential in impedance.

The higher the frequency of a filter, the smaller it will be. For a given frequency and impedance, low pass and high pass filters use larger components than band pass and band rejection filters. However, low and high pass types are simpler in design than the latter.

Of extreme importance is signal levels. Always use filters at the lowest possible voltage and power level. L-C filters using toroids should never be subjected to more than 1.0 volt RMS input level, while the subminiature versions should operate on 0.5 volts RMS or less.

Finally, remember that filters will only work at peak efficiency when all the circuit parameters are controlled. This means constant input voltage, matched impedances, and no signal leakage paths. With regard to leakage paths, it should be fully understood that a filter will pass or reject only the applied signal. It cannot act on any part of the signal that by-passes it. At r-f frequencies where the signal path not only follows wires, but is carried by the chassis and through radiation, a filter in the circuit will not cure the side effects.

Ordering Examples

As an aid in ordering filters, four examples are given, one for each type of filter,

Low Pass Filter (Figure 6)

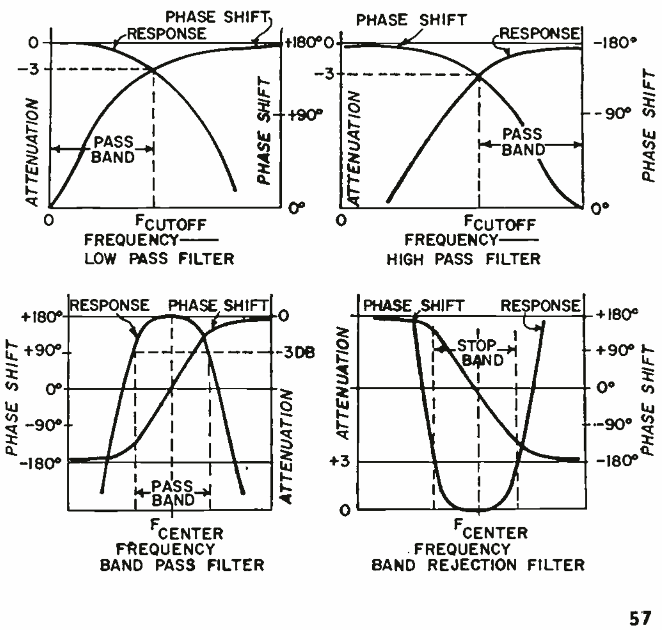
Insertion Loss: Less than 3 db
Input Impedance: 500 ohms
Output Impedance: 500 ohms
Input Voltage Level: 0.75 volts RMS
Cutoff frequency (3 db down): 1000 cps
Attenuation at .5 F_c (500 cps): Not more than 0.5 db
Attenuation at 2 F_e (2000 cps): 30 db
Attenuation at 2.5 F (3000 cps): 40 db

High Pass Filter (Figure 7)

Insertion Loss: Less than 3 db
Input Impedance: 10,000 ohms
Output Impedance: 10,000 ohms

(*Continued on following page*)

Fig. 5: Graphs show filter phase shift characteristics.



Filters *(Concluded)*

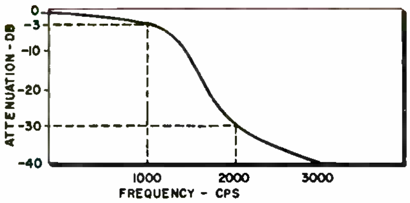


Fig. 6: Low pass filter response curve

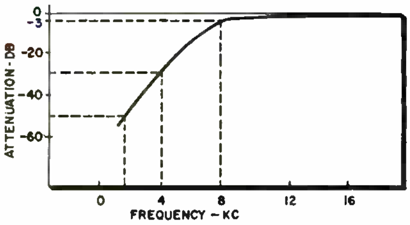


Fig. 7: High pass filter response curve

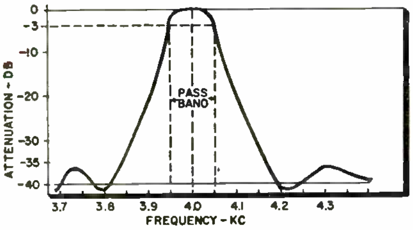


Fig. 8: Band pass filter response curve

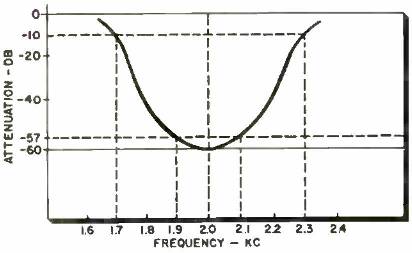


Fig. 9: Band rejection filter response curve

Input Voltage Level: 1.0 volt RMS
Cutoff Frequency (3 db down): 8,000 cps
Attenuation at 2 F_c(16 KC): Not more than 1-0 db
Attenuation at $F_c/2$(4 KC): 30 db
Attenuation at $F_c/3$(2 KC): 50 db

Band Pass Filter

Insertion Loss: Less than 3 db
Input Impedance: 30,000 ohms
Output Impedance: 100,000 ohms
Input Voltage Level: 1.0 volts RMS
Center Frequency: 4 KC
Bandwidth: 100 cps.
Attenuation at ± 200 cps of center freq.: 40 db
Attenuation beyond ± 250 cps of center freq.: greater than 35 db
Temperature Characteristics: From — 20°C to + 85°C; less than ± 4 cps shift in center frequency; less than ± 2 cps change in bandwidth

Band Rejection Filter

Insertion Loss: Less than 2.0 db
Input Impedance: 100,000 ohms
Output Impedance: 200,000 ohms
Input Voltage Level: 1.0 volt RMS
Center Frequency: 2 KC
Bandwidth: 200 cps
Attenuation at Center Frequency: 60 db
Attenuation at ± 300 cps of center freq.: 10 db
Attenuation at beyond ± 350 cps of outer frequency: less than 10 db
Temperature Characteristics: From — 20°C to + 85°C; less than ± 3 cps shift in center frequency; less than ± 1 cps change in bandwidth

A Production Ultrasonic Welder

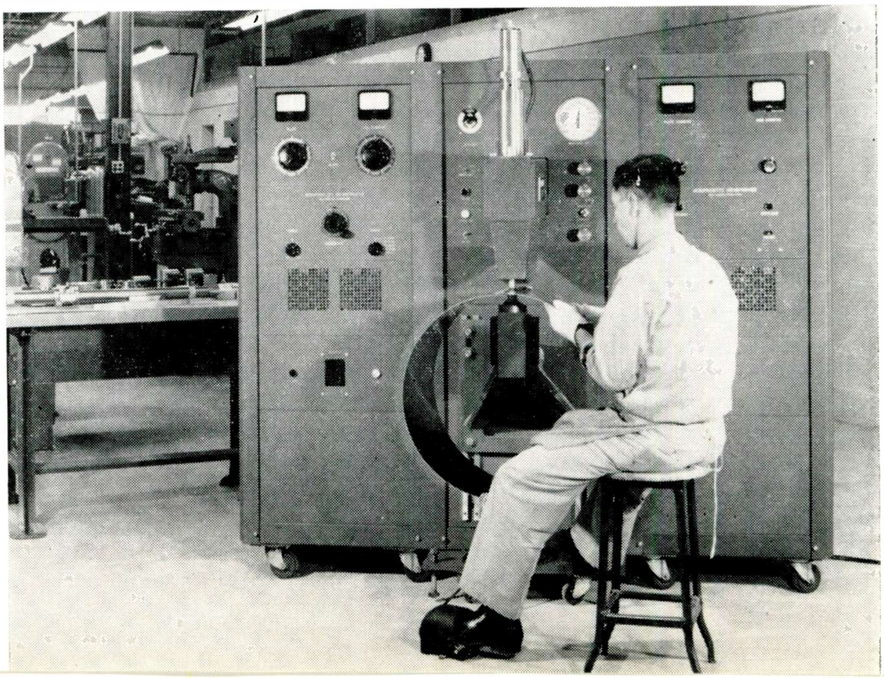
THE welding industry has a valuable new piece of equipment in a 2000-watt welder which utilizes ultrasonics to join similar and dissimilar metals without fusion, and with very little external deformation.

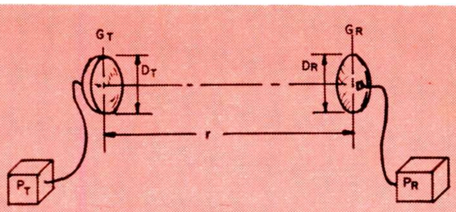
Aeroprojects Incorporated, West Chester, Pa., which originated and developed this new joining method, is marketing the 2000-watt Model W-2000-SR-57-10 Sonoweld production type welder through its subsidiary, Sonobond Corp.

A semi-portable unit, it has a welding frame, of box-beam construction, and a hydraulic force system. Its transducer-coupling assembly consists of a nickel transducer, a coupling wedge and a drive-reed which have been especially designed for this unit. The heavy-duty generator, designed for continuous duty is contained in two separate cabinets. Ample spacing for components allows adequate ventilation and insures high duty cycle operation, at the same time

(*Continued on page* 145)

A single application of the foot switch initiates the complete and automatic welding cycle.





$$\frac{P_R}{P_T} = \frac{G_T G_R \lambda^2}{16\pi^2 r^2}$$

Fig. 1: The well-known Friis Transmission formula with symbols pictorially shown.

Problems of Missiles . . .

Reducing Spurious Radiation

Efficient r-f spectrum use requires radiation limits on microwave equipment. An experimental program, designed to extend existing limits to cover 1-10KMC, established measuring techniques which are described in detail.

A. L. Albin

C. B. Pearlston

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RECOGNITION of the undesirable effects caused by spurious radiations from electronic equipment has led to the adoption of interference specifications delimiting the levels of interference that may be tolerated. Prior to the past year, these limits were applicable only over the range of 0.15 to 1000 MC (as in MIL-I-6181B). But, the increasing use of the extremes of the frequency spectrum in pilotless aircraft and supersonic missiles has led to a proposed extension of the upper limit to 10,000 MC (as in MIL-I-6181C).

The actual interference levels that can be tolerated over this increased frequency range are determined by the use of the systems concerned and their nearness to other electronic equipments. But, the basic criterion remains the susceptibility to interference signals of the associated receivers in the system. This naturally requires considerable statistical data concerning receiver operation in the presence of microwave interference sources, and of the magnitudes of radiated interference encountered in system operation. It further implies the availability of a receiver capable of detecting and accurately measuring the levels of interference.

The receiver for such an interference measuring set must have: (1) sensitivity of —90 to —100 dbm over a wide frequency range, (2) spurious responses down 60-80 db, (3) linearity of response within 1 db, and (4) shielding efficiency of 100-120 db against external interference sources. The antennas must be accurately calibrated to permit measurement of absolute field intensity, and possess sufficient directivity to discriminate among various radiating sources.

Near-Zone Measurements

The experimental work upon which this article is based employed a commercial Interference Measuring

Based on a paper presented at the IRE National Convention, March, 1958, New York.

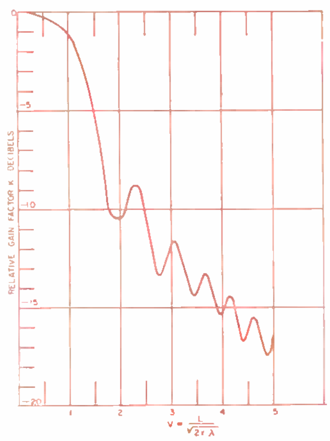


Fig. 2: Gain correction factor for uniformly illuminated rectangular aperture.

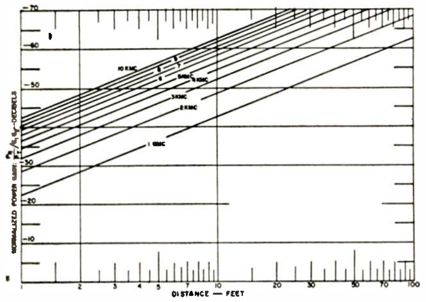


Fig. 3: Variation of power received as function of distance; frequency a parameter.

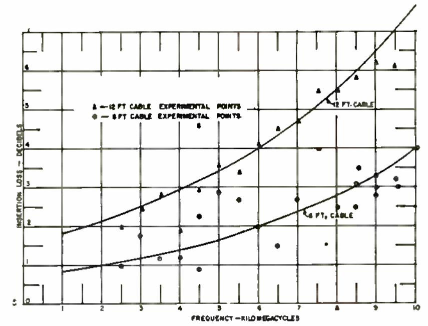


Fig. 4: Insertion loss for the antenna cable of a commercial interference set.

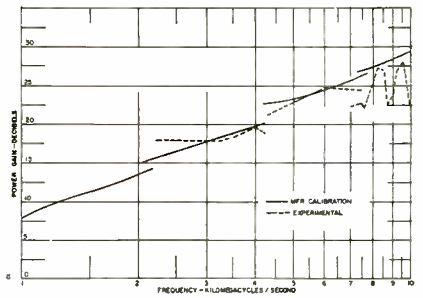


Fig. 5: Antenna gain factors as measured in a shielded enclosure; distance 15 ft.

Spurious Radiation *(Continued)*

Set, which meets the requirements outlined above fairly well. However, the calibration furnished with the antennas (and, indeed, for antennas of most similar equipments) is valid only for measurements within the Fraunhofer region, where the impinging field appears as a uniform plane wave to the receiving antenna. The well-known propagation formula for determining far-zone field intensity in a line-of-sight path is

$$\frac{P_R}{P_T} = \frac{G_R\, G_T\, \lambda^2}{16\, \pi^2\, r^2} \qquad (1)$$

as shown in Fig. 1.

where P_R = Power received
P_T = Power transmitted
G_R = Far-zone receiving antenna gain
G_T = Far-zone transmitting antenna gain
r = Distance between antennas
λ = Wavelength.

If the electric field-intensity vector is not equiphase and uniform at all points of the receiving antenna, destructive interference may occur between the wave components, leading to a reduction of the realizable antenna gain.

The realizable power gains of horns and reflectors can be calculated using optical design principles, and it can be shown that for a point radiating source and an antenna of aperture D, the minimum range r at which Eq. 1 is applicable is given by

$$r = \frac{D^2}{\lambda} \qquad (2)$$

This equation corresponds to a maximum departure of $\pi/4$ radians or $\lambda/8$ from a plane wavefront and entails a power loss of 5% from the far-zone gain. A power loss of 2.5% from the far-zone gain may be approximated by using the equation

$$r = \frac{2\, D^2}{\lambda} \qquad (3)$$

which corresponds to an error of $\pi/8$ radians. Various other approximations may be used for greater accuracy.

When the antennas are comparable in aperture, an approximation for a power reduction not exceeding 10% is

$$r = \frac{1}{\lambda^2}\,(D_1^4 + 6\, D_1^2\, D_2^2 + D_2^4). \qquad (4)$$

Using Eq. 2 for the case of a transmitting antenna with a small aperture compared to the receiving antenna, we find for an 18-in. horn-fed paraboloid at 5000 MC.

$$r = \frac{D^2}{\lambda} = \frac{(18/12)^2}{0.197} = 11.4 \text{ ft.}$$

If the more stringent criterion of Eq. 3 is used, $r = 22.8$ ft.

Because of the range of radiated powers and types of equipment under measurement, the test distance may vary from 1 to 25 ft. Such interference measurements in the near-zone will not obtain the full gain potential of the antennas.

Since the radiation pattern of the antennas (and receiving pattern, since linear antennas and linear, homogeneous, isotropic media demonstrate reciprocity, and the gain patterns are identical for transmission or reception) will vary with distance and frequency in the near-zone or Freznel region, it becomes necessary to supply a separate calibration for each test distance and frequency at which measurements are desired.

Variation of Field Intensity

This general problem of determining the variation in antenna pattern as a function of frequency, aperture, and antenna separation has been examined.[1] Good agreement was reported between theoretical predictions and actual measurements, and it was considered that this method would be useful in obtaining a calibration of the microwave antennas employed in the near-field. Fig. 2, adapted from Reference 1, shows the gain correction factor K, in decibels, which

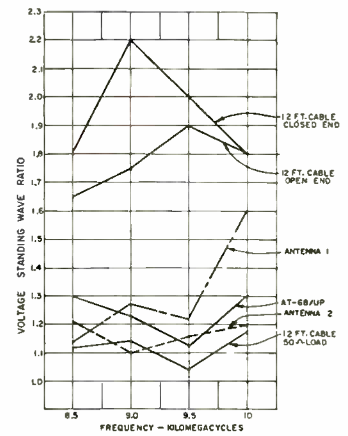


Fig. 6: Measured values of VSWR measurements taken to determine possible adverse effects of screen rooms.

must be applied to Eq. 1 for near-field use. This gain factor is plotted as a function of the parameter V,

$$V = \frac{L}{\sqrt{2r\lambda}} \qquad (5)$$

where L = largest aperture dimension
λ = wavelength
r = distance between antennas.

In conjunction with this curve is Fig. 3 in which are plotted normalized power ratios $(P_R/P_T)/(G_R G_T)$, as a function of distance with frequency as a parameter.

By combining the normalized power ratio, the antenna gain, and the antenna gain-correction factor from the previous figures, we may compute the corrected ratio of P_R/P_T vs. distance at each selected frequency:

$$\frac{P_R^1}{P_T^1} = \left[\left(\frac{P_R}{P_T}\right) \Big/ (G_R\, G_T) + K_R + K_T + G_R + G_T\right] \cdot (6)$$

These theoretical ratios were computed for the various test antennas and an experimental program was then undertaken to verify the predicted values.

Experimental Program

To calculate accurately the field intensity at a given antenna, it is necessary to determine certain component parameters which influence the magnitude of the resultant received power. These parameters include cable losses, antenna gains, receiver sensitivity, voltage-standing-wave ratios, screen room reflections, and propagation characteristics within the near-zone.

As shielded enclosures are utilized to reduce ambient interference, all measurements are made within such an enclosure. Due to the highly directive horn antennas employed, the expected internal room reflections are not severe, and excellent measurement reproducibility is obtained, with variations not exceeding 2-3 db from day-to-day.

Substitution-type insertion loss measurements are performed on the 6- and 12-ft. type RG-9 A/U antenna cables used with the receiver. The values obtained are plotted in Fig. 4, which shows an attenuation logarithmically increasing with frequency.

To obtain experimental verification of the manufacturer's far-field gain figures, the three-antenna calibration method is used,[3] utilizing additional laboratory antennas covering the frequency range of 1-10 KMC. Measurements are made of the space attenuation factors between given transmitting and receiving antennas which, by means of a power-gain equation, are converted into values of antenna gain, Fig. 5. The manufacturer's gain figures are also plotted.

To determine the possible adverse effects of screen room reflections, VSWR measurements are taken under varying test conditions over the 8-10 KMC frequency band. Fig. 6 shows the measured values. The small magnitudes are attributed to the inherent cable losses, and demonstrated that screen-room reflections are not of sufficient magnitude to adversely affect the antenna impedance as seen by the receiver.

Receiver Sensitivity

Receiver sensitivity measurements are performed by injecting an unmodulated (CW) signal and observing the signal level at which it was just detectable. These values are plotted in Fig. 7; it is evident that the sensitivity in the range of 7.5-10 KMC has deteriorated in comparison to the other frequency bands.

To validate the theoretical prediction of near-zone field intensity variation with the distance between transmitting and receiving antennas, propagation measurements are made over the entire frequency range of 1-10 KMC. The antennas are placed approx. 50 in. above the ground plane and the distance between them varied in 6-in. increments from 1 to 5 ft and in 1-ft. increments from 5 to 25 ft.

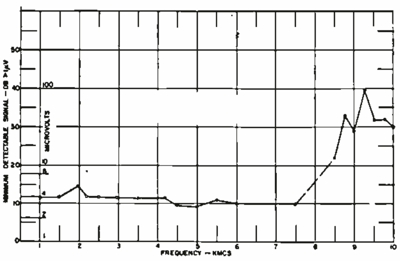


Fig. 7: Minimum detectable signal of interference set used for curves in Fig. 4.

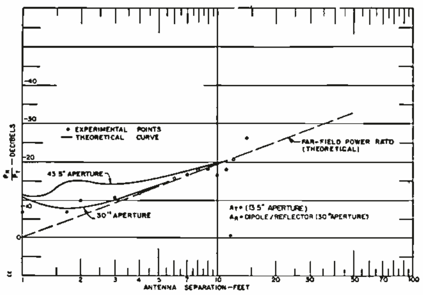


Fig. 8: Relative power propagated at 1 KMC as function of distance between antennas.

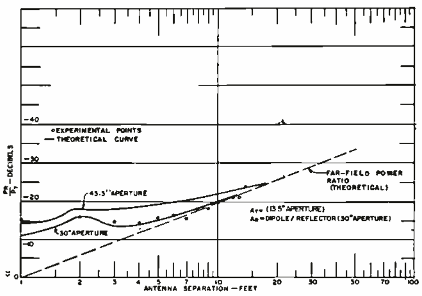


Fig. 9: At 2000 MC, there is a noticeable change in the 30 in. aperture pattern.

While it is undoubtedly true that an anechoic microwave chamber, with a precision lathe-bed for distance measurements, would yield more accurate results, the existing results, determined with the relatively crude test set-up employed, show a quite satisfactory correspondence with the predicted values. Figs. 8 to 12 show the experimental values determined, as well as the theoretical predicted values.

The received power is substantially independent of distance from 3 to 6 ft. over a wide frequency range. However, above 4000 MC, between 1 and 3 ft., wide fluctuations of measured power are experienced with slight variations in the antenna spacing. This extreme sensitivity indicates that interference measurements could most satisfactorily be made at a distance of 3 to 6 ft. from the interference source.

The deviation of the experimental curves from those predicted is due in part to the assumption of linear illumination for the antennas, which is noticeably not satisfied when the reflector-horn combination is em-

Spurious Radiation *(Concluded)*

ployed at close distances, due to the horn shadow effect. A further departure is experienced when antennas of comparable apertures are employed. In this case, as a first approximation, an effective aperture computed from the sum of the individual antenna apertures is used as an empirical formula. This gives satisfactory agreement at distances greater than 3 ft., as can be seen from an examination of Figs. 8 to 12.

In the curves, a slight dip, denoting a power increase, is shown at a distance ranging from 10 ft. at 1 KMC to 25 ft. at 10 KMC. This effect occurs on the power curve for each frequency at a different distance, indicating some mode of cavity resonance of the shielded enclosure.

Near-Field Calibration

As previously mentioned, the calibration supplied with the standard antennas will be sufficiently accurate when the interference sources are located 15-25 ft. from the antennas. This is where the received signal most nearly approximates a uniform plane wave. Interference measurements, however, are usually made from 1 to 10 ft. in practice. Distances less than 3 ft. are inadvisable due to the extreme variation of the near-field calibration with changes in the effective aperture of the source, and distances above 6 ft. are not suitable due to the physical limitations of shielded enclosures or absorption chambers. Thus 3 or 6 ft. appear reasonable distance choices.

The received power density is determined from Eq. 7. It is derived from relationships between power, effective area, gain, and wavelength:

$$P_A = \frac{4\,\pi\,P_R}{\lambda\,2\,G} \qquad (7)$$

where

P_R = power at receiver terminals (watts)

P_A = power per unit area of incident wave (watts/sq. meter)

λ = wavelength (meters)

G = power gain over isotropic radiator.

Using the free-space intrinsic impedance of 377 Ω* and the relation

$$E_a = \sqrt{377\,P_A} \qquad (8)$$

where E_a = electric field intensity in volts/meter, and combining with Eq. 7, we obtain

$$E_a = \sqrt{\frac{1508\,\pi\,P_R}{\lambda\,2\,G}} \qquad (9)$$

Reducing the above and expressing E_a in microvolts/meter, we obtain

$$E_a = 7.29 \times 10^{-3}\,f\,\sqrt{P_R/G}, \qquad (10)$$

where P_R is measured in milliwatts, and f in MC. Summing the components of cable loss, gain correction factor K, and the above determined field intensity, we arrive at a calibration curve for a 1 μv received signal at a 3-ft. test distance, Fig. 13.

A REPRINT

of this article can be obtained by writing on company letterhead to

The Editor

ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

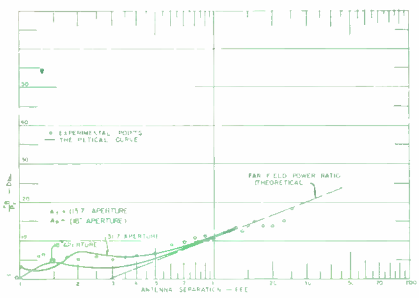


Fig. 10: Relative power propagated at 4200 MC as function of distance between antennas.

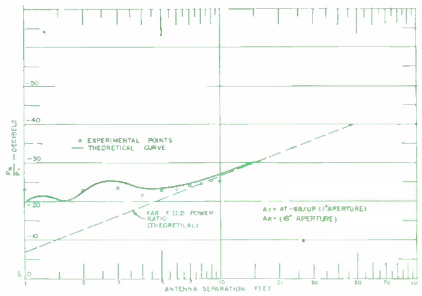


Fig. 11: Measurements at 7500 MC. Fluctuations around 4 ft. show extreme sensitivity.

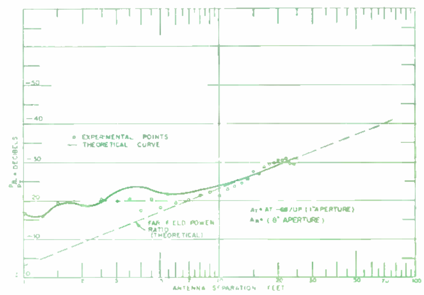


Fig. 12: At 10 KMC, power increase dip at 25 ft. indicates a mode of cavity resonance.

Derivation of Interference Limits

A knowledge of microwave receiver sensitivities in the range of 1 to 10 KMC enables one to determine suitable interference limits for these receivers. The effective sensitivity of such receivers is obtained by subtracting their antenna gains from the basic receiver sensitivity and adding the transmission line losses. Fig. 14 shows an example of this method, assuming a —90 dbm uniform sensitivity, cable losses varying uniformly from 1 to 5 db over the frequency range, and antenna gain varying from 0 to 25 db.

Postulating a signal-to-interference ratio of unity, the corresponding field intensity can be determined in accordance with the method previously given. This is the intensity of an interfering signal which will produce a signal at the receiver equal to the desired signal in magnitude. Correlation of this field intensity with the near-field calibration previously established will yield on interference limit for the receiver in question.

*It should be recognized, however, that considerable departure from the free-space value will be experienced in the near-field and the calibration obtained by the above procedure is not to be considered as an absolute value, but only as an approximation for comparison with existing specification limits.

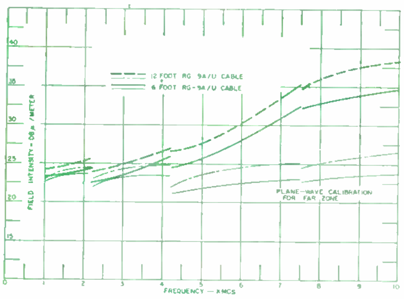


Fig. 13: Directive antenna calibration curve; indicated signal: 1 uv; distance; 3 ft.

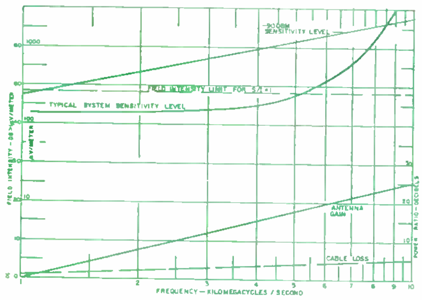


Fig. 14: Determination of permissible interference levels, based on received sensitivity.

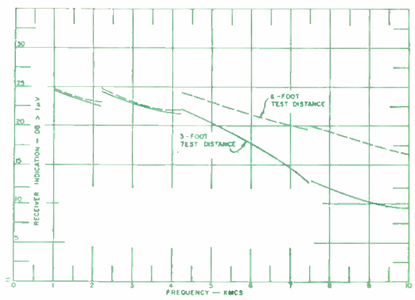


Fig. 15: Computation of typical interference limits using meter with 12 ft. cables.

Fig. 13 shows the field intensity required to produce a signal of 1 μv at the receiver at the 3-ft. test distance. The incident interference field intensities can be computed from Fig. 14, and the decibel difference between that value and the calibration value provides the interference limit for a signal at the receiver. For example, at 7 KMC, the incident field intensity from Fig. 14 is 48 dbμ/meter (65 — 21 + 4 = 48). Fig. 13 shows the calibration factor to be 33.5 dbμ/meter for 1 μv input, using the 12-ft. cable. The difference of 14.5 dbμ or 5.3 μv at the receiver represents the interference limit, and limits so determined are shown in Fig. 15 for both a 3- and 6-ft. test distance.

Fig. 14 also contains a curve of receiver system sensitivity on a typical missile and limits derived for this situation are shown in Fig. 16. These limits are restricted to the case of coupling between antennas. When other propagation paths are present, they must be considered, with due allowance for the shielding properties of any intermediate barriers.

Conclusions

On the basis of the foregoing results of the experimental program, it is concluded that:

1. With horn-type directional antennas, it is feasible to make repeatable CW field intensity measurements in a shielded enclosure from 1 to 10 KMC.
2. With proper calibration, the test instrument can be used within the near-field.
3. Interference limits should not be specified for distances less than 3 ft.
4. The method herein presented for predicting field intensities is a useful tool for near-field antenna calibration.

Acknowledgment

The work on which this article is based was performed by the Filtron Company, Inc., under the following contracts:

DA-36-039 SC-73129, U. S. Army Signal Engineering Laboratories.

AF-04(645)-4, Convair Astronautics Division of General Dynamics Corp.

References

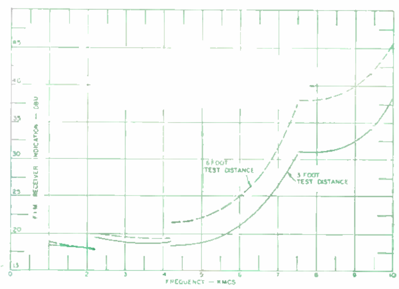
1. C. Polk, "Prediction of Power Densities in the Vicinity of Large Antennas," *Proceedings of the Third Conference on Interference Reduction,* Armour Research Foundation, Chicago, February, 1957.

2. Reich, et al, *Microwave Theory and Techniques,* D. Van Nostrand, New York, 1953.

3. C. G. Montgomery, *Technique of Microwave Measurements,* McGraw-Hill Book Company, Inc., New York, 1947.

4. Handbook of Maintenance and Operation, Polarad Model FIM Interference Measuring Set.

Fig. 16: Interference limits for typical microwave equipments using meter and 12 ft. cables as a function of distance.



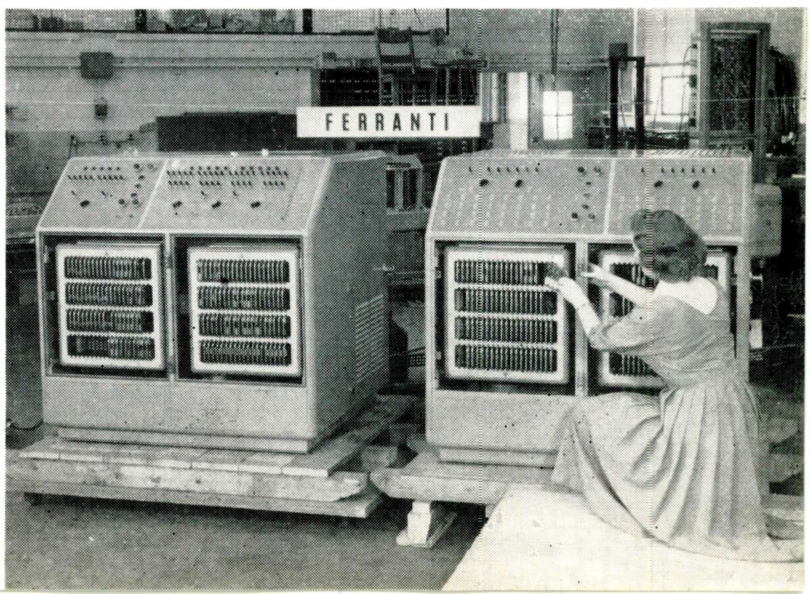
PC's for Canadian PO's

At the direction of the Canadian Post Office, Ferranti Electric Ltd., Toronto, has developed electronic postal sorting machinery. It is currently undergoing tests in Ottawa.

The machinery includes encoding desks, a conveyor with 32 sorting "bins" and a route reference computer which contains a large number of coded addresses in a magnetic drum memory.

As letters come into the post (*Continued on page* 160)

The young lady holds one of the computer circuits, printed on copper-clad laminated plastic, which searches a selected part of the memory drum, for a correct comparison with a 20-bit address code.



Two methods for finding the straight line from which the exponential deviates are discussed. In each case, the results are plotted as error vs time curves. The relation of non-linearity to change in slope is also covered.

Comparison of RC Sweep and Ideal Sawtooth

By DONALD MOFFAT
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Light Military Electronic Equipment Dept.
Utica, N. Y.

THE purpose of this article is to show how

$$E_b\left(1 - \epsilon^{-\frac{t}{RC}}\right) \quad (1)$$

deviates from a straight line as a function of t/RC. Eq. 1 is an exponential that describes the voltage build-up across the capacitor in Fig. 1. Since the equation approximates a straight line for small values of t/RC, the circuit shown, Fig. 1, is the basis of many sawtooth voltage generators.

The simplest method is to determine the initial slope of Eq. 1 and to let it be the slope of the ideal line. Since it is known that this slope will bring the straight line to E_b in one time constant, Fig. 2, the equation of the straight line is

$$e_c = \frac{t}{RC} E_b \cdot \quad (2)$$

The exponential is never larger than the straight line; therefore, the positive difference is given by

$$D = E_b\left[\frac{t}{RC} - \left(1 - \epsilon^{-\frac{t}{RC}}\right)\right] \quad (3)$$

and the percentage difference is

$$\% D = \left[1 - \frac{1 - \epsilon^{-\frac{t}{RC}}}{\frac{t}{RC}}\right] 100 \cdot \quad (4)$$

Fig. 1: Basis of many sawtooth generators.

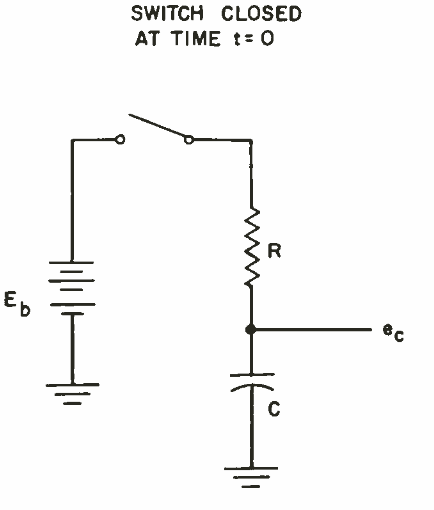
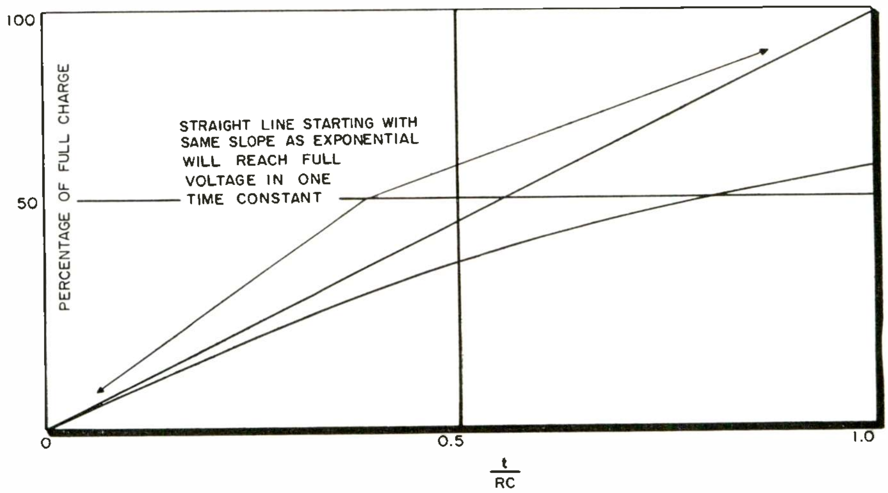


Fig. 2: Straight line represents the ideal, that which equals E_b in one time constant.



Eq. 4 is plotted in Fig. 3. Note that the locus of Eq. 4 deviates slightly from a straight line with the slope constantly decreasing. At the end of one time constant, the exponential is 36.8% of the ideal sawtooth.

Objections

There are several objections to defining the straight line in this manner; for instance, interpretation of Fig. 3 would be difficult after one time constant because the ideal has reached maximum voltage. Another fault is that the straight line's only resemblance to the exponential is in the identical initial slopes; it is not the average, closest approximation, nor does it bear any other relation. A different straight line, defined so as to be valid for any length of time, is shown in Fig. 4. Here, the final value of t/RC, called t_1/RC, is first chosen; then the ideal sawtooth is defined as the straight line joining the origin to e_{c1}, the point the exponential reaches in time t_1/RC. This procedure overcomes the objections stated above but adds a new one—there is a different straight line for every value of t_1/RC, making the mathematics more cumbersome. This is not a serious complication, however, and the equation will be derived. If the accuracy of graphical solutions is sufficient, Fig. 5 can be used, as it is a plot of percentage error according to this new definition.

The equation for Fig. 4 can be derived by starting with the two-point form of the equation of a straight line.

$$\frac{e_{c1} - E_b\left(1 - \epsilon^{-\frac{t_1}{RC}}\right)}{E_b\left(1 - \epsilon^{-\frac{t_1}{RC}}\right) - 0} = \frac{\frac{t}{RC} - \frac{t_1}{RC}}{\frac{t_1}{RC} - 0}$$

$$e_{c1} = \left[\frac{E_b\left(1 - \epsilon^{-\frac{t_1}{RC}}\right)}{\frac{t_1}{RC}}\right]\frac{t}{RC}. \qquad (5)$$

Eq. 5 is a straight line connecting the origin to any point on the exponential curve. The difference between this straight line and the exponential is Eq. 1 minus Eq. 5.

$$D_b = E_b\left[\left(1 - \epsilon^{-\frac{t}{RC}}\right) - \frac{\left(1 - \epsilon^{-\frac{t_1}{RC}}\right)}{\frac{t_1}{RC}}\left(\frac{t_1}{RC}\right)\right] \qquad (6)$$

Whereas the first definition gave a constantly increasing error for a given length of sweep, this new definition has zero error at the start and at the finish of the sweep. Therefore, the point of interest is in determining the maximum error for any given value of t_1/RC. Differentiating Eq. 6 and equating to zero will determine the time at which the maximum deviation occurs.

$$\frac{d}{d\frac{t}{RC}} D_b = E_b\,\epsilon^{-\frac{t}{RC}} - \frac{E_b\left(1 - \epsilon^{-\frac{t_1}{RC}}\right)}{\frac{t_1}{RC}} = 0$$

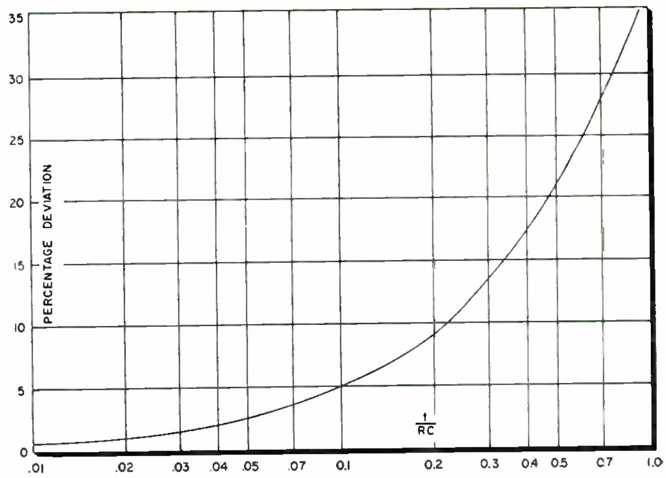


Fig. 3 (above): The locus of Eq. 4, plotted here, deviates slightly from a straight line with the slope constantly decreasing.

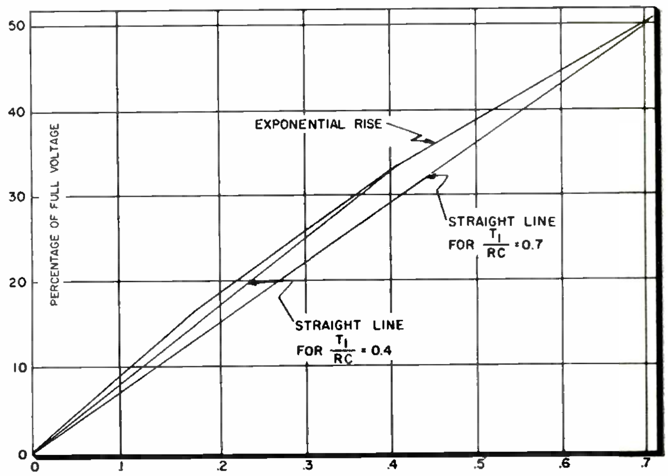
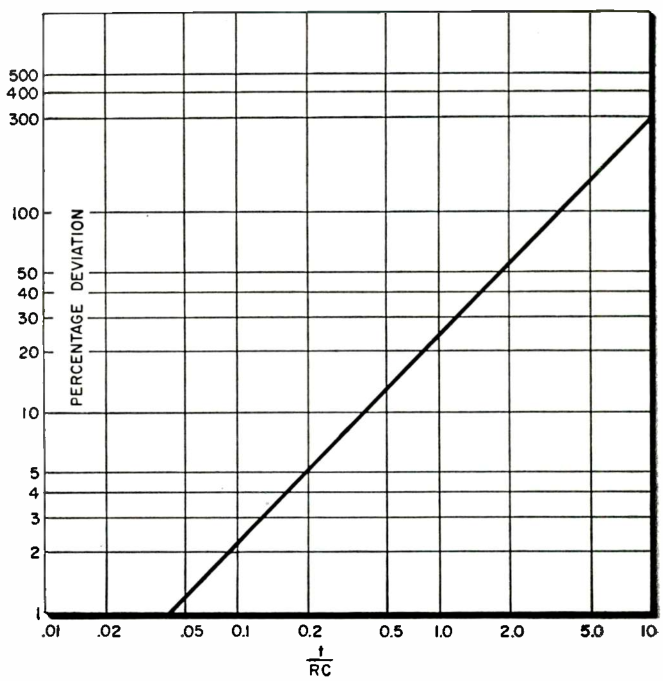


Fig. 4 (above): A straight line from the origin to the voltage for a predetermined t/RC, is valid for any length of time.

Fig. 5 (below): This plot of Eq. 8, Max. Percentage Deviation can be used for any degree of accuracy, since no approximations have been made.



Sweep & Sawtooth

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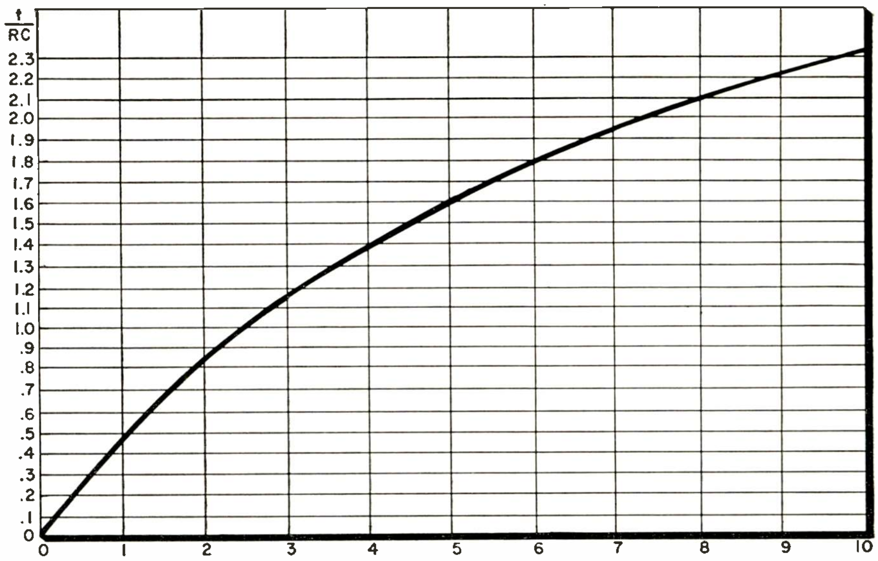

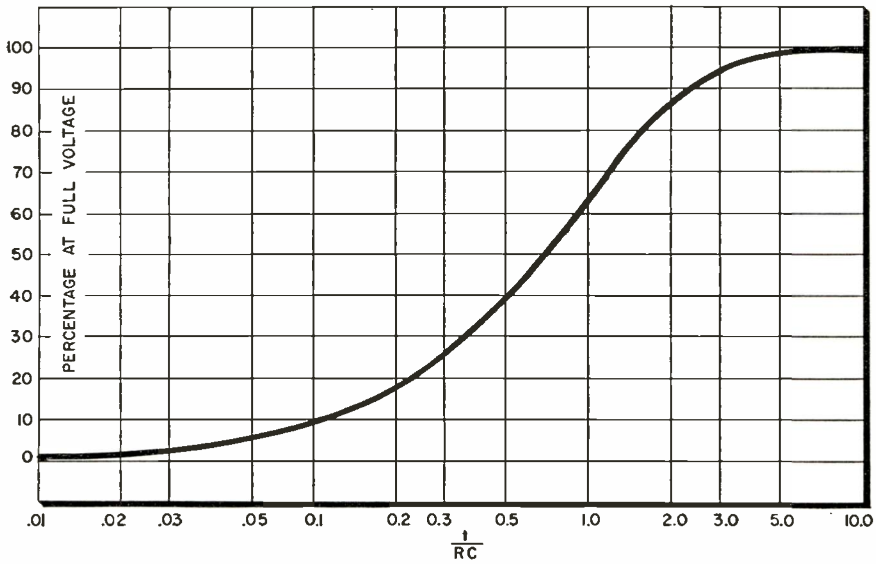

Fig. 6 (above): Plotted from Eq. 7, this curve illustrates how the max. point varies as the sweep duration is changed. Fig. 7 (left): This curve permits the designer to determine the amount of voltage across the capacitor at any time.

$$\frac{t}{RC} = -\ln \frac{1 - \epsilon^{\frac{t_1}{RC}}}{\frac{t_1}{RC}}. \qquad (7)$$

Maximum Percentage Deviation

This time of maximum deviation can now be substituted into Eq. 6 and the new equation divided by Eq. 5 to obtain an expression for the maximum percentage deviation, with the duration of the sweep as the independent variable.

$$\% D_b = \left[\frac{1 - \epsilon^{\ln \frac{1 - \epsilon^{-\frac{t_1}{RC}}}{t_1/RC}}}{\frac{1 - \epsilon^{-\frac{t_1}{RC}}}{\frac{t_1}{RC}} \left(-\ln \frac{1 - \epsilon^{-\frac{t_1}{RC}}}{\frac{t_1}{RC}} \right)} - 1 \right] 100 \cdot \qquad (8)$$

Eq. 8, plotted in Fig. 5, can be used for any degree of accuracy, since no approximations have been made.

Because Eq. 8 is sometimes approximated by assuming that maximum deviation occurs at the halfway point, Fig. 6 is included to show how the maximum point varies as the sweep duration is changed. Fig. 6 is plotted from Eq. 7.

In some applications the slope is of primary importance and nonlinearity is defined by giving the minimum slope as a percentage of the maximum slope.

$$\% \text{ of Non-linearity} = \frac{(\text{Max. slope}) - (\text{Min. slope})}{(\text{Max. slope})} 100$$

where:

Max. slope = initial slope = E_b

Min. slope = First derivative of Eq. 1

$$= \frac{d}{d\frac{t}{RC}} \left[E_b \left(1 - \epsilon^{-\frac{t}{RC}} \right) \right]$$

$$= E_b \, \epsilon^{-\frac{t}{RC}}$$

$$\% \text{ of Non-linearity} = \frac{E_b - E_b \, \epsilon^{-\frac{t}{RC}}}{E_b} 100$$

$$= \left(1 - \epsilon^{-\frac{t}{RC}} \right) 100. \qquad (9)$$

This equation is plotted in Fig. 7.

Note that if Eq. 1 is normalized for voltage by dividing by E_b and then multiplying by 100, Eq. 9 results. By calling the ordinate "percentage of full voltage," the designer can use Fig. 7 to determine the amount of voltage across the capacitor at any time. Fig. 7 does not look like the familiar changing curve because it is on log-log coordinates in order to show more detail at the beginning.

References

Puckle, O. S.; *Times Bases,* New York, John Wiley and Sons, 1951.

Edson, W. A.; *Vacuum Tube Oscillators,* New York, John Wiley and Sons, 1953.

A Look At Modern Network Synthesis

Results of modern synthesis are given in the form of tables of normalized element values for networks with the following characteristics: maximally flat magnitude, equal-ripple magnitude in one filter band, equal-ripple magnitude in both filter bands, and maximally flat time delay.

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SINCE its conception by Zobel the image-parameter theory of filter design has achieved wide application. It is an exceedingly serviceable approximate design theory. The repetitive network structures that it most often yields are advantageous from a manufacturing point of view. And because the theory is fairly straightforward, it lends itself to handbook use.

In the past two or three decades a competitive theory has been developed. It has been variously called insertion-loss theory, modern network synthesis, or *exact* network design. This theory is more general, flexible, and sophisticated than the image-parameter theory. Its very sophistication, however, has contributed to its slow adoption, or even neglect, by engineers who could profit greatly from its use in their practical day-to-day design. It appears that much of synthesis theory assumes a background in network analysis that unfortunately is still not being taught in the majority of schools in this country. Since in many types of problems, however, synthesis can yield results that are optimum, it is imperative that some method be found for making these results available. This article discusses a method that has been used.

(This article is based on a paper presented at the National Electronics Conference, October, 1957.)

It is fortunate that for a large class of problems the results of synthesis can, like those of image-parameter theory, be obtained from a handbook presentation. To try to stimulate such use the writer has prepared tables of element values for the design of three classes of networks;[1-5] a fourth class of networks has been considered by another group of authors.[6] Simple formulas for the element values of one of these types of networks[3] are given in another paper,[7] while a brief discussion of a possible contribution of these tabulations to reliability is presented in still another paper.[8]

After an engineer has decided on the type of network that satisfies his needs, he finds the element values of the normalized network by consulting the appropriate table. The final network is then obtained by a few simple arithmetical calculations, like those involved in the removal of the impedance level and frequency normalizations.

One of the purposes of this article is to direct attention to the sets of tables and briefly summarize the types of networks and characteristics given by each set. But before this is discussed the reader must be furnished with enough comparative data to allow him to choose intelligently among the various tables. Unless this is done the tables will not achieve their full potential usefulness. Therefore, within the space limitations of this paper, the general properties of each of the classes of networks are discussed, particular attention being paid to their optimum properties. This discussion is not intended to substitute for those given in the references, but only to supplement them. It is hoped that the total effect of the article will be to gather together in an integrated presentation what has necessarily been distributed over many papers.

Types of Network Properties

Four types of optimum filters have been considered in the tables of the references. One method of classifying these types is by stating that two possess the *maximally flat* property, whereas the other two have the *equal-ripple* property. The *Butterworth polynomials* yield a maximally flat magnitude characteristic and the use of *Bessel polynomials* gives a maximally flat time delay. *Tschebyscheff polynomials* are used to give an equal-ripple magnitude characteristic in one band of a filter and a monotonic characteristic in the other band. For equal ripples in both the pass and stop bands the *Tschebyscheff rational function* is used.

From the above description another method of classifying the networks becomes evident. Three of them are approximations for a magnitude characteristic, while only the Bessel polynomials are used to approximate a phase characteristic. We now consider each of these types of approximations in turn. The magnitude characteristic is considered with respect to the approximation of an ideal low-pass filter. Confining attention to the low-pass filter is not so restrictive as it appears at first glance; for by the use of frequency transformations[1] the low-pass magnitude approximation may be converted to a high-pass, band-pass, or band-elimination characteristic.

Ideal Low Pass Filter

Consider the ideal magnitude characteristic of a low-pass filter shown in Fig. 1, where the squared magnitude of the normalized transfer impedance is plotted against positive values of the normalized real frequency. In this plot all signals with frequencies in the pass band $0 \leq \omega < 1$ are transmitted without loss, whereas inputs with frequencies $\omega > 1$ yield zero output. It is known that such a characteristic is unrealizable by a physical network[9] so that it becomes necessary to approximate it.

The approximating function must approximate a constant in each of two ranges: unity in the range $0 \leq \omega < 1$ and zero for $\omega > 1$. Thus if the function

$$|Z_{21}(j\omega)|^2 = \frac{1}{1 + A_n(\omega^2)} \qquad (1)$$

is used, it is necessary that

$$\begin{aligned} A_n &<< 1 \qquad 0 \leq \omega < 1 \\ A_n &>> 1 \qquad \omega > 1 \end{aligned} \qquad (2)$$

Since the squared magnitude must be an even function of ω, it is also clear why A_n is chosen as a function of ω^2.

Maximally Flat Magnitude

Butterworth[10] suggested that $A_n = \omega^{2n}$ be used as an approximation. Consequently the function

$$|Z_{21}|^2 = \frac{1}{1 + \omega^{2n}} \qquad (3)$$

is called a *Butterworth function,* and it is reasonable to name the denominator polynomials derived from it *Butterworth polynomials* and the network realizations *Butterworth filters.* The characteristic is also called a maximally flat one,[11] for reasons that are made clear below; and it is also of interest to mention that in amplifier design a network with this characteristic is called a *flat-staggered n-tuple.*[9]

For ω much smaller than unity, the value of the Butterworth function is approximately one, but for large values of ω.

$$|Z_{21}|^2 \cong \frac{1}{\omega^{2n}} \qquad (4)$$

which approaches zero more and more closely as ω increases. Clearly, as n is changed to a larger integer the approximation is improved in both ranges; for all values of n, however, the function is equal to ½ at $\omega = 1$.

Sketches of the approximations given by the first three orders of the Butterworth function are shown in Fig. 2. The characteristic is *monotonic* in both the pass and the stop bands. It is also noted that as n increases the slope of the curve in the *transition region* of frequencies also increases, where the transition region is defined as the frequency range between the cutoff frequency $\omega = 1$ and the frequency at which a specified attenuation occurs; it is clear that a sharp-cutoff Butterworth filter requires a high value of n. The approximation close to $\omega = 0$ is observed to be very good, but there is an increased attenuation at the higher pass-band frequencies. This is true because the approximation is of the Taylor-series type, i.e., it is an approximation *about a point.*

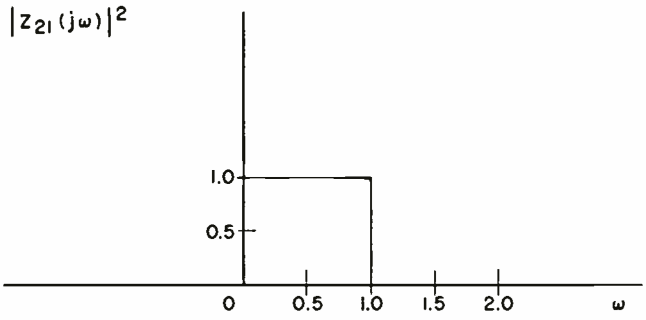

Fig. 1: Ideal low-pass filter characteristic.

However, in filter applications we are most often interested in an approximation over a *band* of frequencies.

Now in what way is such a simple function optimum? Its optimum character may be understood in terms of the adjustment of the derivatives of a function,[12] i.e., setting the derivatives equal to zero. Consider a transfer impedance whose numerator is a constant and whose denominator is a Hurwitz polynomial of degree n. The square of the magnitude of the transfer impedance on the imaginary axis is of the form

$$|Z_{21}(j\omega)|^2 = \frac{1}{1 + a_1\omega^2 + a_2\omega^4 + \cdots + a_{n-1}\omega^{2(n-1)} + \omega^{2n}} \quad (5)$$

where the frequency has been normalized so that the constant term in the denominator becomes unity. Since the function is analytic at the origin, it may be expanded in a Maclaurin series. If the terms are written in ascending order as in the above equation, the expansion is obtained simply by long division. Its first three terms are given by

$$|Z_{21}(j\omega)|^2 = 1 - a_1\omega^2 - (a_2 - a_1^2)\,\omega^4 - \cdots \quad (6)$$

and the coefficient of the next term will involve a_1, 2_2, and a_3, the coefficient of ω^8 will involve the first four a's, etc. Since this is a Maclaurin expansion, the coefficients are the successive even-ordered derivatives of the function with respect to ω, all the derivatives being evaluated at $\omega = 0$; the odd-ordered derivatives are automatically zero at the origin because the magnitude is an even function of ω. Alternatively, the expansion in (6) may be considered as a function of the variable ω^2 so that the coefficients become the *successive* derivatives of the function with respect to ω^2.

Suppose now that we wish to use this function to approximate a constant. A constant can be thought of as a function all of whose derivatives are zero for all values of the independent variable. A good approximation *at the origin* is obtained if a_1, the first derivative with respect to ω^2, is set equal to zero; this, of course, has the effect of flattening the curve at the origin. A better approximation to the constant is obtained, i.e., one that is almost equal to the constant for a wider range of ω, if the second derivative is also set equal to zero. the curve is now even flatter around the origin. Since the second derivative evaluated at $\omega = 0$ is equal to $(a^2{}_1 - a_2)$ and a_1 is already zero, all that is required is that a_2 be made zero. There are $(n - 1)$ a's that are available for adjustment. setting each successively to zero gives a successively flatter curve, until all $(n - 1)$ coefficients are zero and the first three terms of Eq. (6) become

$$|Z_{21}(j\omega)|^2 = 1 - \omega^{2n} + \omega^{4n} - \cdots \quad (7)$$

But, as may be shown by long division of the Butterworth function given in Eq. (3), this is the beginning of the MacLaurin series for the Butterworth function of order *n*.

Thus the sense in which the Butterworth approximation is optimum is clear: for a transfer function whose numerator is a constant and whose magnitude is monotonic in the pass band, the Butterworth function gives the flattest possible curve at the origin. It should also be clear that the higher the degree of *n* (or, what is equivalent, the larger the number of elements we are prepared to use in the network realization), the greater the degree of maximal flatness possible; but for a fixed *n* the optimum flat adjustment is obtained when the *maximally* flat condition has been reached.

The concept of derivative adjustment may be applied to the most general type of magnitude function whose numerator and denominator are both general polynomials. Finally, merely by relabeling this

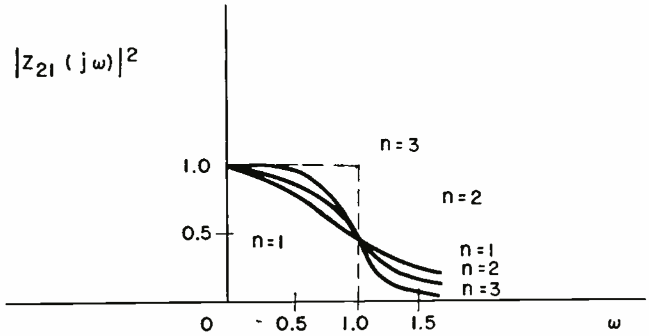

Fig. 2: Sketches of the first three orders of the Butterworth approximation to the low-pass filter.

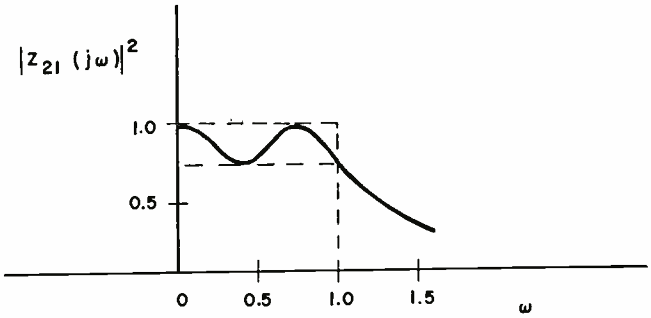

Fig. 3: Approximation, equal maxima and minima in pass band.

general rational function as the time delay of a network, $T_d = -d\beta/d\omega$, the same technique can be used. This is discussed later in connection with the Bessel polynomials.

The Butterworth approximation is useful for many applications. Its main advantage, it should now be clear, is its mathematical simplicity. For some applications, however, it is unsuitable. Such applications may require a more uniform transmission of frequencies in the pass band and a sharper rate of cutoff; or they may relate to the transient characteristic and specify a smaller overshoot in the response to a step-function input than is given by the Butterworth function.[9] Its overshoot increases with increasing *n*, exceeding 11% for $n > 4$. This behavior may be ascribed to the fact that the characteristics in the pass band and the network complexity (i.e., the value of *n*) can not be adjusted independently. If a more uniform coverage of the pass band or a sharper cutoff is desired, then a large *n* must be used and the concomitant large overshoot must be accepted.

Equal-Ripple Magnitude in One Band

An approximation that gives a more uniform coverage throughout the pass band (but no improvement in decreasing the overshoot of the step response) is the oscillating one shown in Fig. 3. Here the magnitude response varies between *equal* maximum and minimum values in the pass band and decreases monotonically outside it; the plot is said to have an *equal-ripple* character in the pass band. Such a characteristic with equal peaks and valleys may be obtained by the use of *Tschebyscheff polynomials*,[13] where we define a Tschebyscheff polynomial by

$$T_n(\omega) = \cos(n \arccos \omega) \quad (8)$$

in which *n* is a positive integer denoting the order (and degree) of the polynomial. The square of the

Network Synthesis *(Continued)*

product a member of this class of polynomials and a ripple factor ϵ is substituted for the A_n of Eq. (1) to yield[14]

$$|Z_{21}|^2 = \frac{1}{1 + \epsilon^2 T_n^2(\omega)} \tag{9}$$

The class of functions given by Eq. (9) is an optimum one.[15] It is optimum in the sense that, of all possible transfer functions all of whose zeros are at infinity, it has the lowest complexity for yielding a prescribed maximum deviation in the pass band and the fastest possible rate of cutoff outside the pass band. An equivalent way of stating the latter part of the requirement is that the transition range for reaching a prescribed attenuation is a minimum and that the attenuation in the stop band is never less than this prescribed attenuation.

The polynomials yielding the characteristic of Fig. 3 are unique: no other polynomials possessing these optimum properties exist. Knowledge of this upper bound on performance is extremely valuable; for example, it permits the determination of how close the characteristic of a given network is to the best that can be achieved, and it shows the futility of searching for other approximating polynomials that will give better performance (as judged by its magnitude characteristic) than the Tschebyscheff polynomials of the same degree.

The filter function given by the use of Tschebyscheff polynomials is exceedingly useful in applications where the magnitude of the transfer function is of primary concern. However, its nonlinear phase characteristic and the resulting variation of its time delay[16] preclude its use where a constant time delay is a paramount requirement. For such time-delay filters the tables based on the Bessel polynomials should be used.

Equal Ripple Property in Both Bands

The optimum requirements that are satisfied by the use of Tschebyscheff polynomials included the restriction that all the zeros of the transfer function lie at infinity, i.e., the reciprocal of the transfer function is required to be a polynomial. If the transfer function is permitted to be a general rational function, then the optimum functions to use for A_n in Eq. (1) are the Tschebyscheff rational functions $R_n(\omega)$.[15] These again are unique: no other transfer functions exist with their optimum properties. The transfer function takes the form

$$|Z_{21}|^2 = \frac{1}{1 + \epsilon^2 R_n^2(\omega)} \tag{10}$$

where $|Z_{21}|^2$ has equal ripples in both bands, as shown in Fig. 4. The frequency ω_a designates the start of the stop band, so that $\omega_a - 1$ gives directly the width of the transition region as a fraction of the width of the pass band.

Depending on whether it is even or odd, the Tschebyscheff function has one of the two forms,

$$R_n(\omega) = \frac{(\omega_1^2 - \omega^2)(\omega_3^2 - \omega^2)\cdots(\omega_{2n-1}^2 - \omega^2)}{(1 - \omega_1^2\omega^2)(1 - \omega_3^2\omega^2)\cdots(1 - \omega_{2n-1}^2\omega^2)} \tag{11}$$

and

$$R_n(\omega) = \frac{\omega(\omega_2^2 - \omega^2)(\omega_4^2 - \omega^2)\cdots(\omega_{2n}^2 - \omega^2)}{(1 - \omega_2^2\omega^2)(1 - \omega_4^2\omega^2)\cdots(1 - \omega_{2n}^2\omega^2)} \tag{12}$$

It is noted that the poles of R_n are the reciprocals of the zeros. The integer *n* determines the complexity of the function; specifically, it is equal to the number of ω^2 zeros (or poles, or a suitable combination of the two types of critical frequencies) that must be specified. To define the function completely, it is necessary to specify, in addition to *n* nonzero critical frequencies, whether R_n is even or odd. Because of the reciprocal relationship between the zeros and poles, it is clear that

$$R_n(1/\omega) = 1/R_n(\omega) \tag{13}$$

In other words, the function has the important property that its value at any ω_1 in the range $0 \geq \omega < 1$ is the reciprocal of its value at $1/\omega_1$ in the range $1 < \omega \leq \infty$. Therefore, if the critical frequencies can be found such that $R_n(\omega)$ has equal ripples in the pass band, it will automatically have equal ripples in the stop band.

In Fig. 4, as in the other figures, it has been convenient to use $\omega = 1$ as the actual cutoff frequency. However, if the normalization is used so that the zeros and poles of R_n are reciprocals, as is done in

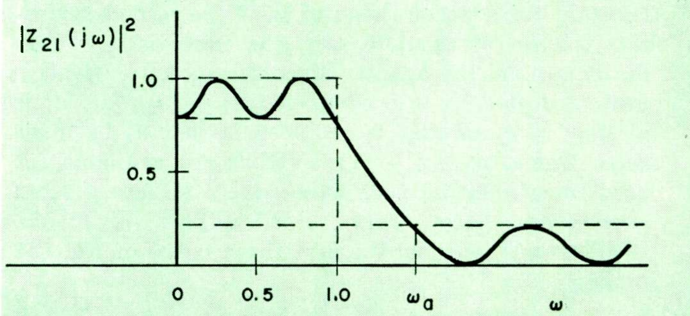

Fig. 4: Low-pass filter with equal ripples in both bands.

Eqs. (11) and (12), then the point $\omega = 1$ will be only the *nominal* cutoff frequency: it will be midway (on a logarithmic frequency scale) between the end of the pass band and the start of the stop band. This property should be borne in mind in using the tables of reference 6.

From the preceding discussion it is clear that there are four parameters in the specification of the optimum filter: the maximum attenuation in the pass band, the maximum gain in the stop band, the transition interval, and the complexity of the function as denoted by n. *Any* three of these may be given in a practical problem; minimizing the fourth is automatically accomplished by use of the appropriate Tschebyscheff rational function.

Ideal Low-Pass Time Delay

If the ideal low-pass characteristic of Fig. 1 is now relabeled as a time delay T_d as shown in Fig. 5, where $T_d = -d\beta/d\omega$ and β is the phase characteristic of the transfer function, then this plot characterizes another class of problems. Since the time delay is constant in the pass band, the phase β is linear; thus a linear phase characteristic is an alternative designation to the constant time delay. This constant time delay is ideal in the sense that, when coupled with the magnitude plot of Fig. 1, it will yield facsimile reproduction of an input signal whose frequencies are confined to the range $0 \leq \omega < 1$.

A monotonic approximation to the time delay of Fig. 5 is given by the use of *Bessel polynomials.* Just as the Butterworth function gives a maximally flat approximation to the magnitude characteristic so the Bessel polynomials give a maximally flat time delay. The first two orders of the approximation are shown in Fig. 6, where the normalized frequency $u = \omega/\omega_0$ and ω_o is the reciprocal of the desired zero-frequency delay t_0.

To explain the maximally flat time delay the concept of derivative adjustment may again be applied to a general type of rational function given by

$$T_d = \frac{c_0[1 + c_1u^2 + c_2u^4 + \cdots + c_mu^{2m}]}{1 + d_1u^2 + d_2u^4 + \cdots + d_nu^{2n}} \qquad (14)$$

where both the polynomials have been arranged in ascending order. If this rational function is expanded in a Maclaurin series, it becomes evident that the coefficients of the expansion are given in terms of *differences* of the corresponding coefficients of like

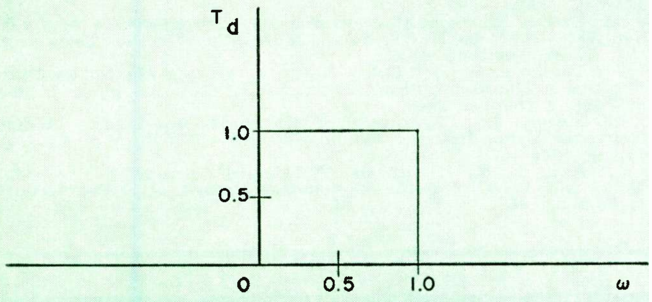

Fig. 5: Time-delay characteristic of a low-pass filter.

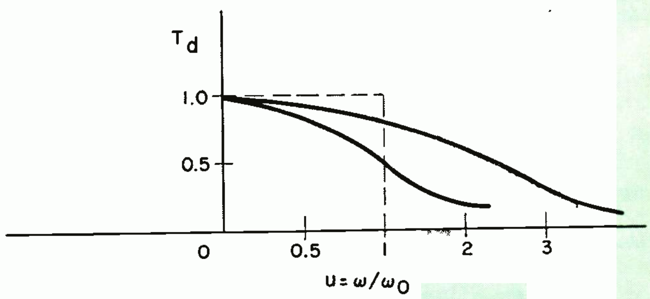

Fig. 6: Maximally flat time-delay, by Bessel polynomials.

powers of the numerator and denominator. For example, the first few terms are

$$T_d = c_0\Big(1 + (c_1 - d_1)\,u^2 + \Big[(c_2 - d_2) - d_1(c_1 - d_1)\Big]u^4 + \cdots\Big) \qquad (15)$$

If we now equate the $(n - 1)$ pairs of coefficients, i.e., adjust the parameters forming the coefficients so that $d_1 = c_1$, $d_2 = c_2$, . . . , then the expression yields a maximally flat characteristic; if $n > m$ and consequently c_{n-1}, c_{n-2}, . . . , c_{m+1} are zero, then the corresponding d's are adjusted to zero. It is therefore clear that the general maximally flat time delay will appear as

$$T_d = \frac{t_0\,[b_0 + b_1u^2 + b_2u^4 + \cdots + b_{n-1}u^{2n-2}]}{b_0 + b_1u^2 + b_2u^4 + \cdots + b_{n-1}u^{2n-2} + b_nu^{2n}} \qquad (16)$$

where t_0 is the zero-frequency delay. The equality of the corresponding coefficients of the numerator and denominator guarantes a Maclaurin series of the form.

$$T_d = t_0\left[1 - \frac{b_n}{b_0}u^{2n} + \frac{b_1b_n}{b_0^2}u^{2n+2} - \cdots\right] \qquad (17)$$

in which the first $(n - 1)$ derivatives with respect to u^2 are zero. Thus even for a general rational function (representing the time delay or the magnitude) the maximally flat property can be recognized by inspection.

However, the adjustment for maximally flat delay need not be laboriously carried out for each particular case, since it can be shown that the use of Bessel polynomials automatically provides this property.[17, 18] To illustrate this we consider the delay given by polynomials derived from the first two Bessel polynomials,

$$h_1 = s + 1$$
$$h_2 = s^2 + 3s + 3 \qquad (18)$$

when used in the transfer function

$$Z_{21} = \frac{H}{h_n(s)} \qquad (19)$$

where H is a constant multiplier. Using $s = ju = j\omega t_o$ we obtain the respective phase functions as

$$-\beta_1 = \tan^{-1} u$$
$$-\beta_2 = \tan^{-1}\frac{u}{3 - u^2} \qquad (20)$$

Therefore

$$T_{d_1} = \frac{-d\beta_1}{d\omega} = \frac{1}{1 + u^2}\,t_0$$
$$T_{d_2} = \frac{-d\beta_2}{d\omega} = \frac{9 + 3u^2}{9 + 3u^2 + u^4}\,t_0 \qquad (21)$$

both of which time delays are evidently maximally flat.

From the preceding discussion it may be observed that the $n + 1$ coefficients of the Bessel polynomials are automatically adjusted in the following way: $n - 1$ coefficients are used to obtain maximal flatness, one is used for the bandwidth ω_0, and the last is used for adjusting the gain of the transfer function.

It has been noted that the Butterworth function is not the most efficient polynomial approximation over a *band* of frequencies. Similarly, Bessel polynomials,

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though yielding a good approximation suitable for many applications, are not the most efficient time-delay approximation.[19] However, no class of polynomials has been found to yield this most efficient approximation. The approximation given by the Bessel polynomials is optimum in a sense similar to that of the Butterworth function: for a transfer function whose numerator is a constant and whose time-delay plot is monotonic in the pass band, the use of Bessel polynomials gives the flattest possible time-delay curve at the origin.

Available Tables of Element Values

How to use each set of tables is adequately presented in the references. What is attempted here is a brief summary of which sets are available in the references. All the tables except those in reference 4 yield a ladder network. References 1, 2, 3, and 5 ar concerned with the Butterworth, Tschebyscheff-polynomial, and Bessel-polynomial characteristics. The tables of the first two references are based on the choice of the zeros of the reflection coefficient to lie in one half-plane. Those in reference 3 have zeros of the reflection coefficient alternating in the left and right half-plane. A full discussion of the problem of choosing the zeros of the reflection coefficient is given in reference 7. The tables in reference 5 give ladder networks with uniform dissipation, while those in reference 4, as the title indicates, yield constant-resistance all-pass lattices with a maximally flat time delay.

The tables in reference 6 give the element values of networks with the equal-ripple property in both the pass and stop bands. They are given in terms of a specified pass-band ripple (0.1 db, 0.5 db, and 1.0 db) and a specified minimum attenuation in the stop band. The degree of R_n runs from $n = 3$ through $n = 5$. For applying these tables the reader may find that the discussion of the equal-ripple characteristic in reference 15 is quite helpful.

References

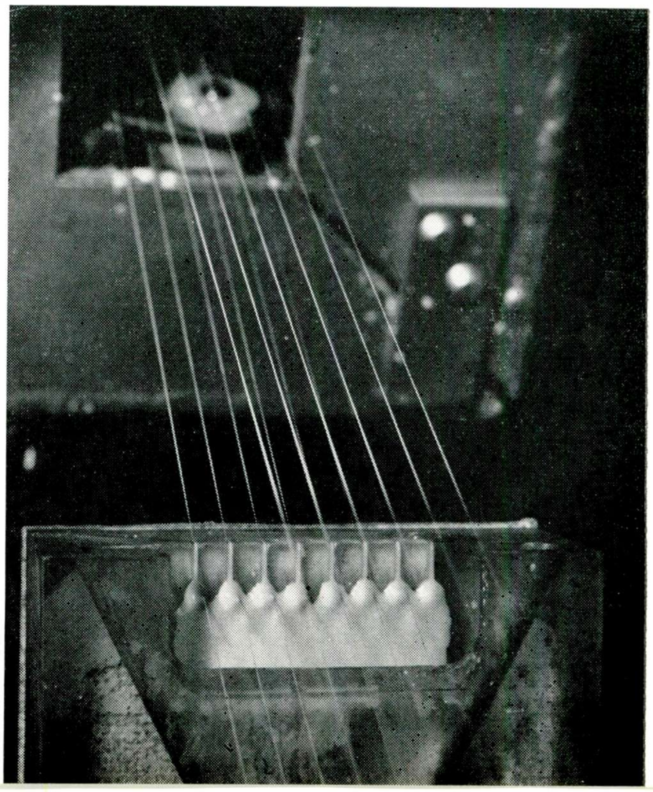
1. Weinberg, L., "Network Design by Use of Modern Synthesis Techniques and Tables," *Tech. Memorandum No. 427, Hughes Research Labs.;* also published in Proc. N.E.C., Vol. 12, 1956.
2. Weinberg, L., "Additional Tables for Design of Optimum Ladder Networks," *Tech. Memorandum No. 434, Hughes Research Labs.;* also published in *J. Franklin Inst.*, July (Part I), p. 7, August (Part II), p. 127, 1957.
3. Weinberg, L., "Tables of Networks Whose Reflection Coefficients Possess Alternating Zeroes," *Technical Memorandum No. 469*, Hughes Research Laboratories; to be published in *IRE Trans. PGCT, Dec. 1957.*
4. Weinberg, L., "Constant-Resistance All-Pass Networks with Maximally Flat Time Delay," *Tech. Memorandum No. 473, Hughes Research Labs.;* a condensed version of part of this paper published in *Electronic Design, Sept. 1957.*
5. Weinberg, L., "Exact Ladder Network Design Using Low-Q Coils," *Tech. Memorandum No. 482, Hughes Research Labs.*
6. Bedrosian, S. D., E. L. Luke, and H. N. Putschi, "On the Tabulation of Insertion Loss Low Pass Chain Matrix Coefficients and Network Element Values," *Proc. N.E.C.*, Vol. 11, 1955.
7. Weinberg, L., "Explicit Formulas for Tschebyscheff and Butterworth Ladder Networks," *Tech. Memorandum No. 459, Hughes Research Labs.;* a condensed version (omitting the appendixes) published in *J. Appl. Phys., Oct. 1957;* also published in IRE National Convention Record, Vol. 5, Part 2, 1957.
8. Weinberg, L., "Contribution of Synthesis to Reliability: Optimum Ladder Networks," *Tech. Memorandum No. 460, Hughes Research Labs.;* also published in the *Proc. Third National Symposium on Reliability and Quality Control in Electronics,* Washington, D. C., January 1957.
9. Valley, G. E. and H. Wallman, *"Vacuum Tube Amplifiers,"* Rad. Lab. Ser., Vol. 18, pp. 721-727, McGraw-Hill Book Company, New York 1948.
10. Butterworth, S., "On the Theory of Filter Amplifiers," *Wireless Engr.*, pp. 536-541, October 1930.
11. Landon, V. D., "Cascade Amplifiers with Maximal Flatness," *R.C.A. Rev.*, pp. 347-362, 1941.
12. Lynch, W. A., "The Role Played by Derivative Adjustment in Broadband Amplifier Design," *Proc. Symp. Modern Network Synthesis,* Vol. 1, pp. 193-201, 1952.
13. Clement, P. R., "The Chebyshev Approximation Method," *Quart. Appl. Math.*, Vol. 11, pp. 167-183, 1953.
14. Darlington, S., "Synthesis of Reactance 4-Poles which Produce Prescribed Insertion Loss Characteristics," *J. Math. Phys.*, pp. 257-353, 1939.
15. Papoulis, A., "On the Approximation Problem in Filter Design," *IRE National Convention Record,* Vol. 5, Part 2, pp. 175-185, 1957.
16. Green, E., *"Amplitude-Frequency Characteristics of Ladder Networks,"* pp. 15-16, 25-26, Marconi's Wireless Telegraph Co., Essex, England, 1954.
17. Thomson, W. E., "Delay Networks Having Maximally Flat Frequency Characteristics," *Proc. I.E.E.*, Vol. 96, Part 3, pp. 487-490, November 1949.
18. Storch, L., "Synthesis of Constant-Time-Delay Ladder Networks Using Bessel Polynomials," *Proc. I.R.E.*, Vol. 42, No. 11, pp. 1666-1675, November 1954.
19. Kuh, E. S., "Synthesis of Lumped Parameter Precision Delay Line," *IRE National Convention Record,* pp. 160-174, Vol. 5, Part 2, 1957.

Reliability Invades Commercial Tubes

A TOP supplier of high reliability receiving tubes for defense and other critical uses, has made the first moves in a full-scale effort to raise standards of commercial tube reliability.

General Electric's Receiving Tube Dept., Owensboro, Ky., has revealed details of nine "extra values" to be built into a "Service Designed" line of 70 types of receiving tubes used in TV sets. The improvements will extend to TV some of the high reliability fea-

(*Continued on page* 134)



This method of applying ceramic coating to heater wire keeps wire away from machinery until after coating is baked — thus producing near-perfect concentricity of coating. Note increasing thickness of coated wire as it passes freely through slots filled with coating "slurry" and then directly into oven.

Page from an Engineer's Notebook

#45 -Temperature Compensation

By STANFORD J. AXEL
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A TEMPERATURE compensated resistance is frequently needed for use in a precision bridge. On the other hand, there is often need for a resistance of a certain value which will change its resistance so as to compensate for another temperature sensitive device such as a transistor.

The two curves given here may be utilized directly for approximate compensation. However, it is recommended that a similar set of curves be obtained for the types of resistors which will be used, and over the temperature range of intended use.

The method used to obtain the curves involved simple equipment: a strain gage indicator, a selection of resistors, and a heat source. The gage factor is set at 2.00 (for convenience). Then various combinations of resistors are heated over the temperature range in question. In the case of the included graphs room-temperature compensation was desired. The applied temperature change was 20°F—from ambient to body temperature. The relation governing the reading of the strain gage indicator is

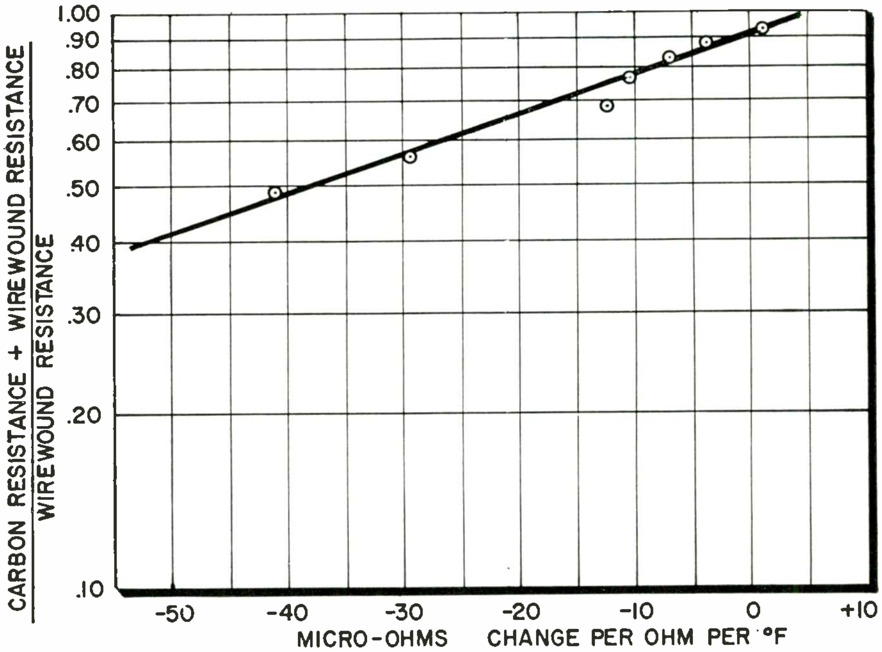
$$\text{Strain} = \epsilon = \frac{\Delta R}{R} \Big/ \text{Gage Factor}$$

From this we get

$$\frac{\Delta R}{R} \Big/ {}^\circ F = \frac{\epsilon\ (\text{Gage Factor})}{{}^\circ F}$$

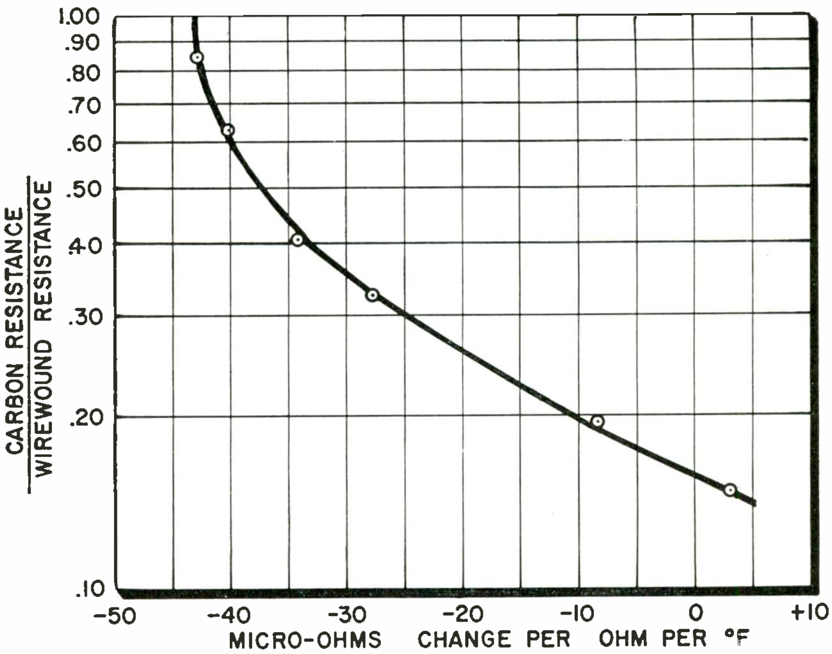
In the case of the 20°F change the equation reduces to

$$\frac{\Delta R}{R} \Big/ {}^\circ F = \frac{\epsilon}{10}$$



Above: Parallel Temperature Compensation.

Below: Series Temperature Compensation.



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Corona Discharge—

The Failing of Dielectrics

Ion and electron bombardment have been considered as independently accountable for failure of insulating materials during sustained corona discharge. Experimental evidence indicates that the latter is primarily responsible.

By CLELLAND D. NAIL
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Univ. of Calif. Radiation Laboratory
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THE mechanism, or combination of mechanisms, that accounts for the failure of insulating material subjected to sustained corona discharge is treated in several papers, particularly by workers in the United Kingdom. Chemical destruction from ozone, decomposition from localized heating, and ion or electron bombardment are frequently mentioned. The latter two types of attack, i.e., ion and electron bombardment, have been studied by Mason[1] and Dakin, Philofsky, and Divens.[2] Mason attributes damage primarily to ion bombardment, while Dakin, Philofsky, and Divens conclude that electrons are responsible.

Problems and General Theory

The occurrence of corona discharges has been studied by Austen and Whitehead[3] by the application of an alternating stress to an insulating film between two metal electrodes. Such a test specimen is basically a capacitor and may be shown as such in an equivalent diagram. However, at the inception of a corona discharge, only a small portion of the charge on the capacitor is destroyed. Therefore the equivalent circuit of Fig. 1 has been proposed and generally accepted in the art.

In Fig. 1, C_0 represents the "good" capacitance of the system; C_1 represents the capacitance of the "good" portion of a path containing a region in which corona avalanche occurs; and C_v represents the "bad" capacitance discharged by an avalanche, usually at a void or discontinuity where a field stress concentration is present.

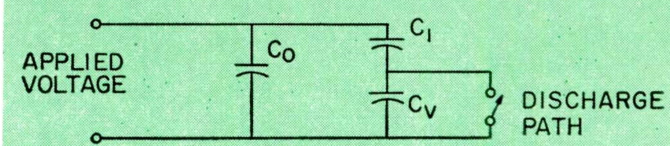


Fig. 1: Equivalent ckt of a specimen undergoing corona discharge.

Two electrodes separated by a sheet of dielectric material such as polyethylene, which does not make uniform contact with the electrode surfaces, can be compared to two capacitors in series. In regions where contact is made and no air voids are present, the system is like a single capacitance. The combination of these configurations is identical to the equivalent diagram of Fig. 1.

Moreover, since the dielectric constant of solid dielectric material is greater than that of air, the capacitance per unit distance along the space will be larger in the dielectric than in the voids. When a voltage is applied to the electrodes, a gradient is developed which is much greater in the air spaces than in the solid dielectric. It is therefore natural to expect the inception of corona to take place in the air voids. When the discharge has occurred, the gradient on the air capacitance (C_v) is removed and must again build up through further increase in the applied voltage.

Discharges of this nature are observed during the rise of applied stress and again during the decrease and reversal of an alternating voltage wave.[1] A good mathematical discussion of this mechanism is presented by Austen and Whitehead.[3]

These discharges occur through the ionization of the air within the void. The discharge current is carried by the products of ionization, so that, depending on the polarity of the field, the electrons and ions are accelerated in opposite directions toward and away from the electrode. This observation suggests that, if the field can be made predominantly unidirectional, the evaluation of the relative effect of electron and ion bombardment can be made. Experiments indicate that a field that accelerates electrons toward the solid dielectric material and ions toward the electrode results in damage to the dielectric at a rate which is many times greater than that produced by a field of opposite polarity.

The duration of the observed avalanches has been measured by the use of fast oscillographic techniques. Pulses are observed which are roughly triangular in wave form with rise and decay times of about 16 mμsec. Pulses shown in the literature appear to be many times longer and more random in height and are ascribed to be the result of integration of large numbers of separate avalanches.

The duration of the pulses furnishes the basis of the further argument presented here in support of the electron bombardment supposition. A simple exercise in kinematics shows that a mixture of large masses (such as the ions of air molecules) and small masses (such as electrons) will be acted upon by forces (in this case an electric field) as follows: the electrons being light attain high velocities soon after the application of force and so initially acquire most of the energy of motion, while the more ponderous ions are still moving slowly. This energy distribution does not continue because of repeated collisions between the particles, and in the thermalization process energy is soon shared with the heavier ions.

It can be shown that in times comparable with 59 mμsec, which is the upper limit of time taken by the discharges, virtually all the kinetic energy still remains with the electrons and little energy can be ascribed to ionic carriers. This simplified picture of the discharge mechanism is well supported by independent investigations at the University of California Radiation Laboratory in the field of arc-discharge phenomena. (The derivation of energy distribution is presented in more detail in the Appendix.)

Since the energy is predominantly carried by the moving electrons, support is given the contention that damage is due to the effect of these energetic particles as they bombard the surface of the dielectric.

Test Description

To produce the conditions required by the foregoing discussion, a combination of a nonuniform field gradient and an unsymmetrical voltage wave form was used. Throughout the tests a pulsating dc voltage, derived from the plate-to-cathode potential of a half-wave, high-voltage power supply, was applied to test specimens in nonsymmetrical geometries. The dielectric used in all tests was sheet polyethylene with a thickness of 0.002 in. The time to failure of the test specimen was observed at a peak applied potential of 10 kv. The failure times were all relatively short and preclude appreciable destruction from chemical attack.

The tests were performed using the following electrode geometries. Test A: One 2-in. diam. electrode with smooth edges and one 3/16-in. electrode with angular edges, separated by one layer (0.002 in.) of dielectric. Test B: Two 2-in. diam. smooth, identical electrodes with two layers of dielectric, one containing a ¼-in. hole (void).

The tests were conducted with both positive- and negative-going voltage waves on the specimens and the failure times were recorded on an electrical interval timer. The equivalent circuit of the test specimens is shown in Fig. 1. The test circuit is shown in Fig. 2.

A pictorial summary of the results appears in Fig. 3. The circuit for study of the avalanche pulses is shown in Fig. 4.

Test Results

Test A

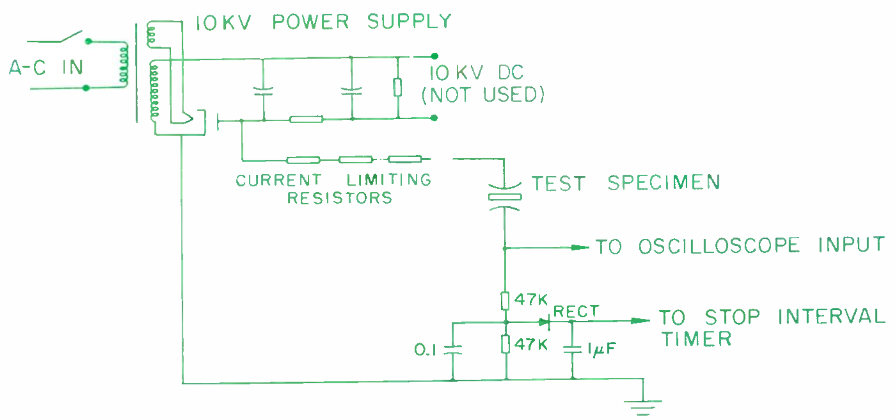
The first experiment using a large smooth electrode and a small angular electrode can be expected to produce a strong field concentration in the vicinity of the corners of the small eletcrode. When the latter electrode was connected to the negative side of the pulsating dc voltage source, dielectric failure was nearly thirty times more rapid than when reverse polarity was applied.

The point of failure with negative voltage was invariably located in the region of stress concentration at the edge of the small electrode. For the application of positive peaks the failure was observed at random locations within the area of the small electrode, and could not be correlated to the areas of high stress.

Test B

The second test was conducted to simulate conditions of a void in the dielectric adjacent to one of the electrodes. A similar experi-

Fig. 2: This is the test circuit for determining the mechanism of corona discharge.



Corona Discharge *(Concluded)*

ment, with alternating voltage, was conducted by Mason.[1]

The second test also showed rapid failure when the electrode near the void is made negative and the failure was most frequently at the edge of the void.

When positive voltage was applied, the failure time was much longer and no correlation in position of the failure to location within the void was apparent.

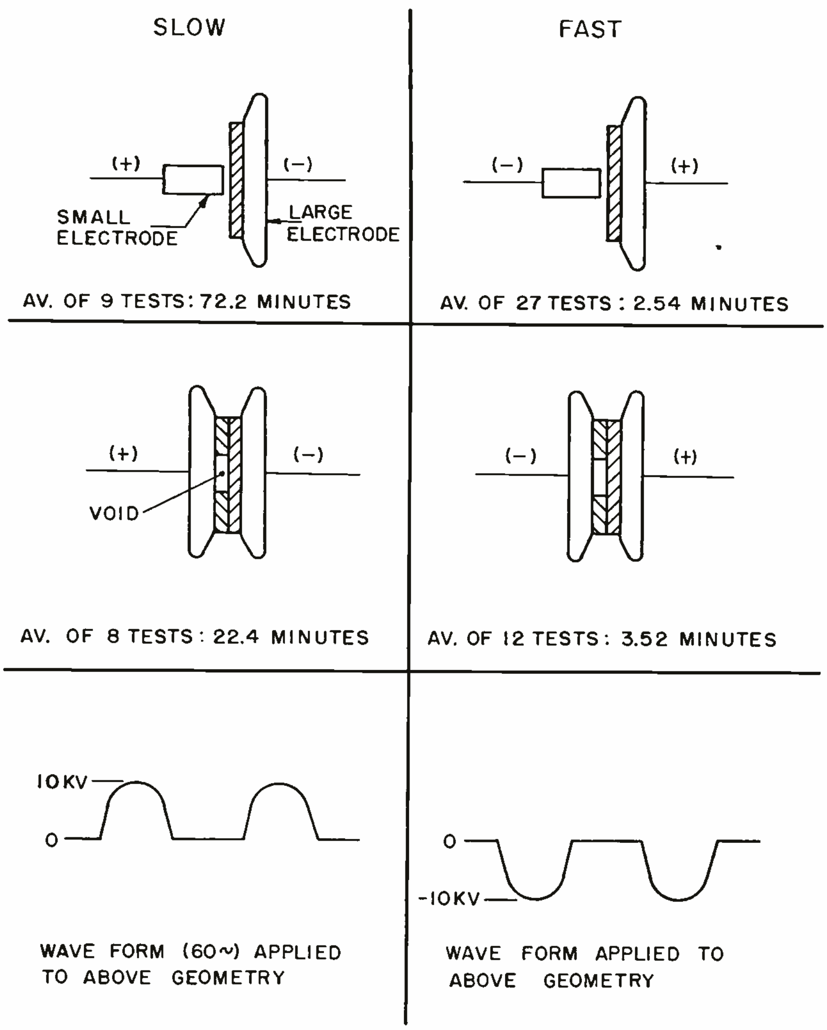
Both of these tests seem to indicate that electrons from ionization of molecules of air in regions of high electric field gradient are accelerated toward the dielectric material and do damage by impact or secondary ionization of the material. The damage by ionic bombardment is regarded as small and in fact may have a protective effect in certain cases. It is necessary to suppose that electrons which bombard the dielectric are left on the surface as an electric charge that raises the surface to some high potential. Thus when the applied voltage has reached the peak value and begins to diminish, a reversal is present in the gradient across the corona discharge path.

This is confirmed by the observation, during the declining portion of the voltage wave, of current pulses that are of reverse polarity.

During the declining portion of a positive wave, the gradient is in the proper direction to accelerate electrons toward the dielectric and create rapid failure. This is not observed and it is surmised that the ions which have been driven toward the dielectric during the rising voltage wave are responsible to some extent for neutralizing the electrons before they can affect the surface.

When observing the current pulses the circuit shown in Fig. 2 was revised so as to use a 90 Ω terminating resistor and coaxial cable to the input of a fast oscilloscope. See Fig. 4. The circuit of Fig. 2 was used originally and results similar to those disclosed in the references were obtained.

Fig. 3: Summary of results showing the correlation between geometry and failure time.



Acknowledgments

The author wishes to express his appreciation to Edward G. Hartwig and Hubert W. Vanness for suggestions and assistance in developing the techniques and in evaluating the results.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

Appendix

We will attempt to show that the energy of an ionization discharge is initially carried almost entirely by the electron until thermalization can occur. Further it will be shown that the observed time of discharge of corona bursts is short compared to the time necessary for such thermalization. Hence it is necessary to assume that the positive ions in the discharge never acquire appreciable energy and consequently can never be responsible for bombardment damage of insulation.

If we assume air as the medium at room conditions, we have a molecular density of about 3×10^{19} per cc and the molecules or ions have a mass M_i of about 5×10^4 that of an electron M_e.

By the simple application of kinematics we can say that, at least in a very short time, t, in which negligible collisions can occur, the ionized particles, both electrons and positive ions, are acted upon in the field by an equal (but opposite) force which produces an acceleration of each that is inversely related to their masses, or acceleration of each that is inversely related to their masses, or

$$\frac{a_e}{a_i} = \frac{M_i}{M_e}.$$

At the end of a short time, t, each will have velocities V_e and V_i such that

$$\frac{V_e}{V_i} = \frac{M_i}{M_e}. \qquad (V = a \cdot t)$$

The energy of the electron is 1/2 M_e V^2, which can be expressed in terms of the ion mass and velocity as

$$E_e = \tfrac{1}{2} M_i \frac{M_e}{M_i} \left(V_i \frac{M_i}{M_e}\right)^2$$

$$= \tfrac{1}{2} M_i V_i^2 \frac{M_i}{M_e}$$

$$= E_i \frac{M_i}{M_e}$$

or $E_e/E_i = M_i/M_e$, so the electron now has about 5 × 10^4 the energy of the ion.

Thermalization, a process where particles with high energy share their energy by collision with slower ones, must take place between the electrons and neutral molecules or ions if sufficient time is allowed.

By considering the conditions necessary for elastic impact, i.e., conservation of momentum and energy, and by making an assumption that the molecules are moving at neglible velocities as compared with the electrons, we can arrive at the average energy loss in one collision. If an electron with an initial velocity V_o encounters a molecule, the two will separate with velocities such that

$$\tfrac{1}{2} M_e V_o^2 = \tfrac{1}{2} M_e V_e^2 + \tfrac{1}{2} M_i V_i^2, \quad \text{(Conservation of energy)}$$

where M_e and M_i are masses of the electron and the molecule, V_e and V_i are the velocities of the electron and the molecule after impact.

Also $M_e V_o = M_e V_e + M_i V_i$. (Conservation of momentum)

Solving simultaneously one finds that for

$$\frac{M_e}{M_i} << 1,$$

$$\frac{V_e}{V_o} \cong 1 - \frac{M_e}{M_i} \text{ or } V_e \cong \left(1 - \frac{M_e}{M_i}\right) V_o.$$

Thus the initial energy E_o of the electron has become

$$E_e = \tfrac{1}{2} M_e V_e^2$$

$$= \tfrac{1}{2} M_e V_o^2 \left(1 - \frac{M_e}{M_i}\right)^2$$

$$= E_o \left(1 - \frac{M_e}{M_i}\right)^2 = E_o \left(1 - 2\frac{M_e}{M_i} + \frac{M_e^2}{M_i^2}\right),$$

$$\frac{M_e^2}{M_i^2} \text{ is negligible}$$

or, approximately,

$$E_e \cong E_o \left(1 - 2\frac{M_e}{M_i}\right).$$

Therefore, we can say that the energy which an electron gives up in an elastic encounter is approximately 2 $(M_e/M_i)E_o$ or 4 × 10^{-5} its original energy.

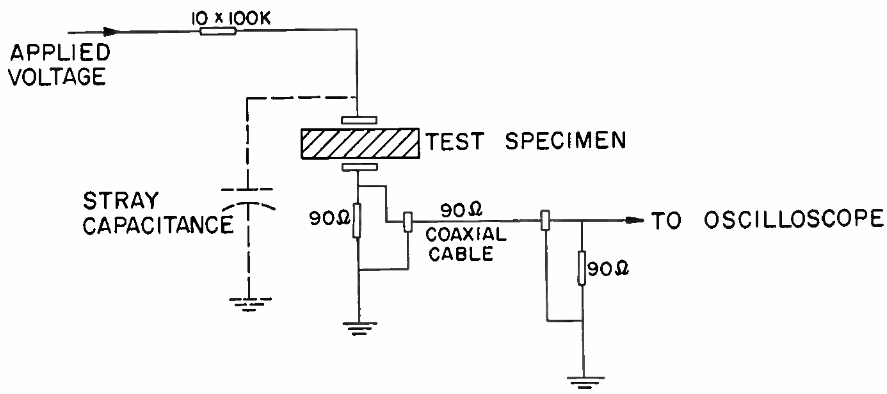
We have not taken into consideration the original energy of the ions or neutral molecules nor have inelastic collisions been considered. Values of energy fraction lost on encounters are given by Massey and Burhop[4] for electrons up to 6 ev with air. These values are much greater than the computed values and are of the order of 10^{-3} at 6 ev, but data at 10 ev and higher are not available. For these reasons the computed value is applied to further discussion.

In order for ionization to occur, electrons must have energies of the order of 10 ev, at which their velocities are about 2 × 10^8 cm/sec.

The mean free path for densities of 3 × 10^{19} is given by $1/N\sigma$, where σ is the cross section for collision ≅ 10^{-16} cm² (Ref. 4, p. 265).

The time between collisions will be given by

Fig. 4: Modifying Fig. 2 facilitates study of fast avalanche pulses during discharge.



$$t = \frac{\lambda}{V} = \frac{3 \times 10^{-4}}{2 \times 10^8} = 1.5 \times 10^{-12} \text{ second per electron.}$$

We know that ionization is not complete and 1% is reasonable to assume. In a time of 5 × 10^{-8} sec. which was observed to be the time for a corona discharge, each electron on the average will make (5 × 10^{-8})/(1.5 × 10^{-12}) = 3 × 10^4 collisions.

Since we assume 1% ionization each electron has 100 molecules with which to thermalize in 3 × 10^4 collisions or 3 × 10^2 per molecule.

We have already shown that the average energy transferred in each collision is 4 × 10^{-5} E_o, so at most the energy lost by the electrons is 4 × 10^{-5} × 3 × 10^2 = 0.012 E_o or about 1.2%. Therefore, we feel assured that the energy during the discharge of a corona burst is very nearly all carried by the electron motion, which further substantiates the experimental results.

References

1. J. H. Mason, "The Deterioration and Breakdown of Dielectrics Resulting from Internal Discharges," *Proc. Inst. Elec. Eng.* (London), v. 98, Pt. I, pp. 44-59, Jan. 1951.
2. T. W. Dakin, H. M. Philofsky, and W. G. Divens, "Effect of Electric Discharges on Breakdown of Solid Insulation," *Trans. Am. Inst. Elec. Engrs.*, v. 73, Pt. I (Communication and Electronics), p. 155, May 1954.
3. A. E. W. Austen and S. Whitehead, "Discharges in Insulation under Alternating-Current Stresses," *J. Inst. Elec. Engrs.* (London), v. 88, Pt. III (Communication Eng.), pp. 18-22, March 1941.
4. H. S. W. Massey and E. H. S. Burhop, *Electronic and Ionic Impact Phenomena,* Oxford (Clarendon Press), 1952, p. 279.

New Dynamic Method . . . Testing

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The new, wide-angle cathode-ray tubes have made static methods of testing horizontal deflection tubes inadequate. The unique method of dynamic testing described here makes use of a peak-reading voltmeter. The voltmeter method allows non-technical personnel to make these tests.

THE horizontal deflection amplifier tube performs a very critical function in a TV receiver. It must produce the horizontal scan and the picture tube second anode voltage. Any deterioration of that tube can be seen immediately in the raster on the picture tube.

With the recent changes in TV receiver design, it has become necessary to take a new look at testing methods of horizontal deflection type tubes. The wider deflection-angle picture tubes, "off-the-line" B+ power supplies, elimination of horizontal-drive controls, and other economy design changes, all impose more rigid requirements on the horizontal amplifier tube.

Inadequate Method

For almost two years, Sylvania's Radio Tube Division has conducted an extensive investigation into the merits of peak current testing, using various types of grid-drive testing methods. For years the static testing method had proved acceptable for testing tubes for the lower angle deflection systems, and there was much to be said for its simplicity. However, the 90° cathode ray tubes and more recently the 110° picture tubes, have imposed new and different requirements upon the horizontal deflection tubes, some of which are as follows:

1—peak plate current controls
2—peak plate current to screen current ratio controls
3—"snivets" or knee control.

The higher accelerating potential and wider deflection angle of the currently popular picture tubes require that the horizontal amplifier tube be capable of considerably higher peak plate currents to achieve full scan at high brightness levels.

Another new factor which must be considered is peak plate current to screen current ratio. A tube with normal peak plate current but high peak screen current level will produce a lower screen voltage in circuits with relatively large screen resistors with a resultant shortened scan and lower accelerating potential on the picture tube. Thus production controls over peak plate current to screen current ratio become important.

"Snivets" is a phenomenon that can better be shown than described (Fig. 1). It is the dark vertical line approximately one-fourth the distance from the right-hand side of the screen. We will discuss the cause of this problem later.

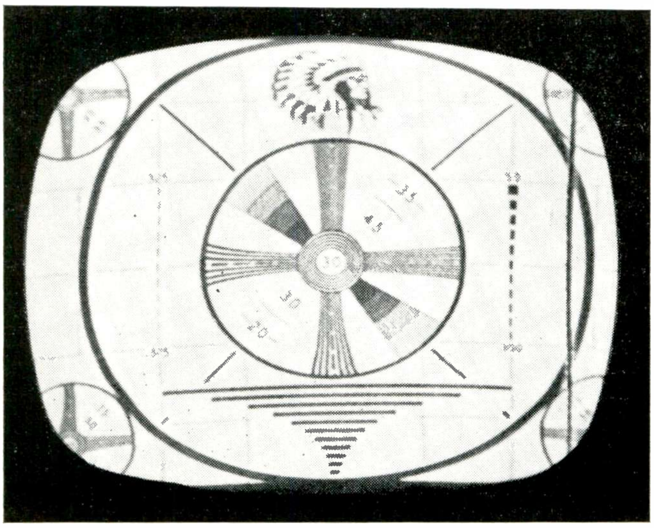
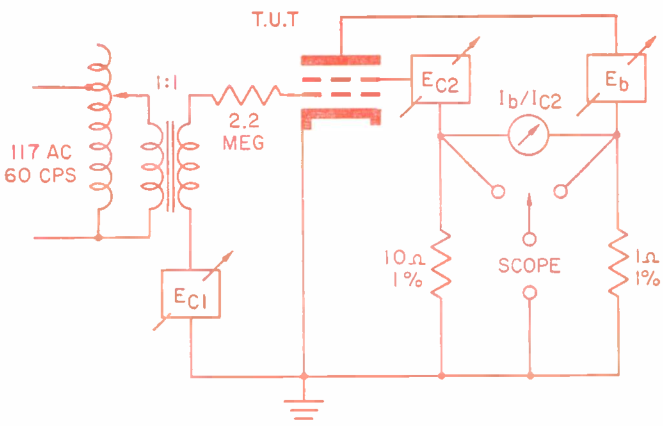


Fig. 1 (left): Test pattern shows a "snivet" on the right

Fig. 2 (below): Schematic diagram for a 60 cycle test set



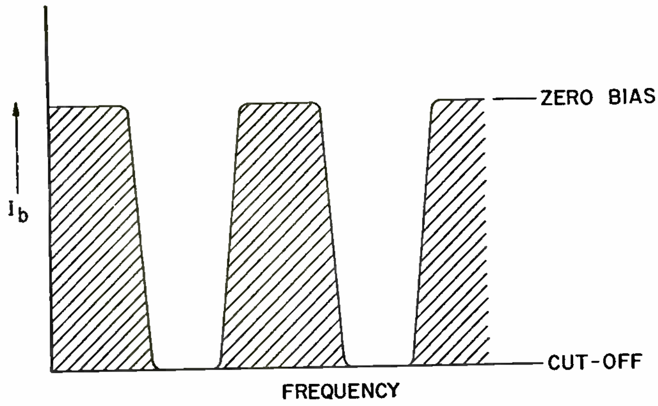


Fig. 3: 60 cycle I_b waveform is shown graphically

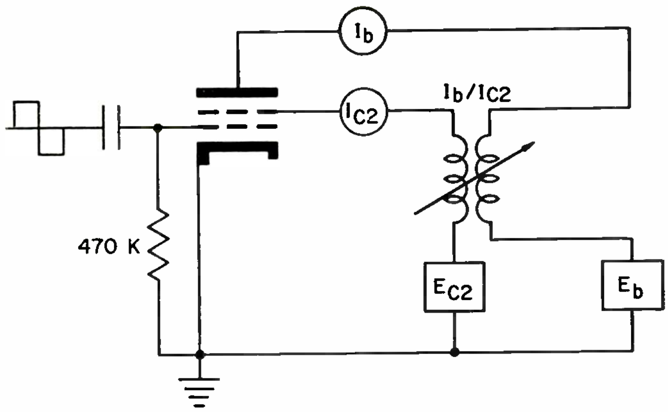


Fig. 4: Schematic shows a square wave test setup

Horizontal Deflection Tubes

A 60 CPS Drive Test Method

Dynamic testing of horizontal deflection tubes (Fig. 2) was tried first using a 60 CPS sine-wave grid-drive voltage. By proper selection of the sine-wave voltage in series with a 2 megohm, unbypassed resistor and a fixed bias, the tubes can be measured for peak plate and screen currents and the rated screen dissipation of the tubes is not exceeded. This method is relatively simple, requiring only the addition of a variable autotransformer to obtain the desired drive from the 60 CPS line voltage and sampling resistors in the plate and screen circuits. The combination of drive voltage and fixed bias are such that the grid is driven from zero-bias to beyond cut-off. The resulting peak plate and screen currents are measured as a voltage across the sampling resistors, and calibrated in terms of peak current. Excellent correlation has been obtained between the 60-CPS drive test and the static zero-bias tests.

The 60-CPS test set was quite easily constructed in the laboratory, requiring only a variable auto-transformer, plate and screen voltage power supplies, plate and screen current sampling resistors and an oscilloscope for measuring the currents.

The drive requirements were easily satisfied. The variable autotransformer demanded no large current capabilities and was small in physical size. The voltage requirements were from 30 to 75 volts RMS. A combination of the 60 CPS sine-wave voltage and a variable direct current bias were selected such that the grid of the tube to be tested would alternately be cut off and driven to zero-bias, and at the same time operating the tube at its rated screen grid dissipation. By alternately driving the grid to zero-bias and cut-off, a direct current oscilloscope was not necessary. and, if desired, a peak-to-peak reading voltmeter could be substituted for the oscilloscope.

The sampling resistors selected were 1 ohm, 1%, in series with the plate circuit, and 10 ohms, 1%, in series with the screen circuit. Since the plate-to-screen-current ratio of most horizontal deflection tubes is between 6 to 1 and 15 to 1, the current can be measured on one instrument without changing ranges.

60 CPS Method Considerations

However, there were several obstacles in 60 CPS testing which did not have to be considered with the static testing method.

Power supplies were the greatest concern. Several horizontal deflection tube types have peak plate current levels in the neighborhood of 500 ma. peak and greater. The level of current imposes greater than average requirements on the power supply output. The plate voltage supply must be capable of providing an average current of several hundred milliamperes plus a peak current of at least twice that value without any reduction or flattening of the current peaks.

A second concern required the sampling resistors to be located in the negative side of the power supplies in order to prevent the case of the instrument used for measuring the current from having the high direct current voltage obtained by placing the sampling resistors in the positive side. Therefore, it is not desirable that the negative terminal of the power supply be at ground potential. (Fig. 3).

The method of reading the currents is as great a concern as the power supplies. Direct current meters cannot be used because the average current is not directly proportional to the peak currents, but is affected by the plate and screen current cut-off characteristics of individual tubes. These vary considerably due to the shape of the clipped sine-wave of the drive voltage.

An oscilloscope works very well for use as a laboratory measuring instrument. Experience has shown, however, that an oscilloscope is not a satisfactory instrument for accurate production testing. The calibration of most inexpensive oscilloscopes must be rechecked frequently, and the reading of an oscilloscope by a production testing operator leaves much to be desired in accuracy.

The commercial peak-reading voltmeters available were the best compromise. The first problem encountered in such meters was to obtain a type stable at the low voltage (in the neighborhood of 0.5 volt peak) appearing across the sampling resistors. The second difficulty was the duty-cycle response of commercial peak-reading voltmeters. Those meters available with low voltage ranges had a duty-cycle response of 10 to 250 microseconds. The duty cycle of the clipped 60 CPS sine-wave is 4000 to 7000 microseconds. These difficulties were overcome by using an accurately calibrated 60 CPS direct current chopper to calibrate an oscilloscope, the oscilloscope in turn being used to calibrate the peak-reading voltmeter. Since the duty cycle is not the same for each tube type manufactured, determined by the plate current cut-off characteristic, the voltmeter must be recalibrated for each tube type. However, a test set operator is familiar with reading meters and the peak-reading voltmeters proved more satisfactory in production testing than did an oscilloscope.

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Although the 60 CPS drive test for peak currents proved quite satisfactory in selecting tubes, it left much to be desired in simplicity and ease of production testing. An oscilloscope is a bulky instrument on a high-speed production line and operators are not familiar with its use. Suitable commercial peak-reading voltmeters are not available. Sampling resistors are required and their accuracy of 1% must be maintained. Because of the relatively low voltage developed, radiated noise from factory equipment, particularly bombarder radiation, interferes with accurate measurements.

Square-Wave Drive

With these problems in mind, it was desirable to investigate a method of measuring peak currents utilizing direct current or average-reading current meters not dependent upon voltages developed across precision sampling resistors. (Fig. 4). The most promising method was a square-wave drive test. The direct current level of a square-wave voltage having identical positive and negative duty cycles will be one-half the peak value of current. This method immediately eliminates precision sampling resistor requirements and their inherent noise pick-up problem. Standard direct current meters with which the average production operator is familiar may be incorporated. Continuous calibration checks are not required as was the case with peak-reading meters.

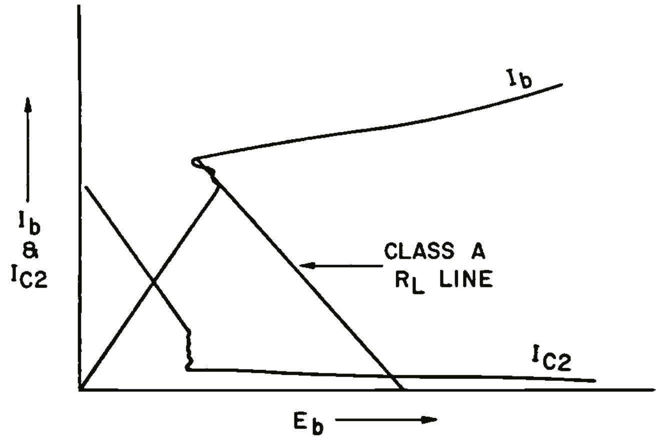


Fig. 5: Tube plate characteristics that cause snivets

The requirements of the factory test equipment are not as great as with 60 CPS testing. Production facilities which were used for measuring static plate and screen currents can be utilized with the addition only of a simple two-tube square-wave generator. The square-wave generator utilizes a Type 6SN7GTA multivibrator at a frequency of approximately 6 to 7 KC, followed by a Type 6AV5GA clipper amplifier. Output voltage of up to 150 volts peak-to-peak can be obtained. A Type 6AL5 tube was utilized as a duty-cycle detector in such a way that a zero center reading microammeter will read zero when the positive and negative duty cycles of the output voltage are equal. Equal positive and negative duty cycles are maintained by means of a potentiometer in the multivibrator circuit.

Sufficient square-wave drive voltage is applied to the control grid of the horizontal amplifier tube under test to alternately drive the grid from zero-bias to beyond cut-off. The grid acts as a switch, permitting zero-bias plate current to flow for one-half the time. In this manner, direct current meters can be utilized in the plate and screen circuits.

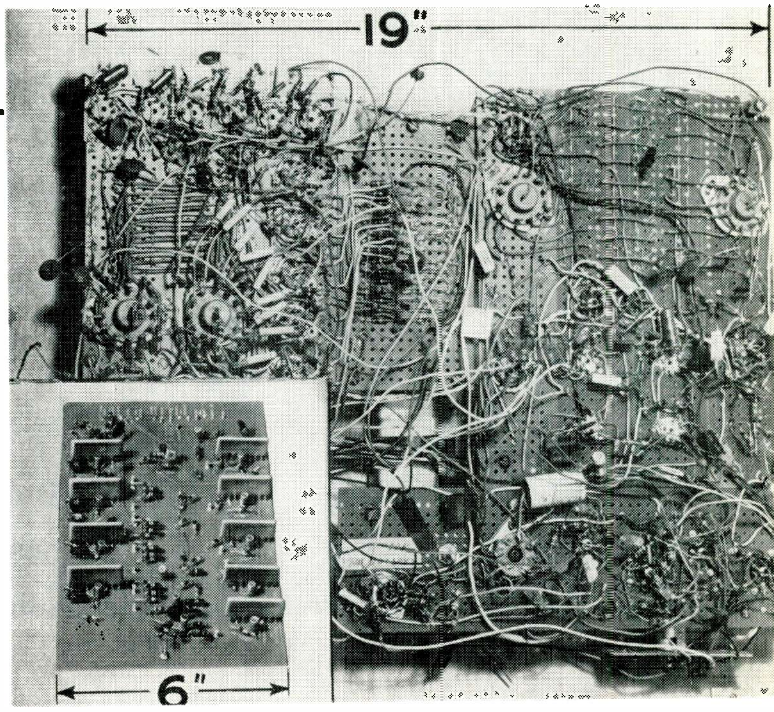
Plate-current to screen-current ratio is measured by a differential current meter. This type of meter has dual coils and a zero-center reading scale. One coil is in series with the screen circuit, the other in series with the plate circuit. Shunts are selected such that the meter reads zero when the plate-to-screen-current ratio is 10 to 1. Suitable limits other than 10 to 1 can be selected if desired.

Plate characteristic knee can also be controlled in the square-wave test method in the same manner used in the 60 CPS test. The plate voltage is varied between two voltages 10 volts apart, the lower voltage

(Continued on page 126)

What's New . . .

Packaged Circuits



The nine packaged circuits contain 81 of the components on the large board; solder connections reduced from 162 to 72. Two of the small boards replace the large board.

THE Alphatype machine, a product of the Filmotype Corp. Skokie, Ill., is a dramatic example of the effective use of packaged electronic circuits in the miniaturization of computer equipment. The Alphatype is an electronic typesetting device that utilizes binary system circuits to automatically determine the proper spacing of letters and lines of words. It performs a number of functions that must be done manually on conventional typesetting machines.

The equipment was originally developed with vacuum tubes and individual components. Prior to actual production it was miniaturized through the use of transistors and packaged circuits (PEC) by Centralab, a Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. An unusual aspect of the miniaturization process was the fact that size reduction was not its primary objective. The main purpose was to achieve high reliability at a minimum cost by the use of components whose reliability had been previously established through their use in equipment miniaturization.

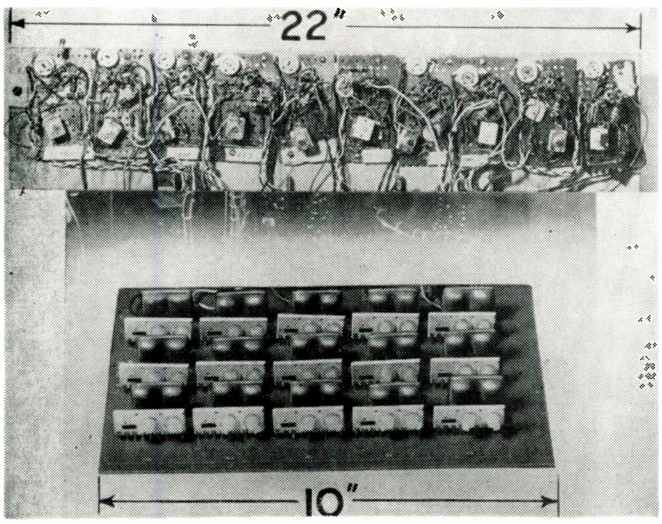
This machine is used by printing and typesetting shops where compact equipment is desirable, but not essential, since most of the machines used in the industry are comparatively large. However, reliability of the equipment is extremely important.

The initial step in the redesigning of the unit—substitution of transistors for tubes—resulted in a considerable increase in reliability as well as a reduction in the size of the original design. The next step was to lower the cost of the unit and at the same time achieve even higher reliability by reducing the number of components and connections in the machine.

Because of the repetitive nature of the circuitry, Alphatype engineers felt that packaged circuits were ideally suited to this purpose. Working with Centralab packaged circuit engineers, they designed a series of PEC packaged circuits with plug-in terminals suitable for etched circuit board installation. These were: A PEC flip-flop, a modification of it with two additional speed-up capacitors, and two units that combined to cover the requirements of a triple bridge T filter circuit.

This technique reduced the size of the equipment an additional 20% by decreasing both the number and size of the etched circuit boards required.

Several other advantages resulted from this redesigning technique. The placement of components was simplified and it was possible to place them closer together, resulting in a much higher component density and considerably reduced assembly costs. Since a packaged circuit, rather than a large number of individual components were involved, additional savings resulted from a reduction in testing time for both individual parts and sub-assemblies.



Miniaturization of a group of bridge T filters: (top) a group of 10 single bridge T filters; (below) the etched board contains 10 triple bridge T filters. Solder connections reduced from 330 to 195.

Fig. 1: Test set up: signal generator, Wayne-Kerr Bridge, receiver

Capacity Neutralization of H-F Transistors

The stability and distortion considerations of i-f transistor amplifiers requires that the small signal, short circuit, reverse transfer admittance parameter be neutralized. The capacity needed for neutralization can be derived and its relation to the standard collector capacity outlined.

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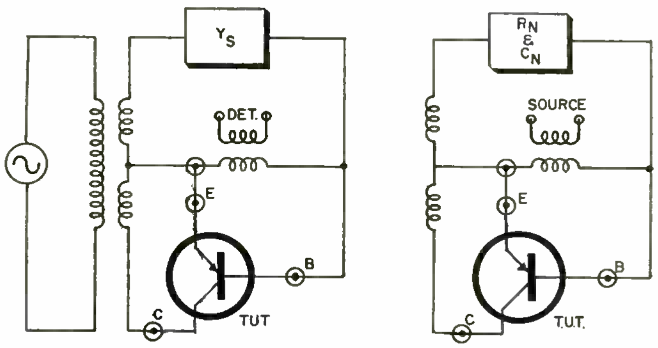
THE standard IRE capacity measurement[1] as shown on most transistor data sheets is not measured in the configuration in which the transistor is normally used in an IF amplifier. This capacity is measured grounded base while the IF amplifiers usually employ a grounded emitter circuit. Examination of the normal measuring circuit for the small signal, short circuit, reverse transfer admittance shows that this circuit is identical with the neutralization section of an IF amplifier, (Fig. 2) The comparison of $Y_{12(e)}$ and $C_{ob}(H_{22(b)})$ given in appendix A shows that $Y_{12(e)}$ is not equal to C_{ob}. Analysis of the stability criteria for neutralization of narrow band amplifiers[2] has previously dealt with this problem. The comparison of these parameters, C_{2b} and $Y_{12(e)}$, and the experimental techniques will be shown. In addition, the problem of measurement will be discussed.

Experimental Procedures

As a reference, a standard C_{ob} measuring set was used. The output capacity of the transistor was read directly on a Boonton RX meter #205A using a circuit shown in Fig. 3. This is a two terminal measurement with the base grounded and the emitter open circuited to AC.

The next circuit employed was a three terminal C_{ob} test set that used a Wayne-Kerr Bridge #B-601. This balanced out all the parasitic capacities associated with the can and leads so that a depletion layer capacity or true collector capacity could be obtained. This circuit is shown in Fig. 4. In this test set

Fig. 2: Diagram, Wayne-Kerr 601B Bridge and I-F amplifier



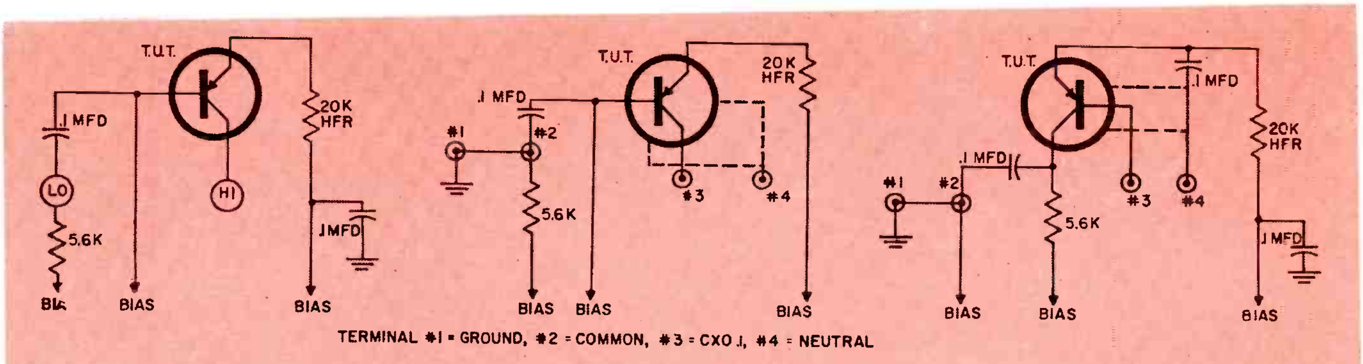


Fig. 3: Testing for 2-term. C_{ob} on RX Meter. Fig. 4: Testing for 3-term. C_{ob} on B-601 Bridge. Fig. 5: Testing for $Y12_e$ on B-601 Bridge.

great care was given to the design of the socket and a shielded cone was developed similar to that used in the measurement of inter-lectrode tube capacities.

In order to compare these C_{ob} readings with the small signal, short circuit, reverse transfer admittance a $Y_{12(e)}$ measuring set up had to be developed. In this set a well shielded signal generator was used to feed the signal into the Wayne-Kerr Bridge and the null condition was detected on a receiver which had low noise. Fig. 5 is a diagram of the circuit used and Fig. 1 is a picture of the test set. The shielded socket mentioned above can be seen in this picture.

The measurement obtained on the circuits described above were compared with the actual neutralization required on an IF amplifier whose circuit is shown in Fig. 6 and a block diagram of the entire testing procedure is shown in Fig. 7. This procedure is similar to the method described by RCA[3] where the capacity is measured on a calibrated feed back condenser whose capacity value is divided by the transformation ratio of 9.4-1. Care was taken to make certain that the transformation ratio did not change with transistor loading.

Experimental Results

A comparison of the measured capacities obtained by the four methods described above is shown in Table 1. Group 1 transistors had 45 megacycle alpha cut-off, group 2, 15 megacycle alpha cutoff, and group 3, 5 megacycle alpha cut-off. The agreement between the IF amplifier neutralization capacity and the bridge measurement of $Y_{12(e)}$ should be noted. In all cases the neutralization capacity did not correspond to the two terminal C_{ob} measurement.

The small signal, short circuit, reverse transfer admittance, $Y_{12(e)}$, was investigated experimentally at different frequencies and the three groups of transistors exhibited different curves; these curves are shown in Fig. 8. The theoretical reason for the variation of $Y_{12(e)}$ with frequency will be the subject of a later article; in which it is shown to be affected by several transistor parameters.

Production Oriented Testing Procedures

The advisability of closer control of the transistors in production necessitated the development of easier to operate testing procedures. The Tektronix Model 130 LC meter proved to be a very useful tool. Two terminal C_{ob} measurements can be made on it directly; in fact, a three terminal C_{ob} measurement can be made also

Fig. 6: Test ckt for determining neutralization values

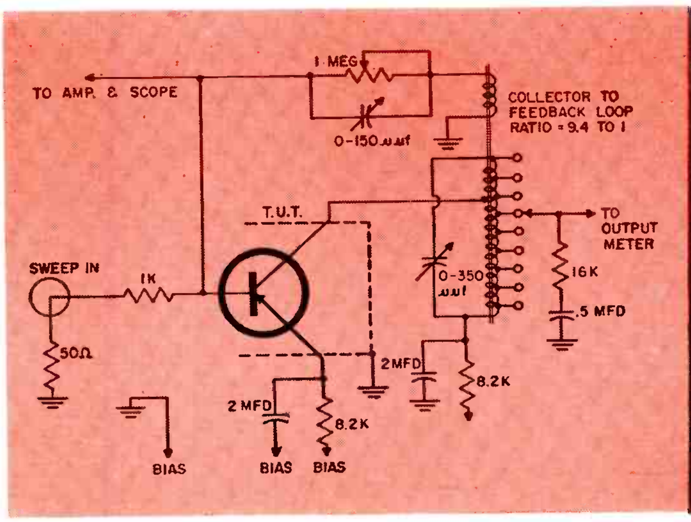
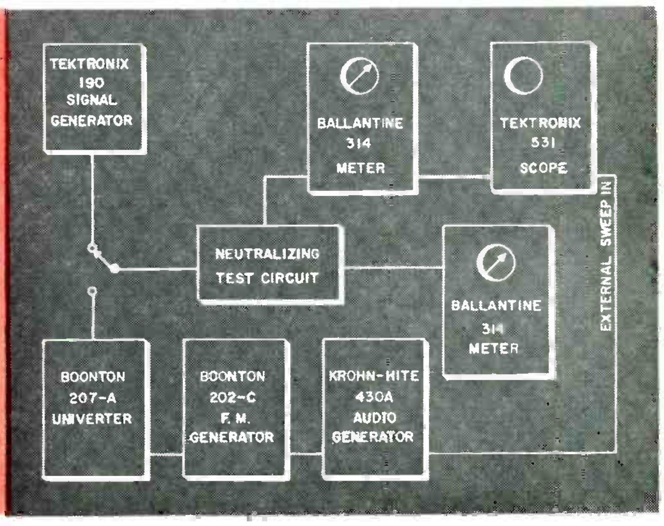


Fig. 7: Block diagram for determining neutralization values



Capacity Neutralization

(Continued)

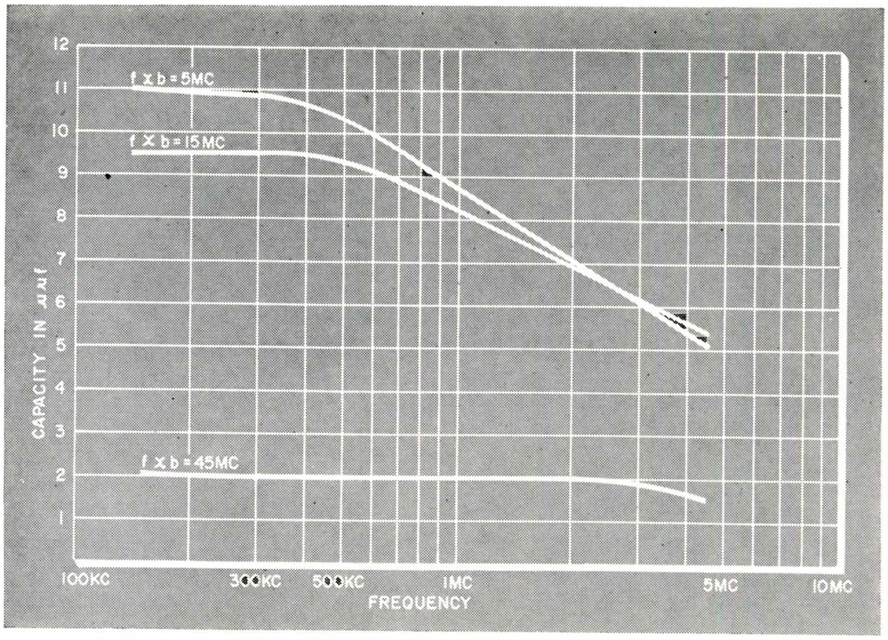


Fig. 8: The three groups of transistors investigated exhibited these different curves.

by employing the guard circuit in this meter as the third terminal. The availability of this third terminal pointed out the possibility of measuring $Y_{12(e)}$ on this piece of equipment. Fig. 9 shows the three circuits used to make these measurements. Both types of C_{ob} measurements are straight forward with the exception that due caution should be observed with regard to shielding of the lead and grounding of the can in the three terminal case. In order to approximate the bridge equivalent circuit a perfect balance must be obtained between the guard and the unknown terminals. This is readily accomplished by the addition of a choke in the emitter bias feed to increase the circuit Q sufficiently to bring the guard circuit into balance. Precautionary measures should also be taken in biasing the transistors through high enough impedances so that the LC meter circuit is not loaded. The use of the LC meter to measure the $Y_{12(e)}$ is most applicable at present to low capacity high alpha cut-off units because of the frequency variation of $Y_{12(e)}$ (See Fig. 8). The operating frequency of the LC meter is 140 KC.

Fig. 10, is a picture of a $Y_{12(e)}$ test set using the LC meter. Table 2 compares the capacity measurements of the standard systems to those obtained on the production test sets.

Conclusions

As the internal transistor capacitance becomes lower with improved design and manufacturing know-how, the parasitic capacitance associated with the package and the leads become more important, and greater attention should be given to the measurement of these ca-

Table 1

RX 2 Term. C_{ob}	WK 3 Term. C_{ob} 500 KC	WK $Y_{12\,(e)}$ 500 KC	CN IF AMP. $Y_{12\,(e)}$ 500 KC
45 MC	Vc = 12 v	Ie = 1 ma	
3.3 μμf	2.24 μμf	2.87 μμf	2.6 μμf
3.9	2.80	3.38	3.1
3.1	2.14	2.59	2.3
2.5	1.23	1.84	1.9
2.7	1.47	2.14	2.0
2.6	1.34	1.96	1.9
2.5	1.23	1.82	1.8
2.7	1.34	2.01	1.9
2.8	1.46	2.12	2.0
3.05	1.72	2.16	2.2
2.6	1.23	1.88	1.9
2.0	1.40	1.73	1.7
2.0	1.42	1.61	1.5
2.25	1.05	1.76	1.9
15 MC	Vc = 6 v	Ie = 1 ma	
11.0	9.4	9.4	9.4
10.4	9.0	8.9	8.9
11.4	9.2	9.0	8.8
11.0	9.3	9.2	9.2
5 MC	Vc = 6 v	Ie = 1 ma	
10.6	9.4	8.3	8.8
11.8	10.2	9.6	9.9
12.9	11.6	10.9	11.2
10.6	9.3	8.6	9.0
10.5	9.1	6.9	7.5
13.6	11.4	11.0	11.3
13.7	10.8	10.3	10.6
12.1	10.0	10.0	10.3

pacitances. The simple addition of a third terminal during the capacity measurement greatly increases the usefulness of the data; a three terminal C_{ob} measurement gives the true collector capacitance value.

If the transistor is to be used in an IF amplifier, the capacity required for neutralization becomes important and this can be obtained by the measurement of $Y_{12(e)}$. Care should be taken in the measurement of $Y_{12(e)}$ because this parameter may be variable with frequency. The ideal condition is to measure $Y_{12(e)}$ at the particular IF frequency at which the transistor is to be used. A quick and inexpensive method of obtaining the useful capacitive measurements was developed employing a Tektronix Model 130 LC meter. This equipment has performed satisfactorily in all the transistors measured to date.

Acknowledgements

The authors wish to acknowledge the help of D. Kennedy with the theory; W. Moloney for circuit suggestions and construction; and Mrs. W. Hall for taking data and the preparation of this paper.

References

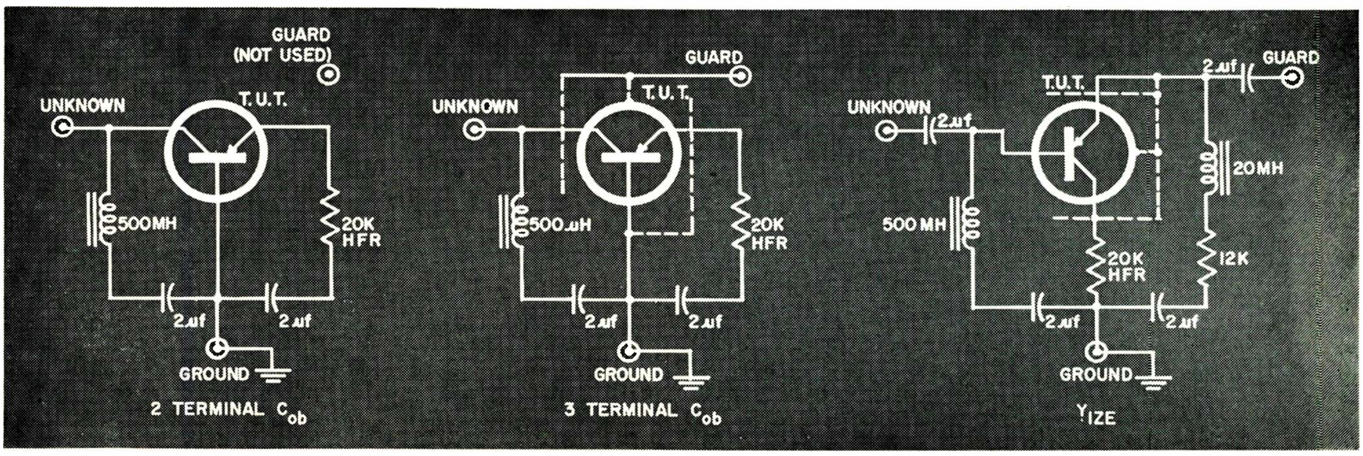
1. IRE Standards or Letter Symbol for Semiconductor Devices, July 1956.
2. "Internal Feedback and Neutralization of Transistor Amplifiers," by A. P. Stern, C. A. Aldridge, and W. F. Chow. Vol. 43, pp. 383-347. July 1955, *IRE*. "Stability and Power Gain of Tuned Transistor Amplifiers," by A. P. Stern. Vol. 45. Pp. 335-343. March 1957, *IRE*.
3. A test set for transistor performance measurement at 455KC, by D. D. Holmes, L. A. Freedman, and T. M. Scott, *"Transistor I RCA."*

Table 2

RX 2 Term. C_{ob}	LC 2 Term. C_{ob} 140 KC	WK 3 Term. C_{ob} 500 KC	LC 3 Term. C_{ob} 140 KC	WK $Y_{12(e)}$ 140 KC	LC $Y_{12(e)}$ 140 KC	WK $Y_{12(e)}$ 500 KC
	45 MC		Vc = 12 v		Ie = 1 ma	
3.3 μμf	3.4 μμf	2.24 μμf	2.2 μμf	2.80 μμf	2.8 μμf	2.87 μμf
3.9	3.8	2.80	2.8	3.20	3.2	3.38
3.1	2.9	2.14	1.6	2.55	2.5	2.59
2.5	2.3	1.23	1.1	2.00	1.8	1.84
2.7	2.5	1.47	1.3	2.10	2.1	2.14
2.6	2.5	1.34	1.2	2.10	2.1	1.96
2.5	2.3	1.23	1.1	2.00	2.0	1.82
2.7	2.5	1.34	1.1	2.10	2.0	2.01
2.8	2.6	1.46	1.3	2.45	2.3	2.12
3.0	3.0	1.72	1.7	2.00	1.7	2.16
2.6	2.5	1.23	1.3	1.80	1.8	1.88
2.0	1.9	1.40	1.3	1.75	1.7	1.73
2.0	2.1	1.42	1.4	1.70	1.5	1.61
2.3	2.2	1.05	1.1	1.95	1.9	1.76
	15 MC		Vc = 6 v		Ie = 1 ma	
11.0	11.0	9.4	9.5	9.6	9.6	9.4
10.4	10.8	9.0	9.0	9.4	9.3	8.9
11.4	11.0	9.2	9.2	9.4	9.3	9.0
11.0	11.0	9.3	9.4	9.4	9.3	9.2
	5 MC		Vc = 6 v		Ie = 1 ma	
10.6	10.5	9.4	9.4	9.0	9.2	8.3
11.8	11.8	10.2	11.0	10.6	10.8	9.6
12.9	12.8	11.6	11.8	11.6	11.7	10.9
10.6	10.5	9.3	9.5	9.5	9.7	8.6
10.5	10.2	9.1	9.4	8.65	8.8	6.9
13.6	13.0	11.4	12.0	11.3	11.2	11.0
13.7	12.8	10.8	11.0	11.0	11.5	10.3
12.1	12.0	10.0	10.1	10.8	10.5	10.0

See following page (86) for summarizations of Tables 1 and 2 and Appendix A.

Fig. 9: Capacitance measurement circuits for use on Tektronix Model 130 LC Meter



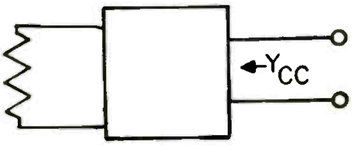
Appendix A

$$h_{22\,(b)} = \frac{Y_{ee} Y_{cc} - Y_{ce} Y_{ec}}{Y_{ee}}$$

If one starts from the matrix

$$\begin{bmatrix} I_e \\ I_c \end{bmatrix} = \begin{bmatrix} Y_{ee} & Y_{ce} \\ Y_{ec} & Y_{cc} \end{bmatrix} \times \begin{bmatrix} E_e \\ E_c \end{bmatrix}$$

$$\begin{bmatrix} I_e \\ I_c \end{bmatrix} = \begin{bmatrix} Y_{ee} + G_g & Y_{ce} \\ Y_{ec} & Y_{cc} \end{bmatrix} \times \begin{bmatrix} E_e \\ E_c \end{bmatrix} G_g$$



$$Y_{cc} = \frac{\Delta}{\Delta_{22}} = \frac{\Delta^{\circ} + G_g \Delta_{11}}{\Delta^{\circ}_{22} + G_g}$$

$$Y_{cc} = \frac{\Delta^{\circ}}{\Delta^{\circ}_{22}} = \frac{\begin{vmatrix} Y_{ee} & Y_{ce} \\ Y_{ec} & Y_{cc} \end{vmatrix}}{Y_{ee}}$$

$$h_{22} = \frac{Y_{ee} Y_{cc} - Y_{ce} Y_{ec}}{Y_{ee}}$$

$$Y_{12\,(e)} = -(Y_{cc} + Y_{ec})$$

Starting from the matrix

$$\begin{bmatrix} I_e \\ I_c \\ I_b \end{bmatrix} = \begin{bmatrix} Y_{ee} & Y_{ce} & -(Y_{ce} + Y_{ee}) \\ Y_{ec} & Y_{cc} & -(Y_{ec} + Y_{cc}) \\ -(Y_{ee} + Y_{ec}) & -(Y_{ce} + Y_{cc}) & Y_{bb} \end{bmatrix} \times \begin{bmatrix} E_e \\ E_c \\ E_b \end{bmatrix}$$

And develop the grounded emitter matrix

$$\begin{bmatrix} I_c \\ I_b \end{bmatrix} = \begin{bmatrix} Y_{cc} & -(Y_{ec} + Y_{cc}) \\ -(Y_{ce} + Y_{cc}) & Y_{bb} \end{bmatrix} \times \begin{bmatrix} E_c \\ E_b \end{bmatrix}$$

$$Y_{12\,(e)} = -(Y_{ce} + Y_{cc})$$

$$Y_{12\,(e)} = -(Y_{ce} + Y_{cc}) = -Y_{ce} - Y_{cc}$$

$$h_{22} = \frac{Y_{ee} Y_{cc} - Y_{ce} Y_{ec}}{Y_{ee}} = Y_{cc} - Y_{ce}\left[\frac{Y_{ec}}{Y_{ee}}\right]$$

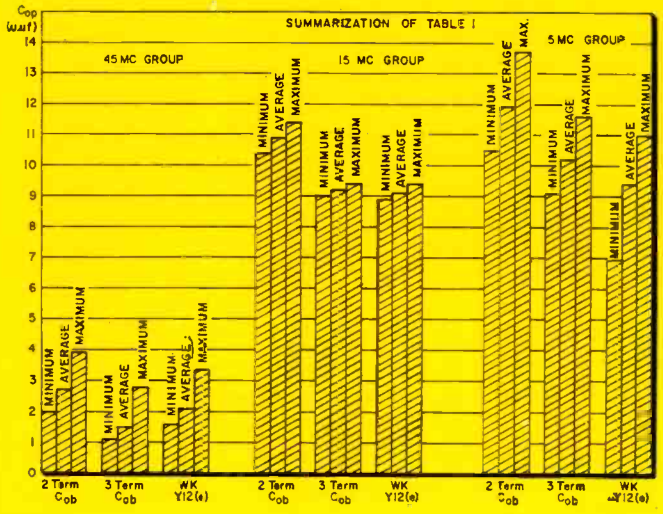
$$\therefore Y_{12\,(e)} \neq h_{22\,(b)}$$

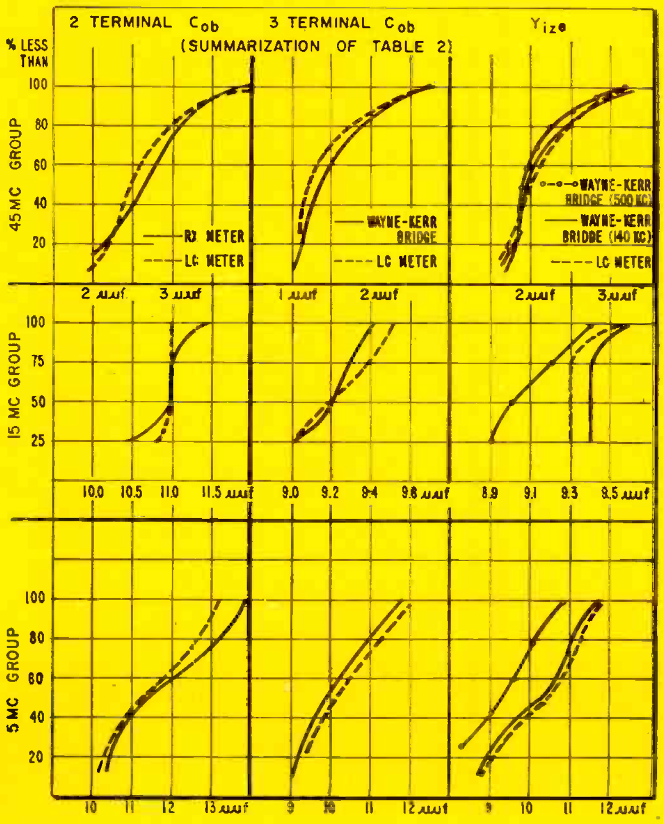
Fig. 10: $Y_{12\,(e)}$ test set using the LC meter.

Capacity Neutralization

(Concluded)

Summarization of Tables 1 & 2





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NEW CINCH
HINGE CONNECTORS

PLUG AND SOCKET SHOWING CONTACT ARRANGEMENT

Patent Pending

The top section of the lock fits into a slot in the top of the cap forming a perfect lock which cannot be accidently opened, as shown below. Lifting up top section releases same prior to unlocking.

INSURE POSITIVE CONTACT; HAVE SIMPLE LOCKING DEVICE, EASY RELEASE. MAXIMUM NUMBER OF CONTACTS IN MINIMUM SPACE

The plug and socket units of the "H" Series are easily engaged with normal pressure and the lock holds them securely together. Releasing the lock the units separate by the spring action of the contacts. A simple locking device insures positive contact. Wiping contact action keeps contacts clean at all times. Either the plug or socket body fit into the cap. Cable entrance hole can be placed at the one end, or in the top, or both. Cover is finished in black wrinkle and the cable clamps are cadmium plated. Contact tails will take either conventional solder wiring or AMP "78" series Taper Tab receptacles.

The plug or socket bodies can be ordered from the code numbers listed. The one that is attached to the chassis should have the lock attached. If an insulating liner is required in the cover, suffix L should be added to the Code Number.

The cap is ordered according to the number of contacts required. Then the letter L designating the liner. The letter giving hole size follows. Then the letter indicating the location of the hole; either T for top, or E for end, and if a cable clamp is required, the letter C is added.

For example, if a 50 contact unit is required with cover, having a ¾" hole in the top with a cable clamp and liner, the code would be 24540-LBTC. The chassis socket would be 24495 and the plug for the cap 24504.

The Cinch "H" series is made in 20 to 100 contacts, in multiples of 10 contacts.

Socket with Lock

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24492	20	1.375	1.750
24493	30	1.812	2.187
24494	40	2.250	2.625
24495	50	2.687	3.062
24496	60	3.125	3.500
24497	70	3.562	3.937
24498	80	4.000	4.375
24499	90	4.438	4.812
24500	100	4.875	5.250

Socket without Lock

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24484	20	1.375	1.750
24485	30	1.812	2.187
24486	40	2.250	2.625
24487	50	2.687	3.026
24488	60	3.125	3.500
24489	70	3.562	3.937
24413	80	4.000	4.375
24490	90	4.438	4.812
24491	100	4.875	5.250

Plugs without Lock—Mates with above

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24501	20	1.375	1.750
24502	30	1.812	2.187
24503	40	2.250	2.625
24504	50	2.687	3.062
24505	60	3.125	3.500
24506	70	3.562	3.937
24507	80	4.000	4.375
24508	90	4.438	4.812
24509	100	4.875	5.250

Plug with Lock—Mates with above

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24476	20	1.375	1.750
24477	30	1.812	2.187
24478	40	2.250	2.625
24479	50	2.687	3.026
24480	60	3.125	3.500
24481	70	3.562	3.937
24412	80	4.000	4.375
24482	90	4.438	4.812
24483	100	4.875	5.250

50 CONTACT ASSEMBLY WITH CABLE CLAMP

Caps for Plugs or Sockets without Locks

Code No.	Contacts	Hole Size	Mtg Ctrs.	Overall
24537	20	A or B	1.375	1.750
24538	30	A B or C	1.812	2.187
24539	40	B or C	2.250	2.625
24540	50	B or C	2.687	3.062
24541	60	B C or D	3.125	3.500
24542	70	B C or D	3.562	3.937
24543	80	B C or D	4.000	4.375
24544	90	C D or E	4.437	4.812
24545	100	C D or E	4.875	5.250

Cap Hole Size / Cable Clamp Size

Letter	Dimension	Cable Clamp Size
A	½" dia.	Small
B	¾"	Small
C	13/16 x 1	Medium
D	13/16 x 1½	Medium
E	13/16 x 1-11/16"	Large

Electrical Rating

	Volts ACRMS	DC
Adjacent Terminals	930	1300
to Ground	1400	2000
Current Rating	4.5 Amperes	
Contact Resistance rated current @	.020 ohms	
Insulation Resistance	1000 megohms	
Capacitance adjacent contacts	.75 MMF	

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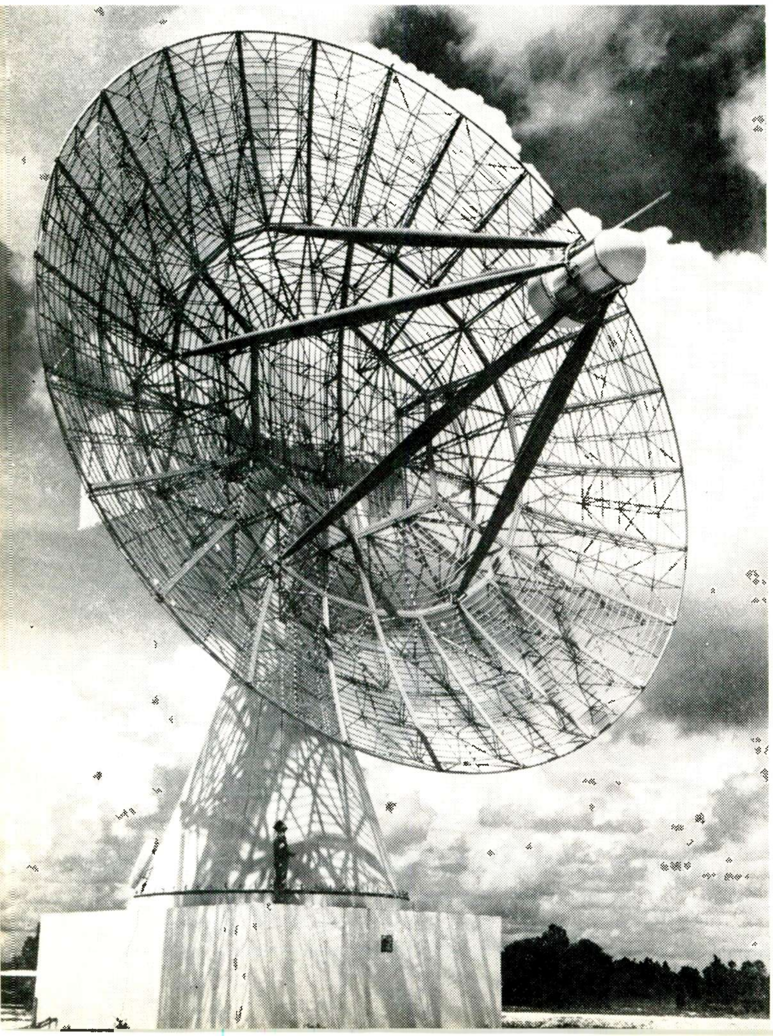
Circle 37 on Inquiry Card page 101

By **FREDERICK C. LINDVALL,**
President, American Society for Engineering Education
Professor of Electrical and Mechanical Engineering,
California Institute of Technology

Engineering Education —Retrospect & Prospect

The past decade has seen more new concepts, new principles and new methods introduced to engineering education than during any other comparable period in its history. Some radical changes are needed to meet this challenge. But in which direction?

Radar, a wartime development, has grown at a rate comparable to the increase in antenna size. Microwave theory and its varied applications are newer additions to the engineering curriculum.



SHAKESPEARE'S plays, as the old lady said, seem to be awfully full of quotations. Without doubt an apt remark could be found from this source which would give the implication that a view in retrospect may give a clue to the future. On the other hand a more homely sage of our time, the old baseball player Satchel Paige, has a number of prescriptions for keeping one's peace of mind, among which is—"Don't look behind you, something may be catching up with you." This says something pertinent to engineering education, because technology is moving so rapidly that it may be gaining on us. We can be more comfortable if we don't look behind us, but through retrospect we may visualize what is ahead for us and for our students.

The next decade, which has just been marked by the dawn of the space age, promises to be no less exciting than the last. At no time in the history of engineering education have there been so many new concepts, new principles, and new methods introduced in such a short period of time. Novel devices, complex systems and wholly new fields of engineering development have come into being bringing with them requirements for broader fundamental knowledge and more penetrating analysis. Let us look briefly at some of the new things which now appear to a greater or less extent in engineering education which simply weren't there at all ten or so years ago. Some of these ideas, some of these devices, were a consequence of intense wartime effort and after the security wraps had been removed at the end of the war their effects began to be felt in the engineering schools. Technical articles, textbooks and personal knowledge of some of the faculty permitted rapid introduction of new material which had almost revolutionary effect on individual courses and on curricula.

Radar immediately comes to mind, with the associated microwave technology. This involves generation, detection and amplification of pulsed and continuous radiation in the microwave range. The circuitry itself was new to Electrical Engineering education, with wave guides commonly known as "plumbing" replacing the orthodox, understandable conductors for lower frequencies. The descriptions and understanding of generators of microwaves necessitated discussions of electron-mechanics, the bunching of electrons, as in klystrons, or the behavior of electron streams in the travelling wave tubes which soon came in as new devices for broad band amplification. The wave guides, themselves, were meaningless until interpreted in terms of wave propagation in various modes, analyzable in terms of Maxwell's equations. Up to this time Maxwell's equations were rather esoteric and limited to sophisticated courses in Electricity and Magnetism or Advanced High Frequency. Now undergraduates talk knowingly of the various modes and coupling devices and measure in the laboratory the electrical performance of microwave equipment with meter sticks and micrometers instead of conventional indicators of current or voltage.

Electronics

Electronics in general had by this time already displaced in large measure the early Electrical Engineering work directed toward power applications. Megawatts and cycles were losing out rapidly to watts and megacycles. But here, too, sweeping changes were occurring. Semiconductor devices, the diodes and particularly the transistors rapidly began to displace vacuum tubes. These semiconductors immediately directed attention to basic materials and to fundamental notions of the electronic character of this peculiar type of conduction. Schools began to present something of the theory of semiconductors, thus bringing in the quantum concepts which are basic to solid state physics. This, in turn, put pressure on the physics departments of engineering schools to modify their course work for the engineers to include some of these modern concepts.

Nuclear energy appeared as a great fireball highlighting a new technology and Engineering Schools began eagerly to seek information on reactors and radiation effects and to assess the probable impact of fission on engineering education. In addition the possibility of fusion as an energy source has led to much speculation about the far-reaching engineering implications. The Atomic Energy Commission has assisted colleges by stimulating new educational opportunities for engineering students in subjects helpful to reactor development and application. This further enforced the desire of engineering educators to have something of modern physics a part of engineering instruction.

Magnetic amplifiers, saturable reactors and other devices had proved their merit during the war and industrial importance was immediately perceived.

As the plane's shape and function changed, the proportion of its cost spent on airborne electronic equipment increased. Ground control, tracking and doppler radar are all reflected in engineering education.

This brought into Electrical Engineering instruction more penetrating consideration of magnetic properties of materials than was formerly true. In fact, the very non-linear properties which permit these new magnetic devices to function were formerly ignored or not taken seriously in the study of electrical machines and magnetic devices. Theoretical treatment of these non-linear devices is difficult, but they and other things which involve similar properties of material have forced extensive academic consideration of analysis of non-linear systems.

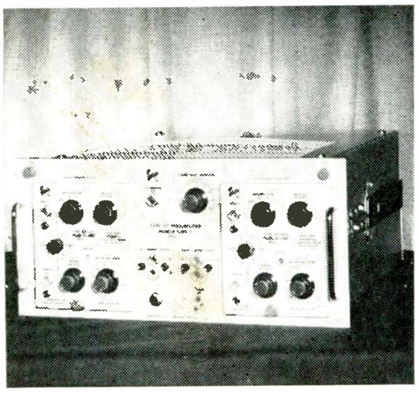
Then computers came on the scene with a rush, bringing problems for engineering colleges. Sudden demand for engineers who knew something of computers brought with it the urge to teach in the colleges courses of various kinds dealing with computer theory, development and their use. Some schools had major research programs in computers and were well equipped to offer instruction. Other schools did not try to meet this specialized demand, but all have begun to ask questions about the mathematical content of engineering curricula to see whether some of the symbolic logic and specialized algebras pertinent to computers might not be a better starting point for college mathematics than our present traditional procedure. This might establish early some clear concepts of logic and notions of groups and sets which would make basic concepts of some of our more familiar mathematics more understandable.

(*Continued on page* 106)

New Products . . . for the Electronic Industries

PREAMP POWER SUPPLY

The Type 127 supplies proper operating power to any one or combination of 2 Type 53/54 Plug-In Preamplifiers. Outputs of the plug-in preamplifiers are fed through dc-



coupled differential amplifier stages and cathode followers to provide a push-pull signal at the output. Gain of the unit is 1 push-pull. Using single-ended output, gain is one-half. Risetime is 0.018 μsec. Output swing is linear ± 3% over a range of ± 0.3 v. All dc voltages supplied to the plug-in units are electronically regulated. Tektronix, Inc., P. O. Box 831, Portland 7, Ore.

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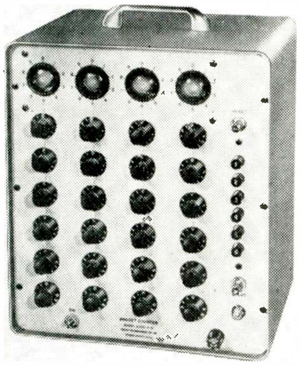
PRESET COUNTERS

Development of the 2020 Multiple Preset Counters for counting and control applications has been announced. They can be supplied with multiple groups of presetting controls for use

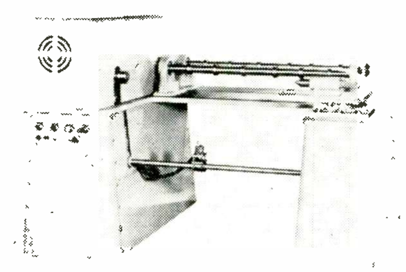


in all vital industrial operations for accurate, high speed sequential predetermining counting and control. A complete program can be preset for winding multiple tapped coils or for any event which requires a machine controlled at different predetermined counts. It can be supplied with various inputs. Freed Transformer Co., Inc., 1726 Weirfield St., Brooklyn 27, N. Y.

Circle 198 on Inquiry Card, page 101

TRANSFORMER WINDER

A semi-automatic machine winds transformer cores in variable lengths to a maximum of 10 in. in multiple of 3. Maximum core OD is 25 in., maximum distance for multiple wind-

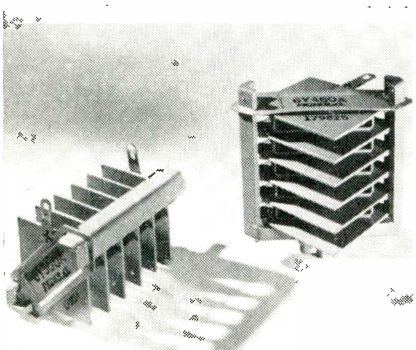


ing 40 in. and output end of spindle 2⅞ in. keyed slot. Emergency stop button halts winding instantly at any point of winding cycle. Jogging switch permits additional core diameter build-up after winding cycle has ended and also permits arbor to be placed in desired position before winding begins. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill.

Circle 200 on Inquiry Card, page 101

SELENIUM RECTIFIERS

A new line of selenium rectifiers for the electronic home entertainment products industry is available. The line presently consists of 2 sizes which cover the range from 150 to 450 ma. for half-wave rectifier applications and for B-plus supplied in voltage doubler circuits. The "Federal Slim-Line" rectifiers are designed to meet rigid requirements. They feature a sturdy yoke-type construction which

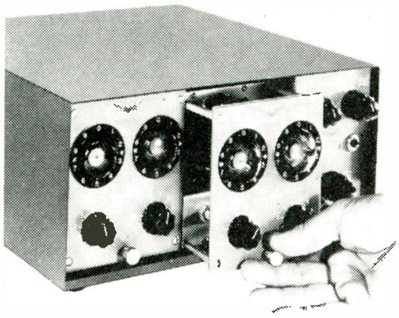


engages the corners of the selenium cells eliminating center holes and permitting the full area of the plate to be utilized. International Telephone & Telegraph Corp., Clifton, N. J.

Circle 197 on Inquiry Card, page 101

MODULAR COUNTERS

The Model 320 series Pre-set Electronic Counters is available in every size from 2 to 6 digits in the standard line. Each standard instrument consists of one pluggable amplifier and control unit plus any combination of pluggable 2 and 3 decade modules. Designed for industrial counting, sorting, batching, winding, packaging and other control functions, it will count at a maximum rate of 5000 counts per



sec., accepting any standard waveform. Either ac or dc coupled inputs may be selected from the front panel. Erie Resistor Corp., 644 W. 12th St., Erie, Pa.

Circle 199 on Inquiry Card, page 101

JUMBO INDICATOR

Jumbo Nixie, type BD-307 is a 3 in. diameter, all electronic in-line indicator designed to meet the needs of visual presentation at viewing distances of over 150 feet. Low power and rugged construction are additional features. It contains the numerals (0) through (9) and a common anode for circuit simplicity. The desired numeral is illuminated with a neon glow by applying a voltage (po-

tential) between it and the common anode. Brightness and clarity as well as size of presentation make long distance viewing possible. Burroughs Corp., Plainfield, N. J.

Circle 201 on Inquiry Card, page 101

SILICON RECTIFIERS

designed and manufactured to meet

THE NEW JAN SPECIFICATIONS

For AXIAL LEAD TYPES

JAN 1N538 (MIL-E-1/1084A)	JAN 1N540 (MIL-E-1/1085A)	JAN 1N547 (MIL-E-1/1083A)

now from **AUTOMATIC**

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers designed to meet the new JAN MIL-E-1 Specification

Type No.	Peak Reverse Voltage (VDC)	DC Output Current @ 25° C. Ambient (MA)	DC Output Current @ 150° C. Ambient (MA)	Maximum Reverse Current* (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
JAN 1N538	200	750	250	0.350	Axial lead	1084A
JAN 1N540	400	750	250	0.350	Axial lead	1085A
JAN 1N547	600	750	250	0.350	Axial lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

PRODUCTION QUANTITIES OF ALL TYPES AVAILABLE FOR FAST DELIVERY

Naturally, you can get these new axial lead JAN types direct from AUTOMATIC, and from authorized distributors throughout the country — and at prices that reflect General Instrument's years of volume production experience.

Together with the earlier JAN type stud mount group, AUTOMATIC now covers the entire medium power silicon rectifier field for the requirements of every military application.

More information? A complete set of data sheets is yours for the asking. Please write us today.

GENERAL INSTRUMENT SEMICONDUCTORS

General Instrument Corporation also includes F. W. Sickles Division, Radio Receptor Co., Inc., and Micamold Electronics Manufacturing Corporation (Subsidiaries)

AUTOMATIC MANUFACTURING

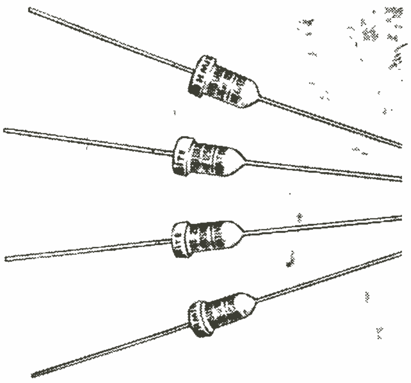
MASS PRODUCERS OF ELECTRONIC COMPONENTS

AUTOMATIC MANUFACTURING DIVISION OF GENERAL INSTRUMENT CORPORATION
65 GOUVERNEUR STREET, NEWARK 4, N. J.

New Products ...for the Design Engineer

TANTALUM CAPACITORS

Tan-O-Mite brand, Series TS capacitors constitute the third type of tantalum electrolytic capacitor to be announced. This type employs a porous slug of sintered tantalum for

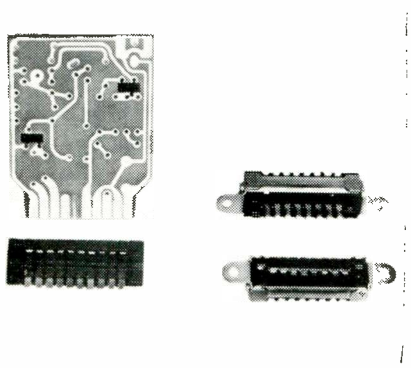


the anode in contrast to tantalum foil (TF) and tantalum wire (TW) types. Series TS slug capacitors feature good shelf and operating life, stability and wide operating temperature range. Supplied in silver cases, their capacitance range is 1.75 to 30 μf—working voltages to 125 are available. Ohmite Manufacturing Co., 3693 Howard St., Skokie, Ill.

Circle 202 on Inquiry Card, page 101

MODULAR CONNECTORS

Uno-Link modular connectors are available for standard wire harness arrangements, the firm's Plyo-Duct film insulated multiconductor cable and printed circuit card receptacles. Multiple unit construction permits the designer to specify the exact number of connection links desired. Available with melamine-phenolic and diallyl phthalate insulation, brass,

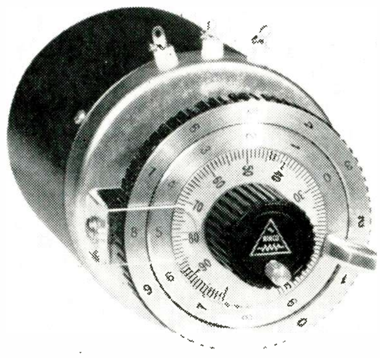


phosphor bronze and beryllium copper terminals, and cadmium, silver and gold finishes. Methode Mfg. Corp., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 203 on Inquiry Card, page 101

VOLTAGE DIVIDER

The Type 85-A Rinco-Pot is a precision voltage divider consisting of 2 switch controlled decades of high accuracy fixed resistors together with a precision wire wound potentiometer



for continuous interpolation between decade steps. This combination provides linearity accuracy to better than one part in 10,000 and resolution of more than 0.002%. Control is provided through 3 coplanor dials mounted on coaxial shafts. Unit mounts in a 7/16 in. hole. All resistors are wire wound. Rinco, Inc., 7962 S.E. Powell Blvd., Portland 6, Ore.

Circle 204 on Inquiry Card, page 101

SUBMINIATURE POTS

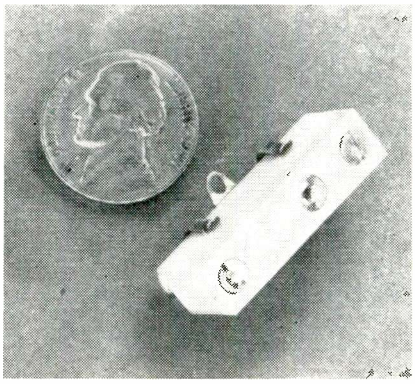
Three new series of rugged subminiature potentiometers will help solve application problems involving severe environmental conditions, such as encountered in high-performance aircraft and missiles. The Series 314 high-temperature 1-turn potentiometers provide resistances from 50 to 25 K at −55°C to +250°C in ½ x ⅜ in. The Series 341 offers the smallest

ten-turn potentiometers available. The Series 319 is comprised of wire-wound, gangable potentiometers ⅞ in. in diameter. Daystrom Pacific, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Circle 205 on Inquiry Card, page 101

MINIATURE SWITCH

This miniature high temperature snap action switch, known as the Melex switch, operates in temperatures from −300° to +500° F. and will withstand a shock of 40 to 50 G's

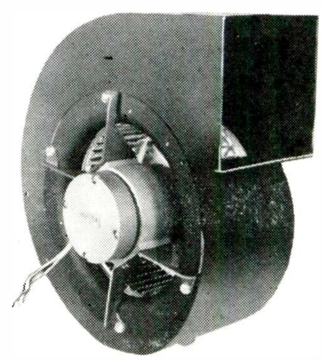


at vibrations of 50 to 2000 cps. Switch is housed in a glass bonded mica case which incorporates a glass plunger that permits the switch to withstand severe humidity and temperature variations. The switch is 1¼ in. long, 5/16 in. wide and 7/16 in. high. Leaf and roller actuators are available for this switch. Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif.

Circle 206 on Inquiry Card, page 101

COOLING BLOWER

F frame blowers are presently being used in large commercial computers to maintain normal power supply temperatures. These motors are mounted inside the impeller to reduce overall size and to obtain a cooling effect on the motor itself. The units can be supplied for military or commercial use in 115 to 220 v, 1 or 3 θ, 60 or 400 cps applications. The mo-



tor shown is 3 13/16 in. diameter and is driving an 8½ in. squirrel cage impeller. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y.

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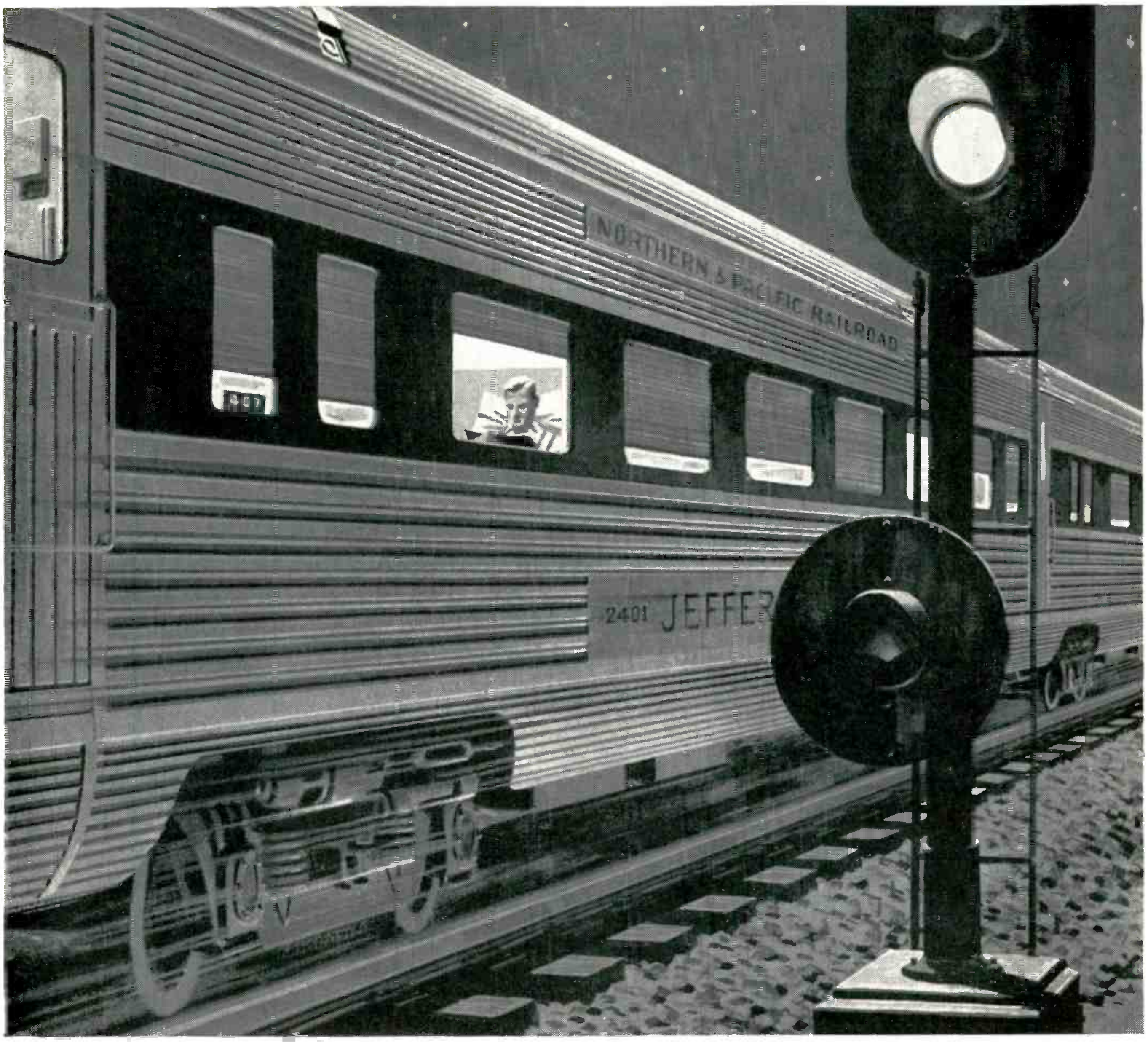
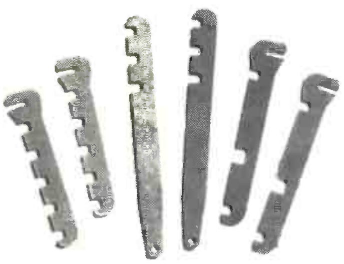


"S" is for Signal, Safety and Synthane



Typical pushers, machined from Synthane laminated plastics, used for railway signal relay.

Railroads can't even think in terms of failure. And that is why, among the many working parts that constitute railway signal relays, you find pushers made of Synthane laminated plastics.

These pushers, on which life itself depends, must in the words of one manufacturer have "excellent insulating characteristics—be durable and unchanging," must "not chip, wear and thus leave residual dust or particles which would cause trouble if they should lodge on the electrical contacts."

Synthane has all of these characteristics plus a combination of many other useful properties required for reliable performance. Equally important is the dependability of Synthane, the company, as a source of supply. You are urged to visit us and see for yourself the plant behind Synthane sheets, rods, tubes and fabricated parts—or to discuss this important point with our representative. Meanwhile, write for our new, complete catalog.

SYNTHANE

SYNTHANE CORP., 11 RIVER ROAD, OAKS, PA.

Circle 38 on Inquiry Card, page 101

New Tech Data for Engineers

(More Tech Data on pages 96 & 132)

Capacitors

A multi-colored bulletin issued by the Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill. describes a line of tubular electrolytic capacitors. All information is listed in simple chart form as an easy-to-use reference.

Circle 161 on Inquiry Card, page 101

Contact Selection

A new 54-page manual about contact selection and use has just been issued by the Stackpole Carbon Co., St. Marys, Pa., containing a wealth of data on composition contacts produced from powders. The manual discusses the possibilities of the different material combinations as applied to modern contact requirements. Factors influencing contact selection such as circuit conditions and equipment design considerations are fully outlined and explained.

Circle 162 on Inquiry Card, page 101

Test Equipment Reports

A new 8-page quarterly technical bulletin entitled "METERS" (Measuring & Electronic Test Equipment Reports) has been introduced by the instruments group of the Industrial Products Div. of International Telephone & Telegraph Corp., 250 Garibaldi Ave., Lodi, N. J. The new publication describes problems in instrumentation and measurement and suggests methods for overcoming them. It also explains the design and operation of high quality laboratory measuring devices.

Circle 163 on Inquiry Card, page 101

Ceramic to Metal

An 8-page booklet covering the application and description of alumina ceramic-to-metal terminals has been released by the Advanced Vacuum Products, Inc., Stamford, Conn., a division of General Ceramics Corp. Booklet describes improved sealing techniques, advanced sealing techniques, engineering data and contains dimensional drawings.

Circle 164 on Inquiry Card, page 101

Cooling & Retaining Clamps

A catalog, designated 5-KK, describing Kool Klamps has been published by the Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif. The 16-page brochure details 17 types of cooling and retaining clamps of silver and beryllium copper alloy for miniature and sub-miniature tubes and components including those with 90° sockets for printed circuitry. The 2-color catalog is complete with photographs, outline drawings and specifications in easy-to-follow tabular form.

Circle 165 on Inquiry Card, page 101

Laminates

The Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio has just issued a series of technical bulletins which describes their epoxy glass grades. Copper Clad properties including bond strength and solder heat resistance information is included.

Circle 166 on Inquiry Card, page 101

Magnet Wire Coating

Complete information on the properties of a new modified silicone magnet wire coating is contained in a new 4-page, 2-color brochure issued by the Dow Corning Corp., Midland, Mich. Illustrated brochure contains complete specifications and information.

Circle 167 on Inquiry Card, page 101

Frame Grid Tubes

A 12-page, 3-color booklet issued by Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. describes their reliable premium quality frame grid tubes for military systems requirements and exacting industrial applications. Brochure is complete with photographs, electrical and mechanical specifications, and circuit diagrams.

Circle 168 on Inquiry Card, page 101

Pulse Magnetic Amplifiers

Application notes No. 5 on "Design of Pulse Magnetic Amplifiers" and No. 6 on "Pulse Magnetic Amplifier—Logic Circuits," have been issued by the Semiconductor Div. of Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill. Notes describe the benefits and advantages of using silicon diodes with magnetic cores.

Circle 169 on Inquiry Card, page 101

Computer Transistors

A 6-page, 2-color brochure issued by the General Electric Co., Semiconductor Products Dept., Syracuse, N. Y. describes their unijunction transistors. Complete electrical and mechanical specifications for these computer transistors are contained along with drawings and circuits.

Circle 170 on Inquiry Card, page 101

Leak Detector

Veeco Vacuum Corp., 86 Denton Ave., New Hyde Park, L. I., N. Y., has just issued a 2-color, 16-page bulletin which describes in detail their complete mass spectrometer leak test stations. Complete technical information is included. Applications for this equipment are: aircraft instruments, gyroscopes, missile components, relays, ceramic-metal seals, vacuum tubes and transistors, vacuum systems and process equipment.

Circle 171 on Inquiry Card, page 101

 Circle 40 on Inquiry Card, page 101

New Tech Data for Engineers

Airborne Recorder

A 4-page, 2-color bulletin has been issued by Consolidated Electrodynamics, 300 N. Sierra Madre Villa, Pasadena, Calif. which describes their Type 5-702 airborne magnetic-type recorder. Complete information is included in this bulletin.

Circle 178 on Inquiry Card, page 101

Variable Resistors

The Chicago Telephone Supply Corp., Elkhart, Ind., has just issued Stock Sheet 172 giving general performance specs and listing 156 types of military and industrial variable resistors now available.

Circle 179 on Inquiry Card, page 101

R & D Publication

"Univac Review" is published quarterly by Remington Rand Univac, 315 Fourth Ave., New York 10, N. Y. This publication contains the latest information on electronic research, product development and new applications. It is an enlarged successor to the "Programmer."

Circle 180 on Inquiry Card, page 101

Speakers & Drivers

A new line folder No. SC 504 has been issued by James B. Lansing Sound, Inc., 3249 Casitas Ave., Los Angeles 39, Calif. illustrated with some 40 photographs, drawings and a chart. Data includes speakers, HF and LF drivers, dividing networks and various types of enclosures and horns.

Circle 181 on Inquiry Card, page 101

Strip Terminals

A new illustrated catalog on continuous strip electrical terminals and attaching machines has been released by Kent Mfg. Corp., 188 Needham St., Newton, Mass. The 16-page conveniently pre-punched booklet describes a wide variety of strip terminals available and a number of dimension charts for easy, accurate selection. The booklet is complete with photographs, outline drawings, and tables.

Circle 182 on Inquiry Card, page 101

Vibration Mountings

A 16-page product bulletin describing Temproof Mountings is now available from Lord Mfg. Co., 1635 W. 12th St., Erie, Pa. These mountings are designed primarily to protect airborne electronic equipment against shock and vibration. Bulletin No. 710 contains complete engineering data, including tables and transmissibility curves, on design and performance of 3 types of mountings.

Circle 183 on Inquiry Card, page 101

Wall Chart

John Oster Mfg. Co., 1 Main St., Racine, Wis., has offered a new easy-to-read chart tabulating ounce inch torque vs RPM at stated horsepower. Engineering data is given for ranges from 1/200 H.P. to 1/3 H.P. and from 1 to 14,000 RPM.

Circle 184 on Inquiry Card, page 101

Transistor Batteries

A 4-page, multi-colored bulletin has been issued by the National Carbon Co., 30 E. 42nd St., New York 17, N. Y. which describes their new line of "Eveready" Energizers for use with transistorized circuits.

Circle 185 on Inquiry Card, page 101

Sampling Devices

General Devices, Inc., P. O. Box 253, Princeton, N. J. has issued a 16-page bulletin titled "Electronic and Electromechanical Sampling Devices for Multichannel Instrumentation." The booklet contains more than 35 diagrams and photographs to illustrate the subject of selection and application of sampling devices.

Circle 186 on Inquiry Card, page 101

Miniature AC Motors

A 10-page catalog describing 4 basic models and sizes of ac hysteresis synchronous and induction motors and 129 spur and planetary gear reductions is available from Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. Performance, MIL Specifications and other technical data is given.

Circle 187 on Inquiry Card, page 101

Connectors

Winchester Electronics, Inc., Willard Rd., Norwalk, Conn. has just issued a set of bulletins which represent up-to-date revisions and additions to their catalog. Bulletins are complete with photographs, outline drawings, electrical and mechanical specifications.

Circle 188 on Inquiry Card, page 101

Forced Air Cooling

A 6-page technical bulletin on cooling electronic equipment has been published for electronic engineers, physicists and builders of rack-mounted electronic cabinets. Booklet describes supply engineering information on thermal design and survey methods of cooling electronic components. Helpful recommendations are made as to type of cooling to be used for various applications. Tables and charts are included on performance, application, methods, etc. McLean Engineering Labs., P. O. Box 228, Princeton, N. J.

Circle 189 on Inquiry Card, page 101

Selenium Rectifiers

Syntron Co., 263 Lexington Ave., Homer City, Pa. has issued an illustrated 8-page booklet which gives complete descriptions, data and specifications for rectifier plates and stacks and for cartridge-type rectifiers and stacks.

Circle 190 on Inquiry Card, page 101

R-F Measurements

How to use comparative r-f measurement techniques without costly, time-consuming test "set-ups" and "take-downs" without problems of detector and amplifier balancing is described in a bulletin available from the Jerrold Electronics Corp., 15th St. & Lehigh Ave., Philadelphia 32, Pa.

Circle 191 on Inquiry Card, page 101

Switches

A 24-page engineering catalog No. G-300 issued by Grayhill, Inc., 561 Hillgrove Ave., La Grange, Ill. covers their complete line of miniature push button switches, rotary switches, binding post, test clips and miscellaneous components. Every part is illustrated with most of the products also shown with exploded views. In addition, engineering drawings of all items are included, giving all standard dimensions.

Circle 192 on Inquiry Card, page 101

Television System

A 4-page brochure describes a precision television system, Model PD-250 manufactured by Precision Laboratory Inc., 63 Bedford Rd., Pleasantville, N. Y. System features, specifications, tube complement, and mechanical dimensions are given.

Circle 193 on Inquiry Card, page 101

Sensitive Switches

A 4-page catalog-digest which covers a line of miniature snap-acting precision switches; includes photographs, descriptions, actuator types, force - and - movement specifications, and electrical ratings. Types shown are general-purpose, high-sensitivity, immersion-proof, metal-cased, reset, ac/dc, automatic-appliance, and AN-JAN switches, Unimax Switch, Div., The W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

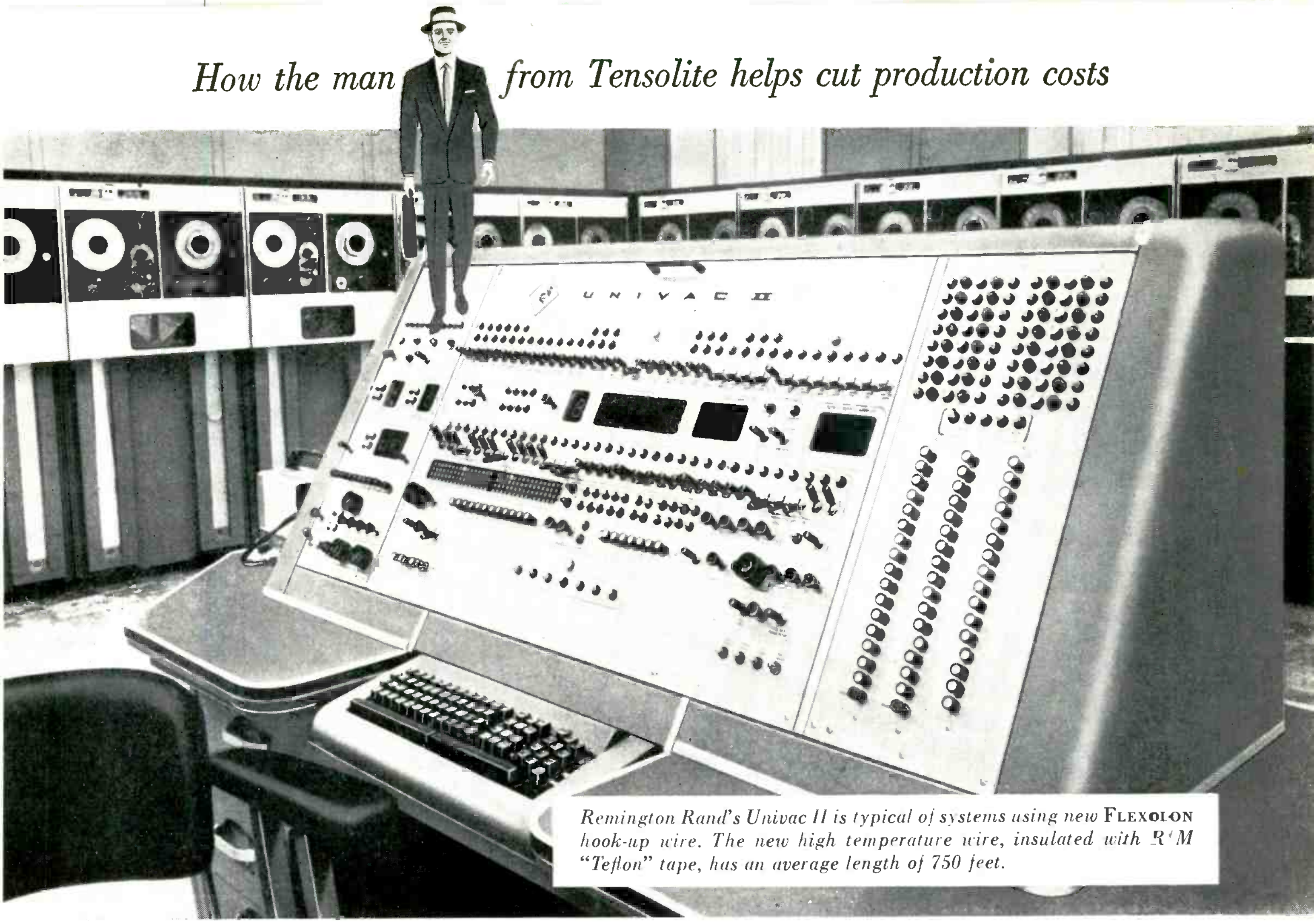
Circle 194 on Inquiry Card, page 101

Tachometer Generators

A 12-page engineering report has been released for distribution by Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J. The report describes test procedures and test equipment used in determining the stability linearity and other characteristics of dc tachometer generators.

Circle 195 on Inquiry Card, page 101

How the man from Tensolite helps cut production costs



Remington Rand's Univac II is typical of systems using new FLEXOLON *hook-up wire. The new high temperature wire, insulated with R/M "Teflon" tape, has an average length of 750 feet.*

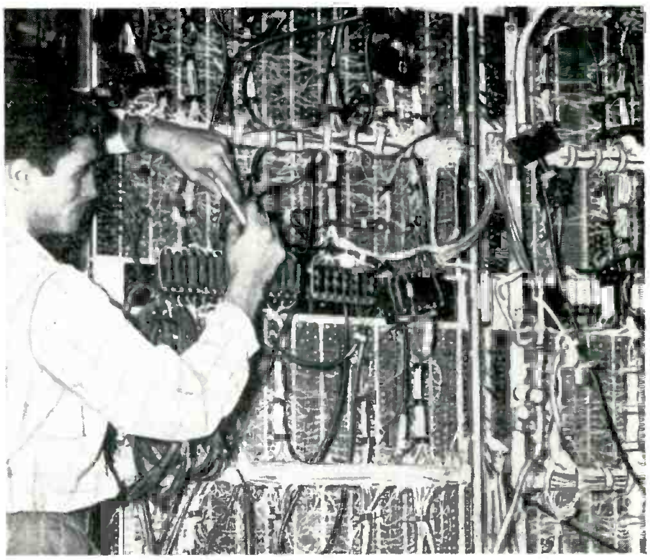
New FLEXOLON hook-up wire with Raybestos-Manhattan R/M "Teflon" tape reduces wire scrap up to 90%

New FLEXOLON high temperature hook-up wire, insulated with Raybestos-Manhattan "Teflon" tape, is setting economy records throughout industry. At Remington Rand, where FLEXOLON wire is used in Univac II, its guaranteed 250-foot minimum length has drastically reduced wire scrap.

Another manufacturer reports a 90 per cent scrap reduction with FLEXOLON wire. A user of 3-foot lengths, he formerly obtained 16 pieces from each 50-foot length of ordinary wire. Two feet ended up as scrap. By switching to FLEXOLON wire, he now obtains 83 pieces from each guaranteed 250-foot length, with only one foot wasted. This is just 1/10 of his former scrap.

Although a minimum 250-foot length is guaranteed, the average distribution of new FLEXOLON wire is approximately 750 feet, assuring even greater savings. Longer lengths of FLEXOLON hook-up wire will also cut your production costs by minimizing set-up time on automatic equipment.

To learn the many other benefits of FLEXOLON hook-up wire . . . its greater dielectric strength, extra flexibility, higher average concentricity . . . call the man from Tensolite. Or write for informative FLEXOLON hook-up wire bulletin.



Univac engineer wires central computer with new FLEXOLON *high temperature hook-up wire. Greater flexibility of the new wire also reduces wiring time.*

Tensolite INSULATED WIRE CO., INC.

West Main Street, Tarrytown, N. Y. • Pacific Division: 1516 N. Gardner St., Los Angeles, Calif.

Circle 95 on Inquiry Card, page 101

WASHINGTON

News Letter

CONGRESS SPECTRUM STUDY—The creation of a five-man commission to determine whether the government is utilizing frequencies that should be available for television was slated to be approved before the adjournment of Congress. The Senate passed unanimously and without debate the resolution of Sen. Charles E. Potter (R., Mich.), but House action on a similar measure by Rep. William Bray (R., Ind.) had not come prior to the EI press deadline. The commission is to be composed of two members appointed by the President, one each by the Vice President (as president of the Senate), and the Speaker of the House, and the FCC Chairman.

GOVERNMENT OPPOSITION—Comments of government agencies on the Congressional study in general either oppose the spectrum investigation or urge that it be extended to cover civilian uses of the spectrum, not just television. Speaking for the Defense Department, the Air Force said the projected study would duplicate a recent survey of the 50-300 MC portion of the spectrum. The AF pointed out that "Since there is evidence that the most efficient use is not being made of the FM broadcasting and UHF television bands, (it) would not oppose a study of frequency usage of non-government users between 50 and 300 MC; similarly the department . . . would not oppose a study of the frequency usage made by all users, both government and non-government, of the frequency spectrum exclusive of the 50-300 MC portion."

INSURMOUNTABLE OBSTACLES — Paul Goldsborough, Director for Telecommunications Policy of the Defense Department, told ELECTRONIC INDUSTRIES that a suggested shift in frequency allocations resulting in a consolidation of television channels into one solid band would create "insurmountable technical, economic, and logistical obstacles" for the military. He commented on the suggestion of FCC Commissioner T. A. M. Craven for a block of 25 VHF TV channels between 174 and 324 MC. Mr. Goldsborough stated that the investment in airborne and ground equipment in this band runs into hundreds of millions of dollars and the use of it extends all over the world.

PAY-TV DEEP FREEZE—As a result of a request by House Commerce Committee Chairman Oren Harris (D., Ark.), the FCC has placed its determination of the future of pay television into an even deeper "deep freeze." The Commission agreed unanimously to withhold approval of pay-TV trial operations until the end of the next session of Congress—mid-1959. The FCC action was taken in view of the interest of Congress in regard to subscription television and because Congress could not study the issues during the present session.

NOT HURT TV DEVELOPMENT — The National Community Television Association has emphasized to the FCC that analysis of the record does not show community television antenna systems have adversely affected the development of television broadcasting. In comments to the FCC, two TV networks, NBC and AB-PT, took the position that CATVs have played a useful role in bringing television to communities which otherwise would have limited or no service, but the FCC should protect the networks on the property rights of their programs picked up by CATVs.

MOBILE RADIO INQUIRY—An FCC investigation questioning "whether major landline telephone companies should be permitted to engage in mobile radio service, and if so, how they should be regulated in the public interest" has been asked by Motorola, Inc., together with two miscellaneous common carriers and three mobile radio maintenance concerns. Motorola and the other organizations raised questions in their petition to the FCC about all telephone company mobile radio operations except those used in construction and maintenance of plant. The Motorola petition also cited that common carrier radio operations should be competitive and urged a nation-wide geographical frequency assignment plan.

25-890 MC HEARINGS—The FCC in its plans for an overall investigation into present and future non-government uses of frequency space between 25 and 890 MC has called for all persons desiring to appear and present evidence to advise the Commission by Oct. 1. The pre-hearing procedures outlined by the FCC are closely similar to those used in the microwave (above 890 MC) proceeding last year. The 25-890 MC area contains all television broadcast allocations and sizeable portions of the allocations for many other major radio services.

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ROLAND C. DAVIES
Washington Editor

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Selenium Rectifiers • Communications, Radar and Navigation Equipment

Circle 41 on Inquiry Card, page 101

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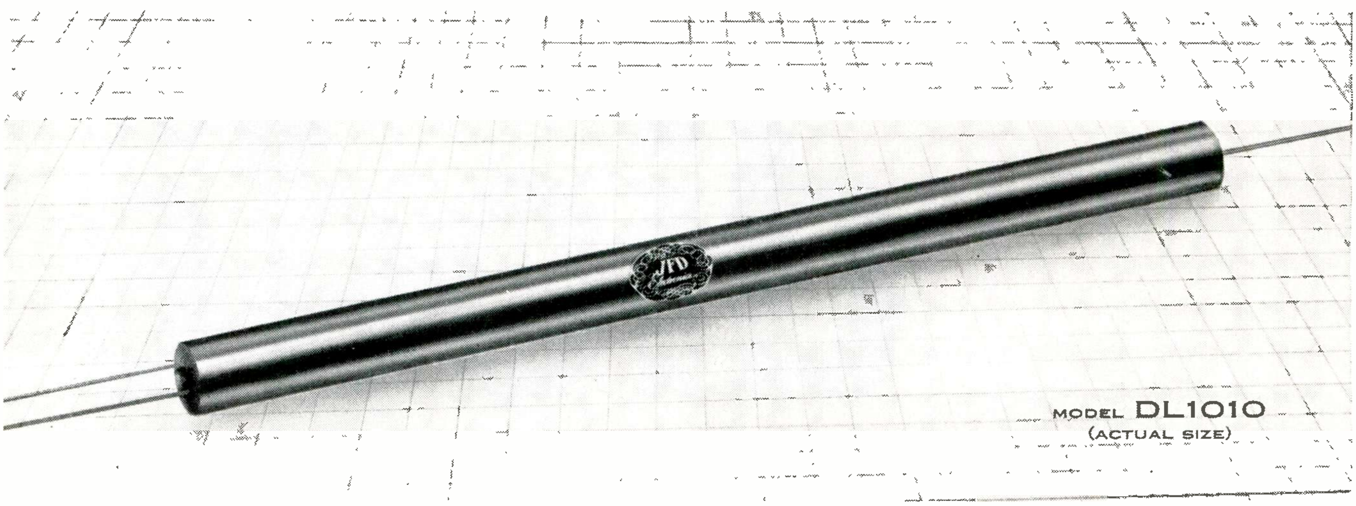

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ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

81 **Acme Electric Corporation**—Voltage stabilizers

16 **Adams & Westlake Company, The**—Mercury-to-mercury relays

64 **Aircraft Radio Corporation** — Snapslide fastener

65 **Alden Products Company**—Tube cap connectors

71 **Alford Manufacturing Co.**—TV antennas

96 **Allen-Bradley Co.**—Hot molded resistors

66 **Allied Radio**—Electronic supply catalog

112 **Alphlex Tubing Division, Alpha Wire Corporation**—Plastic tubing & sleeving

19 **American Electrical Heater Company**—Electric soldering iron

25 **American Time Products, Inc.** — Frequency standards

28 **A M P Incorporated** — Patchcord programming system

12 **Amperex Electronic Corp.** — Germanium and silicon diodes

53 **Amperite Co., Inc.**—Thermostatic delay relays & ballast regulators

100 **Andrew Corporation**—Antennas, antenna systems & transmission lines

14 **Arnold Engineering Company, The** — Magnetic materials

66 **Audio Development Company**—Telephone coils

39 **Automatic Manufacturing Div. of General Instrument Corp.**—Axial lead type silicon rectifiers

83 **Bead Chain Mfg. Co., The**—Contact pins, terminals, jacks, bead chain drives

92 **Biwax Corporation**—Potting compounds

30 **Blaw-Knox Company, Equipment Div.**—Microwave towers

85 **Booker & Wallestad, Inc.**—Custom molds, miniature plastic parts molding

74 **Borg Equipment Division, The George W. Borg Corp.**—Synchronous and induction type motors

77 **Borg Equipment Division, The George W. Borg Corp.** — Instruments, standards, motors

87 **Bruno-New York Industries Corp.**—"Pigtailoring" machine

4 **Brush Instruments Division of Clevite Corp.**—Ultralinear recording systems

32 **Burnell Co., Inc.**—Encapsulated toroids

29 **Bussmann Mfg. Division, McGraw-Edison Co.**—Fuses and fuseholders

68 **Cannon Electric Company** — Audio and electronic plugs

63 **Canoga Corporation of California, A Division of Underwood** — Transistorized power supply

15 **Centralab, A Division of Globe-Union, Inc.**—Capacitors

37 **Cinch Manufacturing Corporation** — Hinge connectors

27 **Cleveland Container Co., The**—Phenolic tubing

97 **Columbian Carbon Co., Mapico Color Unit**—Synthetic iron oxides for ferrites

78 **Conrac, Inc.**—Color monitors

82 **Control Devices, Inc.**—High voltage peak meter

67 **Curtiss-Wright Corp., Electronics Div.**—Thermal time delay relays

33 **Corning Glass Works, Electronic Components Dept.**—Printed circuit board

49 **Dade County Development Department**—Economic Study of Metropolitan Miami

44 **Dale Products, Inc.**—Resistors

13 **Delco Radio Division of General Motors**—High-frequency power transistor

31 **Deutsch Company, The**—Miniature plugs and receptacles

79 **Dilectrix Corporation** — Cast TEFLON film

99 **Dorne & Margolin, Inc.**—Airborne antennas

5 **DuMont Industrial Tube Sales**—Cathode ray tube

98 **Du Mont Instrument Div., Allen B. DuMont Laboratories, Inc.** — Vacuum tube voltmeter

102 **Eisler Engineering Co.** — Vertical spot welder

57 **Electrical Communications Inc.**—Selective control devices

103 **Film Capacitors, Inc.**—Precision film capacitors

48 **F-R Machine Works, Inc.** — Waveguide components

104 **Freed Transformer Corp.**—Transformers

8 **General Electric Co., Receiving Tube Dept.**—Tube Design News

73 **General Transistor Corporation**—Transistors

105 **Graphic Systems**—Visual control panel

2 **G-V Controls Inc.**—Thermal time delay relays

56 **Houston Fearless Corporation** — Remote control TV camera heads

6 **Hughes Products**—Microwave tubes

24 **Hughes Products, Semiconductor Division**—Germanium point-contact or silicon junction diodes

70 **Illinois Condenser Company**—Subminiature electrolytic capacitors

34 **Indiana Steel Products Company, The**—Permanent magnets, magnetic research

106 **Induction Motors Corp.**—Motors

54 **Industrial Test Equipment Co.**—Phase sensitive null meter

107 **International Electronic Research Corp.**—Heat-dissipating tube shield Guide

42 **JFD Electronics Corporation** — Delay lines

94 **Jones Division, Howard B., Cinch Manufacturing Corp.**—Plugs & sockets

76 **Johnson Company, E. F.**—Metal-clad nylon tip jacks

69 **Kay Electric Company**—Attenuators

20 **Kester Solder Company**—Flux core solder

9 **Kleinschmidt Laboratories, Inc., A Subsidiary of Smith-Corona Inc.** — Teleprinted communications equipment

47 **Lavoie Laboratories, Inc.**—Robotester

88 **Measurements, A McGraw-Edison Division**—Pulse generator

80 **Methode Manufacturing Corp.** — Custom printed missile circuitry

108 **Mica Importers Association, Inc.**—Mica insulation

45 **Motorola Semiconductors, Motorola, Inc.**—Computer transistors

84 **Narda Microwave Corporation, The**—Coaxial and waveguide instrumentation for microwaves & UHF

22 **Narda Ultrasonics Corp., Subsidiary of Narda Microwave Corp.** — Ultrasonic cleaner

18 **National Vulcanized Fibre Co.**—Vulcanized fibre and nylon

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New Products and Technical Data—September '58

226 Accelerometer, linear—Minneapolis-Honeywell
216 Amplifier, relay—Acromag, Inc.
208 Amplifier, remote—Gates Radio Co.
207 Blower, cooling — Air-Marine Motors, Inc.
231 Capacitor, tantalum—P. R. Mallory & Co.
202 Capacitor, tantalum—Ohmite Mfg. Co.
227 Chopper, miniature—The Bristol Co.
222 Connector, miniature — Dejur - Amsco Corp.
203 Connectors, modular—Methods Mfg. Co.
199 Counters, modular—Erie Resistor Corp.
198 Counters, preset — Freed Transformer Corp.
219 Crystals—Bulova Watch Co.
218 Detector, X-ray — Universal Transistor Prods.
209 Film processor—Houston Fearless Corp.
210 Generator, AM-RF—Philco Corp.
215 Generator, microwave — Raytheon Mfg. Co.
228 Generator, pulse—ESC Corp.
201 Indicator, jumbo—Burroughs Corp.
211 Mobile communications—Motorola Inc.
213 Phono drawers — Par-Metal Products Corp.
205 Pots, subminiature—Daystrom Pacific
196 Power supply, preamp—Tektronix, Inc.
197 Rectifiers, selenium—IT&T Corp.
206 Switch, miniature—Meletron Corp.
230 Switch, subminiature—Electrosnap
225 Tape, electrical—Dilectrix Corp.
220 Tape loop adapter—Consolidated Electrodynamics Corp.
212 Tape recorder—Presto Recording Corp.
217 Towers—Rohn Mfg. Co.
229 Transducer, pressure—Fairchild Controls Corp.
221 Transformer, audio—Chicago Std. Transformer Corp.
224 Transistor, switching—Motorola Inc.
214 Tubing, core—Stevens Prods., Inc.
223 Waveguide, flexible—Airtron, Inc.
204 Voltage divider—Rinco, Inc.
200 Winder, transformer—Geo. Stevens Mfg. Co., Inc.

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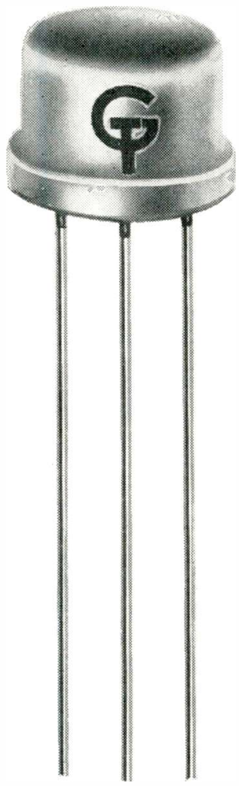
NEW TECH DATA

169 Amplifiers, pulse magnetic — Hoffman Electronics Corp.
185 Batteries, transistor — National Carbon Co.
161 Capacitors—Illinois Condenser Co.
172 Capacitors, silvered mica—Electro Motive Mfg. Co.
164 Ceramic to metal — Advanced Vacuum Products
184 Chart, wall—John Oster Mfg.
167 Coating, magnet wire — Dow Corning Corp.
188 Connectors—Winchester Electronics
173 Connectors, miniature—The Deutsch Co.
162 Contact selection—Stackpole Carbon Co.
165 Clamps, cooling & retaining—Birtcher Corp.
186 Devices, sampling—General Devices, Inc.
189 Forced air cooling—McLean Engineering Labs.
195 Generator, tachometer—Servo-Tek Products
175 Klystron facts—Eitel-McCullough
166 Laminates—The Formica Corp.
171 Leak detector—Veeco Vacuum Corp.
191 Measurements, r-f—Jerrold Electronics Corp.
174 Perforated metals—F. L. Berglund Co.
187 Motors, miniature ac—Globe Industries
183 Mountings, vibration—Lord Mfg. Co.
178 Recorder, airborne—Consolidated Electrodynamics
190 Rectifiers, selenium—Syntron Co.
180 Publication, R & D—Remington Rand
179 Resistors, variable — Chicago Telephone Supply Corp.
181 Speakers & drivers—James B. Lansing Sound, Inc.
192 Switches—Grayhill, Inc.
194 Switches, sensitive—The W. L. Maxson Corp.
193 Television system—Precision Labs., Inc.
182 Terminals, strip—Kent Mfg. Corp.
163 Test equip. reports—I T & T
177 Transistor booklet — Sylvania Electric Prods.
170 Transistors, computer—General Electric Co.
168 Tubes, frame grid—Amperex Electronics Corp.
176 Tubes, microwave—Varian Associates

NEW HIGH VOLTAGE NPN TRANSISTORS ALLOW TUBE REPLACEMENT AND CIRCUIT COMPATIBILITY



GT's new high voltage germanium alloyed junction transistors now allow the same optimization as formerly could be realized only with vacuum tubes. These characteristics plus conventional "transistor" advantages offer new design opportunities in computers, magnetic memory cores, data processing equipment, gas filled indicator tubes and other applications where reduction of space, weight and high reliability are prime requisites.

The GT 1200 is particularly suited to drive gas filled display tubes, such as the Burroughs Nixie ® and Pixie ®, without changing existing circuitry other than altering voltages so as not to exceed the rating of the transistor.

		GT 1200
Collector to Base Voltage (Emitter Open)	$I_C = 25\ \mu A$	90 Volts Min.
Emitter to Base Voltage (Collector Open)	$I_E = 25\ \mu A$	20 Volts Min.
Collector to Emitter Voltage (Punch Through)	$I_E = 25\ \mu A$	90 Volts Min.

Supplied in TO-5 case

GT 1201 — GT 1202, in addition to driving gas filled display tubes, are ideally suited for driving high inductance loads, driving transformer coupled loads and allow more nearly perfect impedance matching. These transistors are fast devices capable of handling high impedance loads and large signal swings.

		GT 1201	GT 1202
Collector to Base Voltage (Emitter Open)	$I_C = 25\ \mu A$	75 Volts Min.	45 Volts Min.
Emitter to Base Voltage (Collector Open)	$I_E = 25\ \mu A$	20 Volts Min.	20 Volts Min.
Collector to Emitter Voltage (Punch Through)	$I_E = 25\ \mu A$	75 Volts Min.	20 Volts Min.

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ACTUAL SIZE

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Circle 73 on Inquiry Card, page 101

Engineering Education *(Continued)*

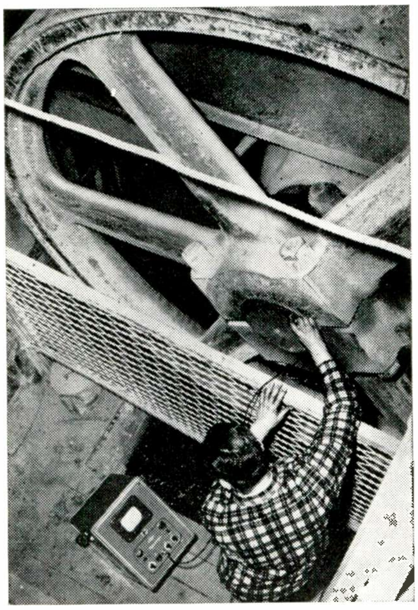
Information Theory

Information Theory is another new subject which came from the communication art with its problems of signals and noise but which has far-reaching implications into all of our measuring and recording techniques, data handling and communication of ideas. Here again the mathematical basis of Information Theory brings in probability and statistics normally not a part of engineering mathematics, but which as a single example is also vital to the work of the Quality Control Engineering in inspection procedures and to modern vibration testing using random loading procedures.

Aeronautics has also had problems of aeroelasticity and flutter suddenly come into prominence with higher speed flight. New methods of analysis have emerged, based in large measure on computer capabilities. Thermal stress problems plague the designer of high speed aircraft and hundreds of little problems have arisen because of the extended range of environment with very high altitude flight.

Jet Propulsion

Jet Propulsion has redirected engineering education toward a more theoretical consideration of physical-chemistry principles and to the basic understanding of combustion problems. Materials of motors and nose cones as in all other high temperature, high performance devices, become a real limitation. Our college work in engineering materials must be re-examined and conducted on more fundamental levels of Physical Metallurgy and Solid State.



Ultrasonics for testing, inspection, cleaning and in medicine, are just a few applications of this new principle that was, until recently, known to a very few, much less taught in engineering schools. At left, a Sperry Reflectoscope is used to ultrasonically inspect machinery between runs, thus eliminating prolonged downtime and production losses.

Guidance and control, with related instrumentation and telemetering focus attention on servomechanisms which must operate under extreme environmental conditions with fantastic accuracy and exceptional reliability. But, more significantly, jet propulsion and the guided missile have developed to an extent even greater than for aircraft a type of systems thinking which is the very essence of engineering.

Chemical Engineering, also, has new facets brought about in large measure by wartime nuclear work. Isotope separation, as by the Gaseous Diffusion Method has become a new technique; new solvent extraction schemes have evolved; ion exchange techniques have moved forward in spectacular fashion.

Structural Engineering

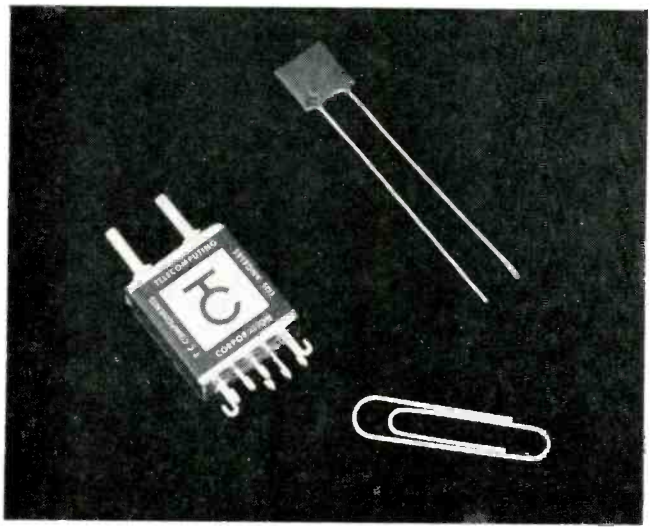
Structural Engineering has had less spectacular, but none-the-less important advances which modify our engineering education. New methods of design and construction have appeared. Much more detailed analysis of stress is being done and digital computer techniques are assuming greater and greater significance in advanced designs, particularly in aircraft and missile structures. Test methods and instrumentation have made remarkable advances which are rapidly replacing the traditional "busting laboratory" and giving the students new confidence and a detailed knowledge of stress distribution to verify more sophisticated designs. New schemes for construction, such as tilt-up and lift-slab, pre-stress and limit design, encourage the student to imagine still other ways of building structures and deliberately instrumenting them in the process of construction to gain new design information. Also structural engineers have become more conscious of dynamic load effects caused by wind, earthquakes and possible blasts, and so the students of Civil Engineering are getting a new appreciation for dynamics and for the related mathematics.

Non-destructive testing, with radiation and ultrasonic techniques is relatively new in our laboratories. New instrumentation has greatly extended our capabilities in research, measurement and control. Both old and new physical principles have been adapted to sensing devices, creating whole families of transducers which have rapidly become working tools of technology as well as being beautiful examples of basic principles.

The list could go on but I have cited enough to indicate that during the past decade much new material has been crowded into an already crowded curriculum and the intellectual level of the work has been raised markedly. Also in the new engineering we find ourselves working more and more in areas earlier identified as classical physics. Solid state, spectroscopy, cryogenics, low and high pressure are plasmas, electron mechanics and optics, physical properties of materials at extremes of temperature are subjects of importance in many of today's engineering developments. Then when we further intensify our interest in the humanities, we are clearly faced with such a crowded course schedule of study that some of the older engineering material must be omitted and deferred to experience learning.

Dropping Courses

Getting rid of some of the older courses has not been easy. Professors have vested interests in these and are reluctant to give up courses which they have had fun teaching for the last fifteen or twenty years. Also, some of the Professional Societies have viewed



Guided missiles and portable TV sets both further the trend towards miniturization; saving space and weight, using modular methods in their compressed but complex electronic circuits.

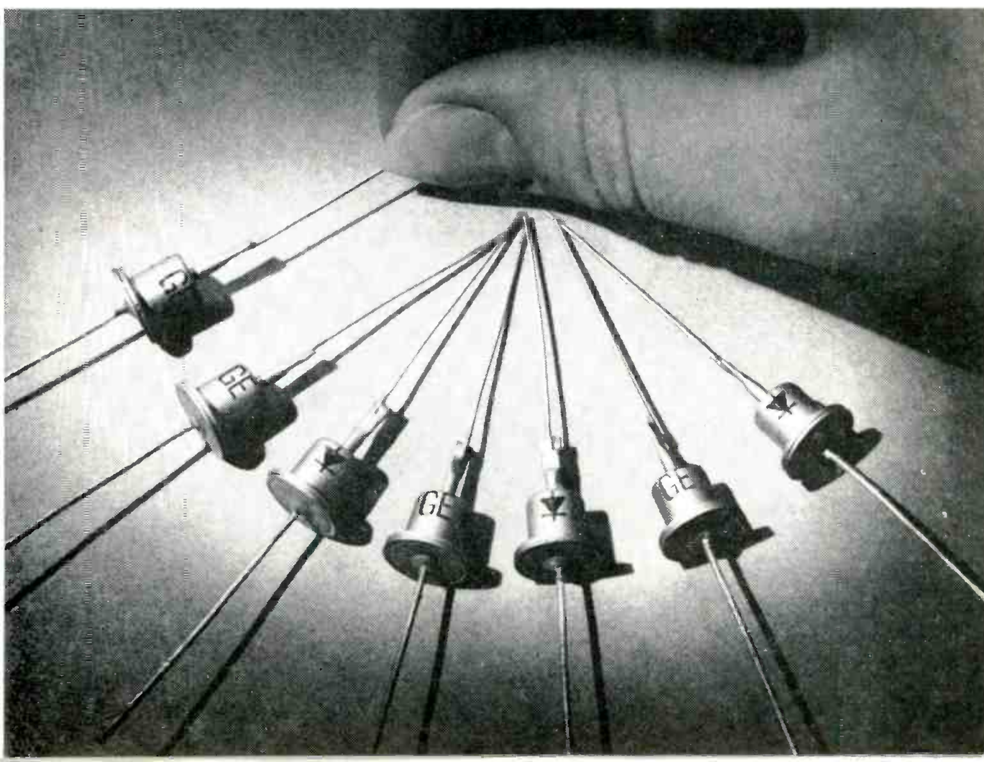
with alarm the disappearance or shrinking of some of the traditional engineering college material, such as Shop Work, Foundry, Drafting, Surveying, and the courses which deal with the art and practise of engineering. Not a few professional men are troubled by the young graduates of today who may not be able to earn their way immediately as designers or operators. Yet we in engineering education who are trying to anticipate the trends and the consequent educational requirements take comfort in the advice of many thoughtful engineers to concentrate in the colleges on the fundamentals, the basic sciences and engineering sciences and on the humanities, and to leave to industry the specialized training on the job or in more formal company education and orientation programs.

Thus we see that today's engineering and tomorrow's engineering requires greater breadth of education and depth as well. Let me quote to you a few of the appeals in today's recruiting advertising which suggest new achievements in research, design and production involving materials, techniques and methods not presented in text books or even job descriptions. These few samples will give a feeling of this climate of modern engineering. Phrases such as "a career that requires creative thinking, utilizes all your skills and talents, offers the chance to learn the latest techniques,"—"want to grab the atom by the tail and put it to useful work?" "—want to dig in and really get down to the basics?" "—start today and plan tomorrow."—"up to two years of theoretical and practical training are offered."—"you will push beyond existing limitations into new concepts and new products,"—"today more and more new ideas come from men trained to an awareness of that which is yet to be accomplished,"—"the door to electronic wonders is only slightly ajar. The greatest discoveries lie ahead," "—seeking men educated to solve tomorrow's problems which today cannot even be stated."

The emphasis is on the new, the undiscovered ideas, devices and systems. Creative thinking is an ideal eagerly sought and carefully nourished. Advanced ideas and methods intensify the need for a basic engineering education which has extensive scope and depth in the fundamental sciences and the engineering sciences. This basic education is a foundation, a start, for professional work to be learned in practise and for graduate study which is becoming increasingly a necessity. Admittedly a four-year curriculum with this orientation must omit some of the engineering details which we have all been accustomed to present in our teaching and which have some immediate value to the young graduate if he happens to fall into work in the general area he has studied. But, if our engineers of the future are to be identified with the highest levels of effort in technology, the advanced designs and the new materials and processes, we must accept the fact that a Bachelor's degree program is insufficient for the highest level of professional engineering practise in the same way our colleagues in Physics and Chemistry expect the Bachelor's degree to be an initial, rather than a terminal degree. We are all well aware of the fact that during the war many scientists distinguished themselves in work which was quite foreign to their professional experience and which they regarded as essentially engineering development or analysis in character, but which had never before been studied. In fact this experience has led to a certain arrogance among some scientists with respect to the competence of engineers. However, the invidious comparison overlooks the fact that at the time of World War II very

(*Continued on page* 111)

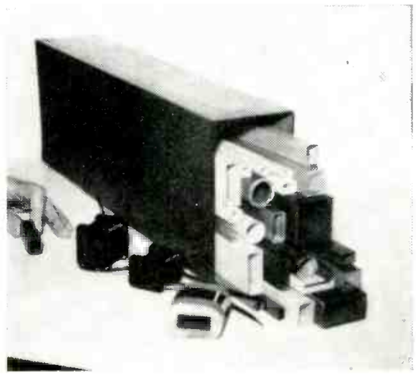
As semiconductors replace tubes for reasons of weight, performance and reliability, the quantum concepts and solid state physics gain importance in the classroom.



New Products

CORE TUBING

New manufacturing technique enables production of convolute wrapped cylindrical tubing with the same close tolerances as square tubing. All temperature ranges are included in the glass silicone, glass epoxy polyester, melamine, and paper phenolic materials which are used to produce these close tolerance, rigid, square cornered tubes for transformer core



insulation. Close-tolerance wall thicknesses are held to fabricate tubing to your specifications in lengths to 18 in. Stevens Products, Inc. 86-88 Main St., East Orange, N. J.

Circle 214 on Inquiry Card, page 101

MICROWAVE GENERATORS

A microwave power generator for research and development labs. is available. Called the PGM-100, the equipment is a completely integrated packaged generator with a maximum power output of 800 w. CW at 2450 MC. Peak power is as high as 1125 w. Equipment is used in experiments which depend on microwave power, including the production of free radicals in chemical and biological sub-

stances. Other applications include the excitation of gases for the production of spectral lines and microwave heating, curing and drying. Raytheon Mfg. Co., 100 River St., Waltham 54, Mass.

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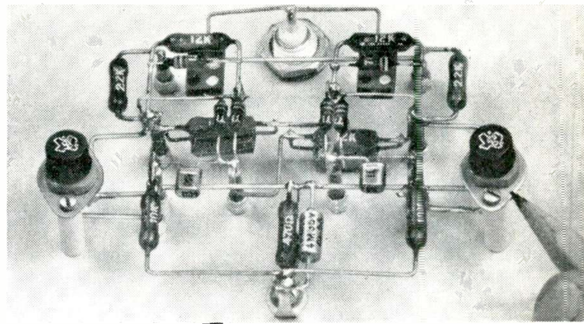
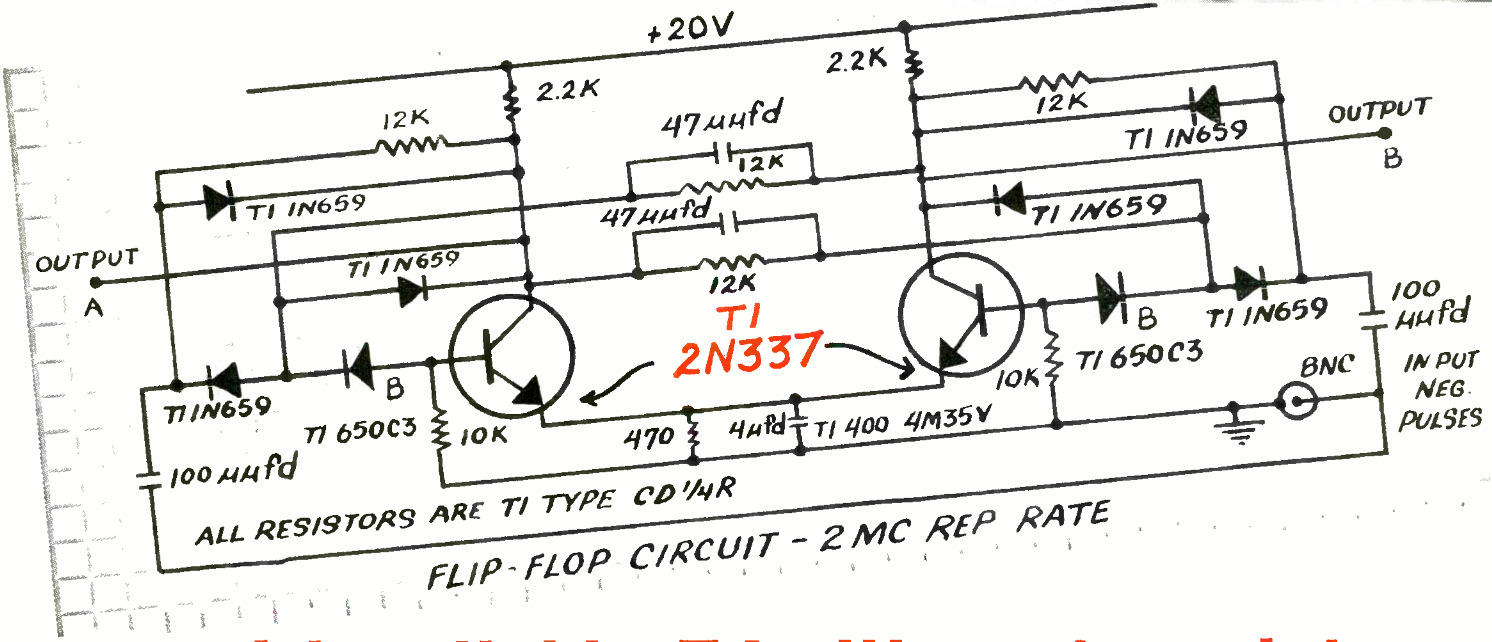
Circle 60 on Inquiry Card, page 101

HIGH SPEED SWITCHING





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New improved TI 2N337 and 2N338 specifications provide greater design flexibility for your switching circuits . . . nuclear counters . . . pre-amplifiers . . . RF amplifiers . . . 455 KC IF amplifiers . . . and many other high frequency applications.

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NEW IMPROVED SPECIFICATIONS FOR 2N337 AND 2N338

	from	to
BV_{CBO}	40 V max	45 V max
R_{CS}	300 Ω max	150 Ω max
h_{ib}	90 Ω max	80 Ω max

Consider TI's guaranteed specifications when you select semiconductor devices for your next transistor circuit.

design characteristics at 25° C ambient (except where advanced temperatures are indicated)

		test conditions		2N337 min	2N337 design center	2N337 max	2N338 min	2N338 design center	2N338 max	unit
I_{CBO}	Collector Cutoff Current	$V_{CB} = 20V$	$I_E = 0$	—	—	1	—	—	1	μA
	at 150°C	$V_{CB} = 20V$	$I_E = 0$	—	—	100	—	—	100	μA
BV_{CBO}	Breakdown Voltage	$I_{CB} = 50\mu A$	$I_E = 0$	45	—	—	45	—	—	V
BV_{EBO}	Breakdown Voltage	$I_{EB} = 50\mu A$	$I_C = 0$	1	—	—	1	—	—	V
h_{ib}	Input Impedance	$V_{CB} = 20V$	$I_E = -1mA$	30	50	80	30	50	80	Ohm
h_{ob}	Output Admittance	$V_{CB} = 20V$	$I_E = -1mA$	—	0.2	1	—	0.2	1	μmho
h_{rb}	Feedback Voltage Ratio	$V_{CB} = 20V$	$I_E = -1mA$	—	200	2000	—	300	2000	X10-6
h_{fb}	Current Transfer Ratio	$V_{CB} = 20V$	$I_E = -1mA$	0.95	0.985	—	0.975	0.99	—	—
h_{FE}	DC Beta	$V_{CE} = 5V$	$I_C = 10mA$	20	35	55	45	80	150	—
$f_{\alpha b}$	Frequency Cutoff	$V_{CB} = 20V$	$I_E = -1mA$	10	20	—	20	30	—	mc
C_{ob}	Collector Capacitance*	$V_{CB} = 20V$	$I_E = -1mA$	—	1.2	3	—	1.2	3	μμf
R_{cs}	Saturation Resistance†	I_B ‡	$I_C = 10mA$	—	75	150	—	75	150	Ohm
h_{fe}	Current Transfer Ratio	$V_{CB} = 20V$	$I_E = -1mA, f = 2.5mc$	14	22	—	20	24	—	db
t_r	Rise time§			—	0.05	—	—	0.06	—	μsec
t_s	Storage Time			—	0.02	—	—	0.02	—	μsec
t_f	Fall time			—	0.08	—	—	0.14	—	μsec

* Measured at 1 mc † Common Emitter ‡ I_B = 1mA for 2N337, 0.5mA for 2N338 § Includes delay time (t_d)

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DALLAS, TEXAS

Circle 43 on Inquiry Card, page 101

New Products

RELAY AMPLIFIER

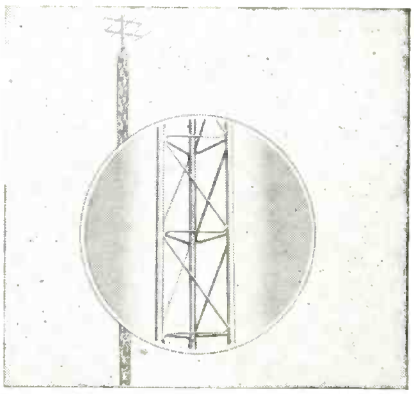
The Model 701 relay magnetic amplifier operates on less than 3 microwatts of dc control power and delivers 0.4 w. output. Amplifier makes it possible to operate small power re-

lays from low energy sources such as photoelectric cells, null detectors, and thermocouples with good reliability and accuracy despite extreme shock, vibration and temperature. It is connectable as either a linear amplifier or as a bi-stable amplifier and can operate as a memory device, as a time delay unit, or as a logic device. Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.

Circle 216 on Inquiry Card, page 101

TOWERS

A general-purpose communication and heavy-duty TV tower is available. Listed as the No. 25 tower, it features a 12½ in. equilateral triangular design, utilizes special 1¼ in. extra-heavy-gauge tubing for side rails and "zig-zag" solid steel cross-bracing. High-quality steel combines with good design and construction to give a sturdy tower. Can be utilized self-supporting to 50 ft. heights or guyed



up to 150 ft. Towers are available in either hot-dipped galvanized or "RohnKote" enamel finish. Rohn Manufacturing Co., 116 Limestone, Bellevue, Peoria, Ill.

Circle 217 on Inquiry Card, page 101

Computers are finding application just as fast as their theory is being disseminated. Solving complicated mathematical problems or storing vast amounts of data are just two performances that teachers can train young engineers to design them to do.

Engineering Education *(Continued)*

few engineers had had graduate education and even fewer held the Doctorate degree; whereas these useful scientists were, for the most part, exceptionally able people who were also Ph.D's Their additional education, together with maturity, and research experience was of great value, but most important of all, it was sufficiently fundamental and general to be applicable to new situations and new developments. In short, the education was general, flexible and powerful in application to new technology.

Such strength should also mark the education of our best engineers so that they may function truly as engineers in advanced development, synthesis and design with no handicap of a shallow base of fundamentals nor weakness in analysis. Obviously, not all engineers will work at this high level, but their basic education should not exclude them from the opportunity. Indeed the opportunities and challenges are unlimited in all areas of technology. The space age with its "new dimension" clearly dramatizes the future for us and for the public, and establishes a favorable climate and receptive attitude which will be of enormous help in our efforts to strengthen engineering education.

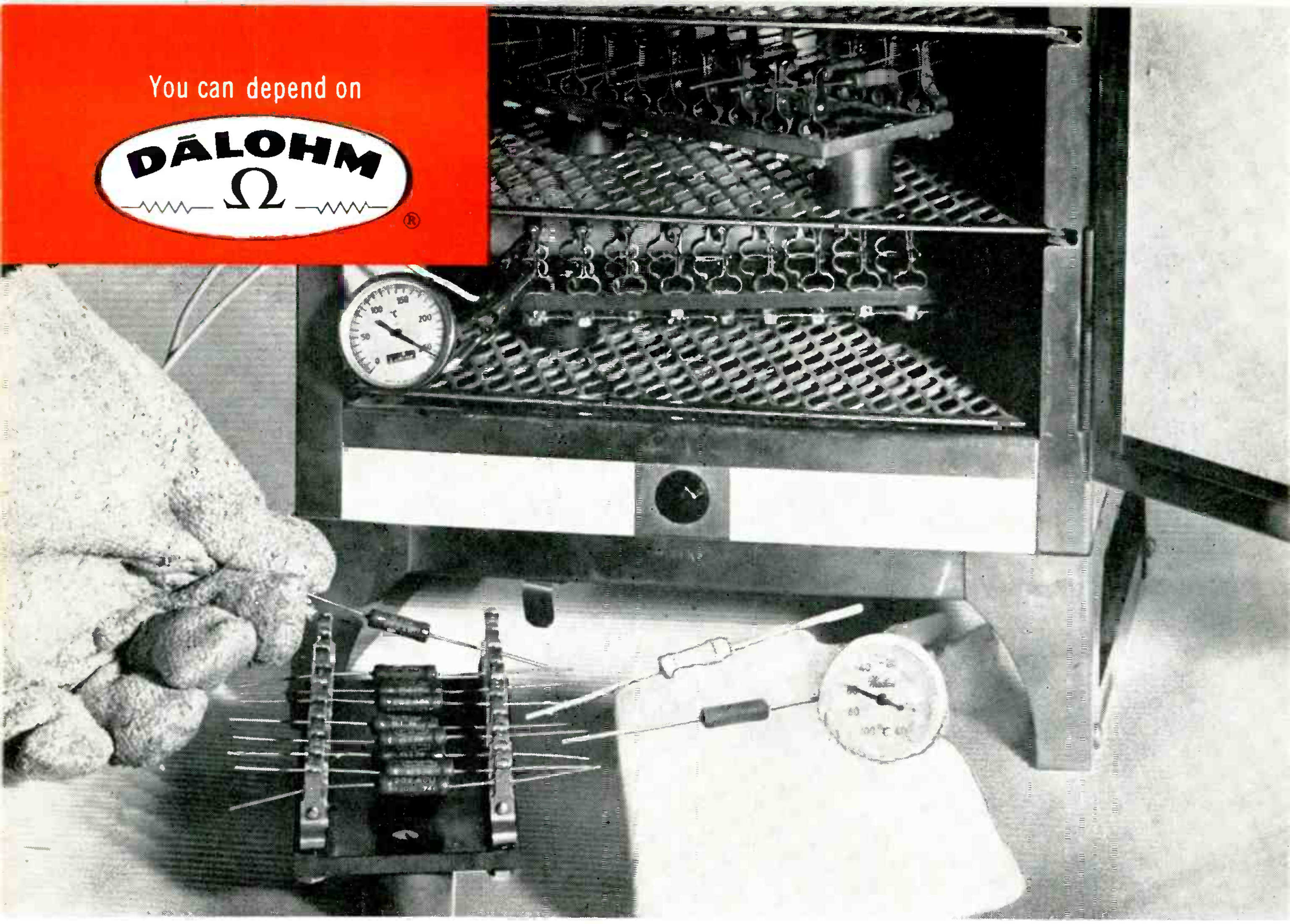
Quantity of Students

Thus far I have put the emphasis on quality, which should get the emphasis. As to quantity of engineering students, no one can predict. The general trend of population growth will bring an increasing number of students to the engineering colleges, even though no more than the customary fraction of college students enroll in engineering. Indices such as the number of engineers per unit of population, the number of engineers per unit of employed workers, the number of engineers per unit of gross national product or per unit of industrial productivity, all suggest that the long-term national demand for engineers will increase. However, we will see a gradual shift in the definition of an engineer. As we begin to achieve greater professional stature in engineering, the right to use the title "Engineer" will be more jealously guarded with the result of fewer but better educated engineers entering the profession. This will be a consequence of raising admission standards in the engineering schools with concurrent improvement in instruction to develop these better students to their full capacity. The Junior Engineer, the Engineering Aide, or Technician will begin to supplement the ranks of the engineering profession in order that the entire spectrum of engineering activity be complete. The enrollment in engineering schools is within our control, but I suspect that it will grow despite efforts at control. However, this growth cannot be allowed to interfere with the necessary improvement in engineering education.

Too Few Good Teachers

It is in the achievement of this improvement that we are in most serious difficulty. We have not enough competent teachers in our engineering colleges to meet the needs of increased enrollment and higher quality of instruction. Evidently the rapidly increasing amount of graduate work will create a greater demand for more teachers with advanced degrees. Nationally a large number of advanced degree men ought to enter the teaching profession. A special study for the ASEE by its Committee for the Development of Engineering Faculties reveals that during the next ten years, due to the normal growth of engineering student enrollment, faculty retirements, loss to industry, and for other reasons, about 9,500 new teachers of engineering will be needed, or some 1,000 per year. Last year a national total of 590 Ph.D. degrees in engineering was reported. A few of these new Ph.D's entered teaching, but if all of them had done so, the number would have been too small. Next year will not be significantly better. Thus our problem is, first to encourage more of the best students to

(*Continued on page* 115)



RS Resistors take severest THERMAL SHOCK . . . yet retain 100% reliability!

Dropping from 275° C. to −65° C. in just seconds is a severe test of resistor reliability. DALOHM RS resistors are made to meet such demanding specifications.

At the same time they provide a wide margin in meeting power, precision and reliability requirements. They are designed especially for sub-miniature applications.

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- Operating temperature range: −65° C. to 275° C.
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- Rated at 1, 2, 3, 5, 7, and 10 watts.
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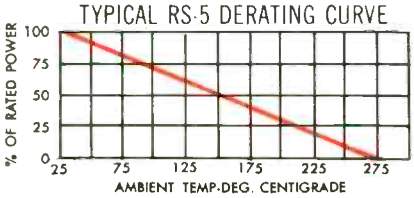
- Surpasses requirements of MIL-R-26C.
- Temperature coefficient: 0.00002/degree C.
- Complete welded construction from terminal to terminal.
- Silicone sealed, providing maximum protection from abrasion, moisture, salt spray and other environmental conditions, and assures high dielectric strength.

TYPICAL RS-5 DERATING CURVE



TWO NEW SUPER-MINIATURE SIZES for TRANSISTORIZED CIRCUITRY

RS-1A
3/32 X 13/32 inches,
1 watt,
.05 ohm to 30K ohms.

RS-1B
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1 watt,
1 ohm to 10K ohms.

COMPLETE RANGE OF WIRE WOUND POWER RESISTORS

RS-2A
3/16 X 13/16 inches,
2 watts,
.5 ohm to 28K ohms.

RS-2B
3/16 X 9/16 inches,
3 watts,
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RS-2
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3 watts,
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RS-5
5/16 X 7/8 inches,
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RS-7
5/16 X 1-7/32 inches,
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.1 ohm to 90K ohms.

RS-10
3/8 X 1-25/32 inches,
10 watts,
.3 ohm to 175K ohms.

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DALOHM line includes a complete selection of miniature precision power resistors (wire wound and deposited carbon), precision wire wound miniature trimmer potentiometers, and collet fitting knobs. Write for free catalog.

If none of DALOHM standard line meets your need, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production. Just outline your specific situation.

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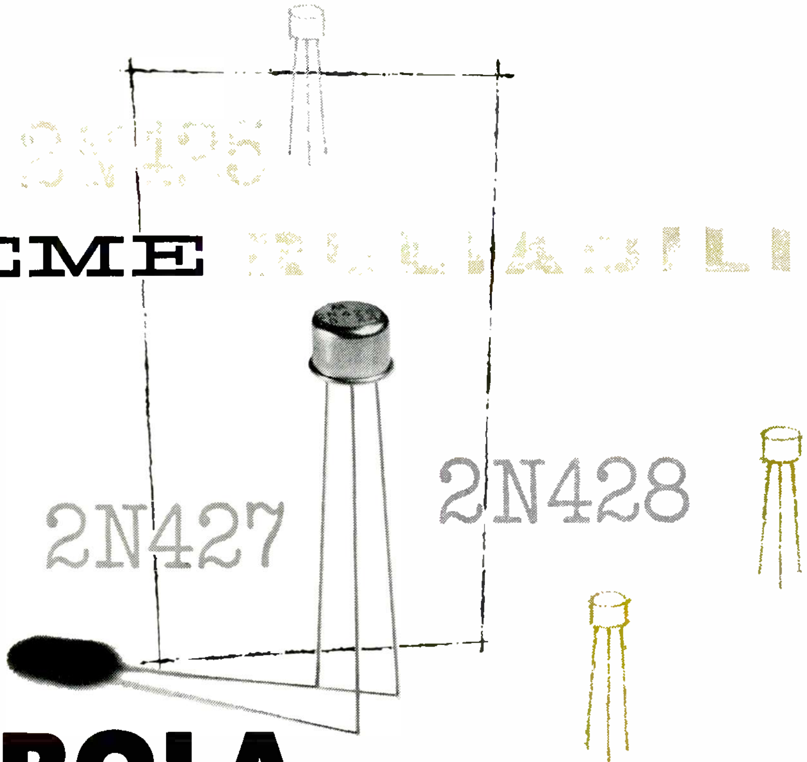
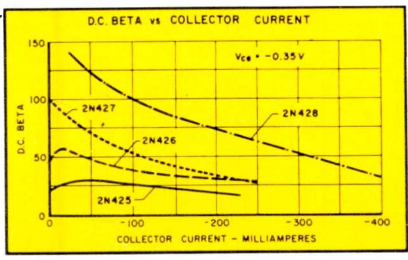
EXTREME RELIABILITY!



MOTOROLA COMPUTER TRANSISTORS

TECHNICAL DATA					
TYPE NUMBER	V_{CB} volts	V_{EB} volts	V_{CE} volts	f_{ab} min mc	h_{FE} typ.
2N425	—30	—20	—20	2.5	30
2N426	—30	—20	—18	3.0	40
2N427	—30	—20	—15	5.0	55
2N428	—30	—20	—12	10.0	80

Collector dissipation in free air: 150 mw
Derate 2.5 mw /°C above 25°C



- High reliability and stability assured by Motorola's advanced production methods and by rigid control of electrical parameters.
- Meet or exceed mechanical and environmental requirements of MIL-T-19500A.
- TO-9 package, hermetically sealed.
- Improved Beta vs Current characteristics.
- Temperature range —65°C to +85°C.
- Special selections to customer specifications are available.

FOR COMPLETE TECHNICAL INFORMATION concerning 2N425-428 switching transistors, contact the nearest Motorola regional office; or wire, write, or phone:

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BRidge 5-4411. Teletype PX 80

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WHitney 5-7500

HOLLYWOOD 28, CALIFORNIA
6555 Sunset Boulevard
HOllywood 5-3250

Circle 45 on Inquiry Card, page 101

New Products

X-RAY DETECTOR

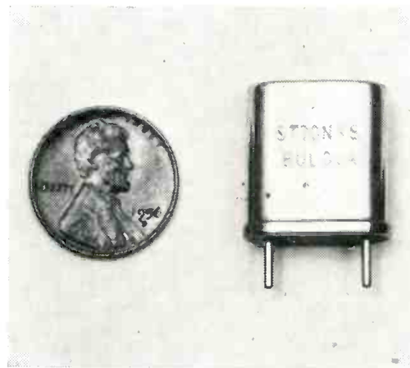
A portable protective device that warns against over-exposure to X-rays from high power radar equipment and other high voltage apparatus has been developed. Model 607-X

detects and measures X-rays produced as secondary emission from high power radar transmitters, magnetrons, klystrons, high potential cathode ray tubes, high voltage scientific electronic equipment, and high acceleration beam-type tubes. It operates accurately over the 100 KEV to 600 KEV energy level. Uses standard 1½ v. flashlight batteries. Universal Transistor Products Corp., 17 Brooklyn Ave., Westbury, L. I., N. Y.

Circle 218 on Inquiry Card, page 101

CRYSTALS

A new concept of small size with good stability in miniature low frequency shock mounted crystals is incorporated in the ST-70NXS series now available. Hermetically sealed and mounted in the miniature HC-6/U Military type holder, the series covers a range of 100KC to 250KC, with a tolerance of ±0.015% over a −50°C to +90°C range. Crystals can withstand initial shocks up to 100 G's and



meet all environmental specifications of MIL-E-5272, MIL-E-5400 and MIL Std. 202. Bulova Watch Co., Electronics Div., P-1059, Woodside 77, N. Y.

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enter graduate school to prepare for a career in engineering teaching and research; second, to make a teaching career as attractive, competitively, as possible with reasonable pay and good basic research opportunities; and third, to do everything possible to assist existing engineering faculties to develop professionally in the new technological directions and improve in effectiveness in their teaching. For it is only from superior teachers that we can expect to obtain the superior graduates. There is no substitute for quality.

In the next decade we must make an all-out effort to improve the quality of our engineering education. We will need help from all quarters. Industry, private foundations, and government should assist in the financial problems which must be met. Employers of engineers must use great restraint in drawing away from the colleges to attractive professional opportunities our best academic seedcorn. Professional engineers through their Societies can be helpful by developing an understanding of the serious problems which confront the colleges in up-grading curricula, dropping old material and introducing new material. We all at times feel that the younger generation is going to hell, but it is the younger generation that will be doing tomorrow's engineering problems not yesterday's or today's.

Alfred North Whitehead, the mathematician and philosopher, has some apt remarks which appear in "The Aims of Education": "A well-planned University course is a study of the wide sweep of generality. I do not mean that it should be abstract in the sense of divorce from concrete fact, but that concrete fact should be studied as illustrating the scope of general ideas. This is the aspect of University training in which theoretical interest and practical utility coincide. Whatever be the detail with which you cram your student, the chance of his meeting in after-life exactly that detail is almost infinitesimal; and if he does meet it, he will probably have forgotten what you taught him about it. The really useful training yields a comprehension of a few general principles with a thorough grounding in the way they apply to a variety of concrete details. In subsequent practise the men will have forgotten your particular details; but they will remember by an unconscious common sense how to apply principles to immediate circumstances."

Of course we rise hastily to remark "we are teaching principles"—but are we doing it in the sense that Whitehead means,—with thoroughness, with the breadth and with the full meaning of rigour which is the essence of mathematical thinking? Have we examined carefully our various courses for those concepts and principles which are really fundamental —so that the entire curriculum represents an orderly sequence of development? Is our traditional academic organization by departments a handicap in achieving the kind of breadth and unity which modern education should have? Today technology is so diffuse and so inter-disciplinary in character that it is difficult to identify the older or classical kinds of engineering —Civil, Electrical, Mechanical, etc. In fact, it has been said that our engineering colleges are organized after an engineering world which has ceased to exist

Engineering Education *(Concluded)*

and that the classical options are vestigial rather than functional. This sort of academic administration is for administrative convenience and should not really matter unless departmental fences prevent the free flow of ideas and new developments to seek their natural place in a logical curriculum pattern.

In turn, does our own ASEE organization give us the opportunity for broad perspective judgment in engineering education? We have our Divisional organization, in which people with common subject interest find a forum for exchange of ideas,—but are these Divisions large enough to be functional in today's sense? For example, where does the general body of knowledge pertinent to Jet Propulsion belong in our Divisional structure? The subject matter involved would include problems of fuel chemistry, combustion, unusual problems of stress analysis and thermal stress, advanced questions of heat transfer, aerodynamics, guidance and control, shock and vibration and instrumentation.

Or to broaden the question,—do we have in our Society and in our engineering schools organizational structures compatible with the broad scale thinking necessary in our modern complex engineering systems? Indeed the description "hyper-complex" has been applied seriously in at least one recent paper! All facets of a system must be considered, machines, the environment and the people who may be a part of that system. Conflicting requirements must be reconciled, interactions between portions of the system must be analyzed and, despite the complexities involved, an optimum solution must be found. True enough this process, call it systems thinking, always has been the essence of good engineering, but today's problems and tomorrow's needs require intensity and scope of effort beyond conventional engineering capability. Team work, knowledge from many fields, and overall analysis characterize systems engineering. This is not new in principle nor in practise, but is evolving rapidly in scope, methods and techniques. Our tightly compartmented educational patterns unfortunately do not reflect these trends. Consciously, not by a new course labelled "Systems Engineering", —but through a prevading philosophy in all of our instruction, we must lead toward this goal of broad scale engineering analysis and synthesis which we call systems thinking.

As was well said some seventy years ago by a great engineer, A. M. Wellington, discussing the art of reconnaissance for railway location,—"The young and inexperienced engineer cannot proceed on a safer hypothesis than this: that however forbidding the region, a line exists which is conspicuously better than any other, and which will in all cases be found to be—in comparison with what was expected—a line cheap to build and economical to operate." This statement taken today in the larger context of modern systems is engineering in the best sense. In the exciting prospects ahead we have this spirit of great engineering to guide us.

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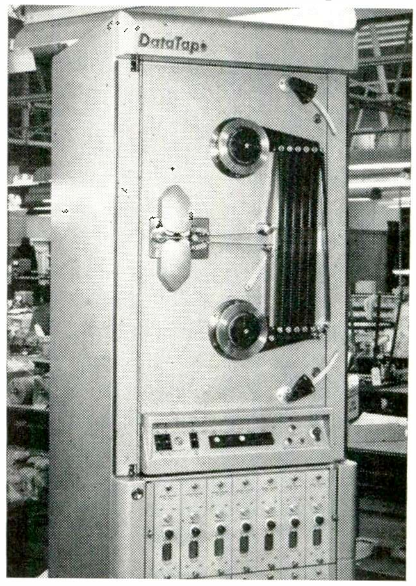
New Products

TAPE LOOP ADAPTER

Detailed repetitive spectrum analysis of information recorded on magnetic tape are now possible with a new Tape Loop Adapter. Designed to be attached to the front plate of

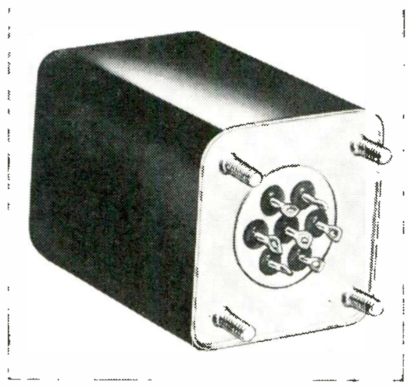


Type 5-752 Magnetic Tape Recorder/-Reproducer, the continuous loop adapter permits study of transients in rocket engine tests, wave analysis by means of time compression, and similar operations. The adapter can be substituted for the standard reels without major modification. Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

Circle 220 on Inquiry Card, page 101

AUDIO TRANSFORMERS

A stock line of audio transformers in military standard cases are now available. Units are designed and built in accordance with MIL-T-27A, Grade 1, Class R specifications and have a life expectancy of 10,000 hours minimum. All of the units in this



series are in "AJ" size cases, measuring 1⅝ x 1⅝ x 2⅜ in. high and weighing 0.6 pounds. Chicago Standard Transformer Corp., 3501 Addison St., Chicago, Ill.

Circle 221 on Inquiry Card, page 101

6528 medium mu, high current, twin power triode for series regulator service!

Volume output makes Tung-Sol/Chatham 6528 available for widespread use!

Enthusiastic acceptance of the 6528 Twin Power Triode forced rapid expansion of production quotas, in turn resulting in lower manufacturing costs. These savings are reflected in lower prices to the user making Type 6528 economically practical for a vast number of new industrial and military applications.

Type 6528 requires fewer passing tube sections . . . permits lower range control circuits . . . and combines low internal tube drop with top control sensitivity — a definite advantage over previous series regulators. Also, 6528 triodes may be used in parallel or separately. This simplifies circuitry . . . saves space.

DESIGN FEATURES OF TUNG-SOL/CHATHAM TYPE 6528!

1. Hard glass envelope permits full out-gassing . . . takes higher temperatures without gas evolution . . . increases thermal shock resistance.
2. Zirconium-coated graphite anodes assure excellent gettering. Graphite virtually unaffected by heat.
3. Oversize cathodes provide adequate emission reserve . . . eliminate standby deterioration.
4. Extra-rugged grids. Sturdy chrome-copper side rods support gold-plated molybdenum lateral wires.
5. Overall ruggedness. Metal snubbers and ceramic insulators support mount. Heavy button-stem has rigid support leads.

Tung-Sol Electric Inc. specializes in special-purpose tube development . . . can match any design requirement you have. For full data on Type 6528 . . . to fill any power tube socket . . . contact: Tung-Sol Electric Inc., Newark 4, N. J. Commercial Engineering Offices: Bloomfield and Livingston, N. J.; Culver City, Calif.; Melrose Park, Ill.

TYPE 6528 RATINGS

Max. plate dissipation per tube	60 watts
Max. plate dissipation per section	30 watts
Max. steady plate current per section	300 ma.
Max. plate voltage	400 volts
Max. heater cathode voltage	300 volts
Amplification factor*	9
Transconductance per section*	37,000 μmhos

**Average characteristics at* $E_b = 100v$, $E_c = -4v$, $I_b = 185$ *ma.*

TUNG-SOL®

Circle 46 on Inquiry Card, page 101

New Products

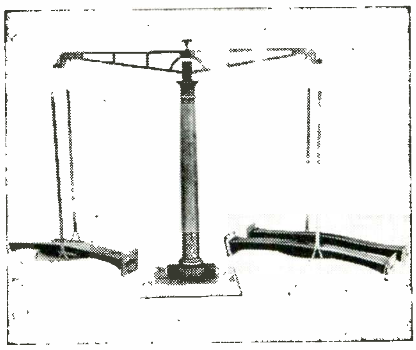
MINIATURE CONNECTOR

A miniature hexagonal connector manufactured by Continental Connector is available. The two contact connector is suitable for high altitude applications requiring high breakdown voltages under critical environmental conditions. A polarizing barrier between the 2 pin contacts is an integral part of the low arc resistance Melamine molding MIL-M-14E, (Type MME mineral filled). The barrier provides a long leakage path and permits use of high voltage (4000 v. RMS) and current (30 a.) without breakdown. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 222 on Inquiry Card, page 101

FLEXIBLE WAVEGUIDE

As shown in illustration, a "2-to-1" weight reduction in flexible waveguide assemblies has been achieved. This has been accomplished through the use of aluminum tubing and aluminum flanges in combination with a newly developed featherweight jacket. Depending on the size of the unit, weight savings up to 60% have been attained. Flexaguides offer improved performance as well as light weight. The all-aluminum waveguide construction allows special brazing techniques to minimize corrosive action. They can also be manufactured in complex bend configurations without expensive tooling. Airtron, Inc., 1096 W. Elizabeth Ave., Linden, N. J.

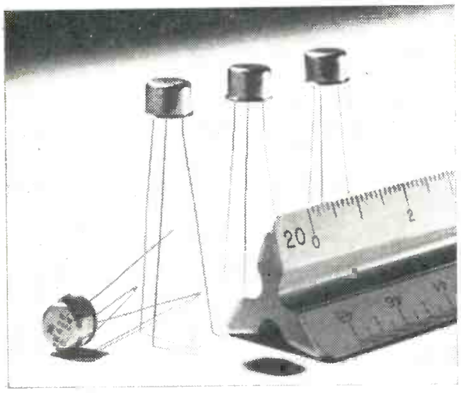


Circle 223 on Inquiry Card, page 101

New Products

SWITCHING TRANSISTORS

A new line of germanium high frequency switching transistors are available. Marketed under EIA numbers 2N425, 2N426, 2N427 and 2N428 the line features the standard TO-9

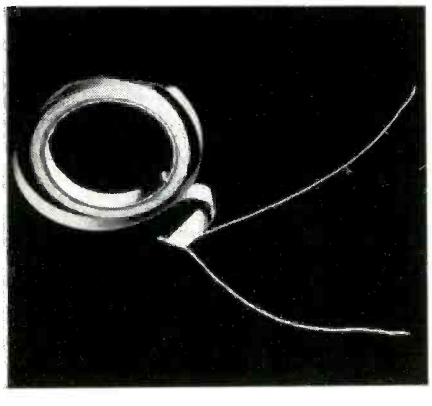


package and is designed to meet or exceed the electrical and mechanical requirements of MIL-T-19500A. These switching transistors assure high reliability and long life even when ordered in large quantities. Motorola Inc., 4545 W. Augusta Blvd., Chicago 51, Ill.

Circle 224 on Inquiry Card, page 101

ELECTRICAL TAPE

A new cast "Teflon" film of high dielectric strength for various electrical-tape applications is available. Dilectrix possesses such advantages as strong dielectric characteristics, performance over a wide thermal range, negligible water absorption, low rate of moisture vapor permeability, and inertness to chemicals and



solvents. Available in lengths of 100 and 500 ft. in widths from ¼ to 12 in. in increments of 1/32 in. Dilectrix Corp., Allen Blvd., Grand Ave., Farmingdale, L. I., N. Y.

Circle 225 on Inquiry Card, page 101

New Products

LINEAR ACCELEROMETER

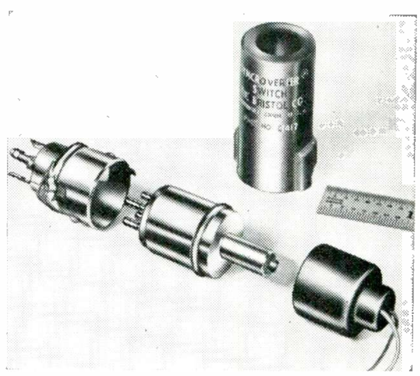
Friction is eliminated in a new AC Linear Accelerometer just introduced. Type LA-600 consists of a non-pendulous seismic mass supported on a frictionless spring suspension and

incorporates an ac variable reluctance type pick-off. Designed for aircraft and missiles, it is inherently insensitive to cross-coupling accelerations both when at null and when under an acceleration along its sensitive axis. Minneapolis-Honeywell, Boston Div., 40 Life St., Boston 35, Mass.

Circle 226 on Inquiry Card, page 101

MINIATURE CHOPPER

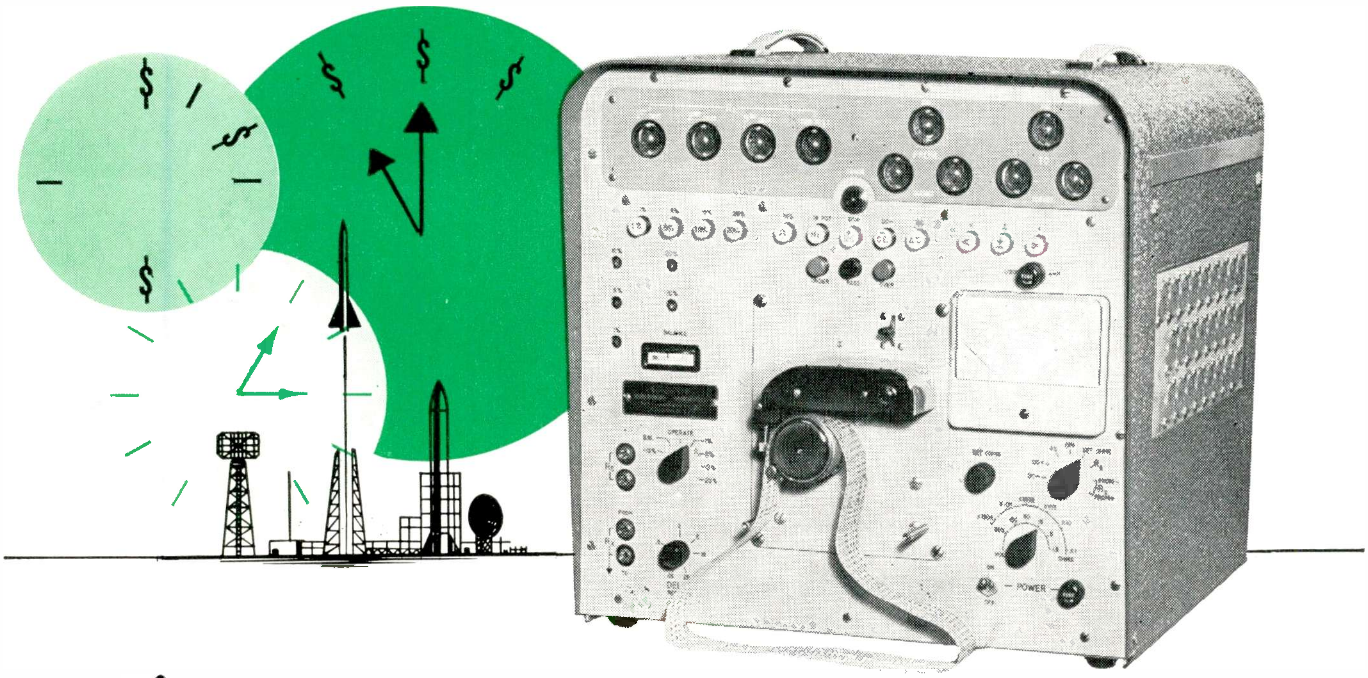
A new low noise miniature Syncroverter chopper featuring low thermal construction is particularly useful in chopper stabilized dc amplifiers where thermal stability and extremely low noise are of prime importance. It offers the same contact ratings and high degree of reliability in dry circuit applications as does the com-



pany's standard external coil units. Unit has complete electrostatic shielding of the coil from the contact assembly. The Bristol Co., Waterbury 20, Conn.

Circle 227 on Inquiry Card, page 101

"beat the clock" on every electronic test



NEW *Lavoie* ROBOTESTER SLASHES TEST TIME AND EXPANDS CHECKOUT CAPABILITIES

CUTS FINAL TEST TIME 80%

A state-of-the-art ADVANCE with unlimited applications

The new Lavoie Robotester brings a fresh viewpoint to operational testing and production line checkout through continuous, high-speed sampling and comparison . . . split-second recognition, isolation, and identification of abnormal functions — with the added versatility and flexibility of **pre-programmed** acceptance standards.

Nominal circuit values and specified tolerances are tape-punched **in minutes** to accommodate voltages (AC and DC) from 0.5 to 500 volts; resistances from 1 ohm to 9.99 megohms; and tolerances of 1%, 5%, 10%, and 20% of nominal. The Robotester will check any two of 250 circuit points at rates up to 100 tests per minute. Automatic operation stops when an out-of-tolerance value is met, while nixie-tube readout identifies the isolated, faulty circuit.

The high speed of the Robotester means a saving of up to 80% of your production test time or a five-fold increase in test capabilities . . . **NOW.**

In research, development, manufacturing
In avionics, communications, missile count-down
In design, production, maintenance

Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

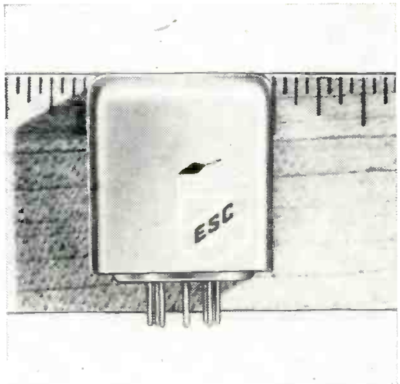
Circle 47 on Inquiry Card, page 101

Circle 69 on Inquiry Card, page 101

New Products

PULSE GENERATOR

The development of a low cost, portable 1 in. square pulse generator called the Modupulser has been announced. The specified pulse rate is factory-set to allow for quick, simple

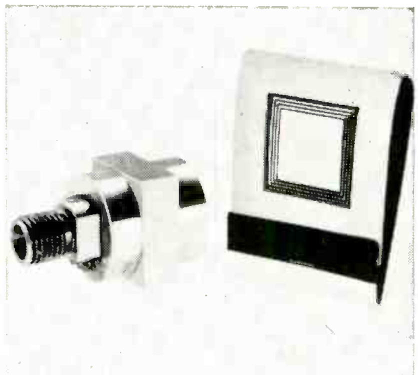


plug-in operation. The unit can be supplied with a variable repetition rate. The unit with external triggering is also available. Modupulsers, for commercial or military applications are available from stock or custom-built to specifications. ESC Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 228 on Inquiry Card, page 101

PRESSURE TRANSDUCER

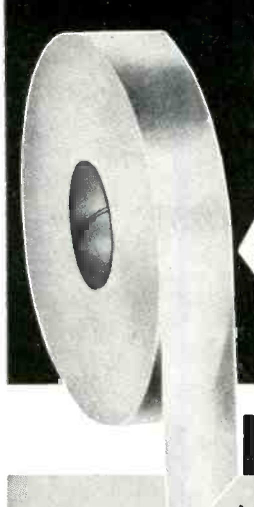
A miniaturized pressure transducer designed for airborne instrumentation, which occupies a volume of only ¾ of a cubic inch and weighs less than 2 ounces is available. Designed specifically for high speed aircraft and guided missiles, unit can be adapted to measure absolute, gage, or differential pressures in the range



from 0-5 to 0-350 psi. with a linearity of ±1%. The TP-100 output has a resolution of 0.25% in most pressure ranges. Fairchild Controls Corp., 225 Park Ave., Hicksville, L. I., N. Y.

Circle 229 on Inquiry Card, page 101

Circle 70 on Inquiry Card, page 101



CAST 'TEFLON'* FILM BY

DILECTRIX

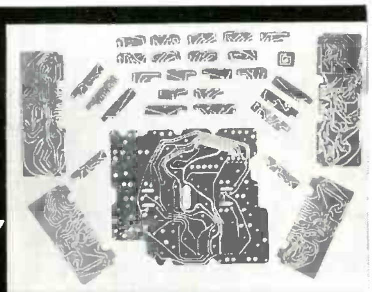
Among the many forms of "Teflon" now available to the design engineer, Cast "Teflon" Films are outstandingly distinguished by their unique qualities: high dielectric strength, zero void content, complete freedom from stresses, uniform physical dimensions, chemical inertness and high heat resistance. Available in thicknesses ranging from 0.00025" to 0.004". Your inquiries are invited.

DILECTRIX CORPORATION
ALLEN BOULEVARD, FARMINGDALE, L.I., N.Y.

*Trademark du Pont "Teflon" TFE resin.

Circle 79 on Inquiry Card, page 101

Custom Printed *MISSILE CIRCUITRY*



A problem in management organization, engineering coordination, and production skill . . . . . .

Problems:

1. 82 Kits of Parts, too few for production tooling, too many for hand means.
2. 39 printed boards per kit.
3. 31 different circuit configurations.
4. Close mechanical tolerances.
5. Duo-metal electroplating, gold and solder.
6. Running changes.

Solutions:

1. A separate precision circuit organization.
2. Close customer liaison.
3. Personnel and know-how geared to military quality requirements.
4. Outstanding plant and equipment.
5. Large tooling and production resources.
6. High production momentum.

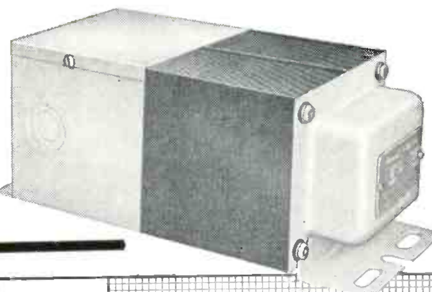
METHODE has the same SOLUTIONS for YOU . . .

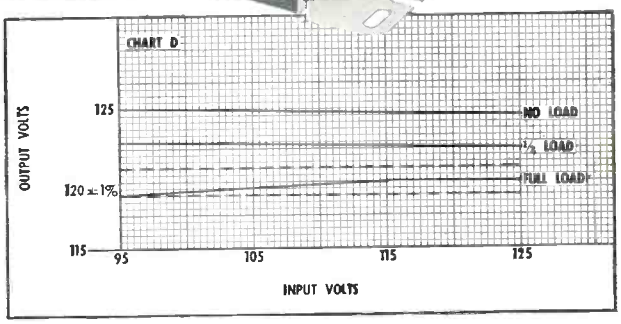
For further information address: MILITARY CONTRACTS COORDINATOR

METHODE
Manufacturing Corporation
7447 W. Wilson Ave. • Chicago 31, Illinois

Circle 80 on Inquiry Card, page 101

REDESIGNED TO STABILIZE 120 x 240 VOLT CIRCUITS





★ These constant voltage stabilizers designed to provide standard packaged units as practical, low cost replacements for many special designs we have been producing as components for electronic equipment manufacturers.

These features have been incorporated in these new units:

±1% Voltage Stabilization
Current Limiting Output
Wide Range of Input Voltage Stabilization

These standard stock units are available in ratings from 15 VA thru 2000 VA. Primary input range 95 to 130 volts; 190 to 260 volts. Stabilized output voltages 120; 240. For filament heating applications standard units are available with 6.3 volt stabilized output.

Write for Bulletin CVS-321.

ACME ELECTRIC CORPORATION
899 WATER STREET • CUBA, NEW YORK

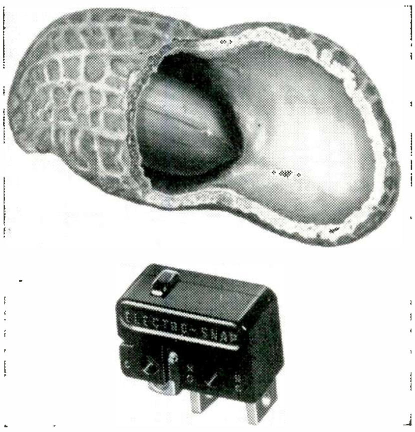
Acme Electric TRANSFORMERS

Circle 81 on Inquiry Card, page 101

New Products

SUBMINIATURE SWITCH

A new sub-sub-miniature basic switch called the "Peanut" has been produced. Switch has a 2½ million cycle mechanical life, no dead break for perfect super-sensitive application

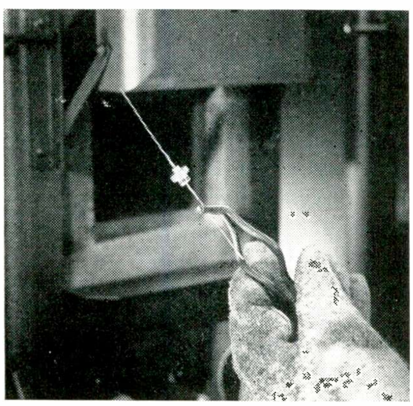


and high repeatability with only one moving part besides button. Other features are: consistent, close tolerance mounting in single or ganged set-ups; high temperature and impact resistant case. It may be obtained with any of the usual types of standard actuators. Simplified ganging is achieved by using a No. 1 screw bolt. Electrosnap Corp., 4230 W. Lake St., Chicago 24, Ill.

Circle 230 on Inquiry Card, page 101

TANTALUM CAPACITOR

A line of hermetically sealed tantalum capacitors offer 150°C operation in a small size. Known as the M2 line, the units measure 0.50 in. in length by 0.287 in. body diameter and 0.484 flange diameter. They are especially suitable for rugged, high-temperature service such as aircraft and missile electronic systems. They are available



in a wide range of capacities from 11 mfd. 90 volts to 140 mfd. 6 volts at 85°C and from 11 mfd. 75 volts to 140 mfd. 4 volts at 150°C. P. R. Mallory & Co., Indianapolis, Ind.

Circle 231 on Inquiry Card, page 101

Horizontal Deflection Tube Testing

(*Continued from page* 80)

selected being 5 volts above the maximum acceptable plate knee. A maximum limit for increase in screen current is established when varying the plate voltage from the higher to the lower value. Maximum plate characteristic knee voltages were established such that tubes which have discontinuities in the knee characteristic will have the discontinuity at a value below the operating point of the tube. Therefore, it is not likely that those tubes will cause "snivets."

Parameters once satisfactory for selecting and controlling horizontal deflection tube manufacture are desirable for design control. Those parameters previously measured in production are static plate and screen currents, emission and gm. The more important characteristics measured in production are now believed to be: 1—Peak zero bias plate current, not only at rated filament voltage, but peak plate current at reduced filament voltage is a good indication of emission capabilities of the tube; 2—Grid current or grid emission; 3—Plate current cut-off; and 4—Plate-current to screen-current ratio. These are in addition to screen grid emission, heater-cathode leakage, mechanical defects, etc.

"Snivets"

During the operation of a horizontal system in a TV receiver, a phenomenon known as "snivets" is frequently observed. It can be distinguished on the screen as a dark vertical line approximately three-fourths of the distance from the left side of the screen when viewed from the front. (Fig. 5). There are many theories concerning the cause of "snivets." This author believes that "snivets" is caused by a discontinuity or abrupt changes in the shape of the plate characteristic knee of the horizontal deflection amplifier. When the grid is driven to the zero-bias condition and passes through that discontinuity, oscillations occur which are picked up by the receiver front end and will appear on the TV screen as a black vertical line, or a blotch under some circumstances.

During the investigation of 60 CPS, peak-current testing, a test was devised for controlling the plate characteristic knee. The plate-knee or "snivets" test devised is a "go-no-go" test in which the plate voltage is varied between two voltages, the lower voltage selected being five volts above the maximum desired plate knee. A maximum limit is set for increase in screen current. Screen current was selected for monitoring because it has the same numerical change in current as the plate current, but the percentage of change is considerably higher, resulting in a more precise test.

Conclusions

The advantages of peak current testing of hori-

(*Continued on page* 128)

TROUBLED WITH TRANSIENTS?

Unsuspected high voltage peaks can upset the most carefully designed equipment. They can cause erratic behavior of electronic circuits or even bring about out and out malfunction. These unwanted "transients" can completely upset your calculations.

HERE'S THE ANSWER!

For the laboratory technician, missile circuit designer or other electronic engineer interested in detecting such important variables, our Model PTM-7 Peak-Meter supplies the answer.

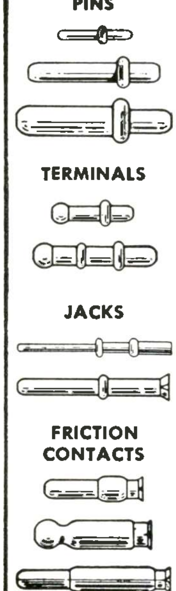
NOW AVAILABLE WITH 3000 VOLT FREQUENCY COMPENSATED PROBE, the Peak-Meter features a retentive memory for these elusive "transients."

Write for literature.

CONTROL DEVICES, INC.
8299 East Nine Mile Road
Warren, Mich.—SLocum 8-4444

Circle 82 on Inquiry Card, page 101

50% SAVINGS with BEAD CHAIN® Multi-Swage Parts



also PRINTED CIRCUIT MINIATURE PARTS

Contact pins, terminals, jacks or any small tubular parts. Maximum ¼" diameter x 1¼" length.

Send sketch for quotations.

BEAD CHAIN DRIVES

Low-speed positive drives or motion transfer ... at far less cost!

Send for Multi-Swage or Bead Chain Drive Catalogs!

THE BEAD CHAIN MFG. CO.

201 Mountain Grove, Bridgeport 5, Conn.

Circle 83 on Inquiry Card, page 101

NEW GIANT narda SonBlaster

Generator G-5001
500 watts output

Transducerized Tank NT-5001
Capacity: 10 gallons
Dimensions: 20" L x 11½" W x 10" D

Generator features tank selector and load selector switches on front panel to operate one or two NT-5001 tanks alternately. Other combinations of tanks and submersible transducers available from stock; larger tanks available on special order. **$1325**

For mass-production cleaning and high capacity chemical processing!

Here's a new Narda SonBlaster ultrasonic cleaner with tremendous cavitation activity and generating capacity! Featuring full 500 watts output, this SonBlaster is available with a fully transducerized giant 10-gallon capacity tank. In addition, it will operate from six to 10 Model NT-605 high energy submersible transducers, at any one time, in any arrangement in any shape tank you need up to 70-gallon volume.

Install this new Narda SonBlaster, and immediately you'll start chalking up savings over costly solvent, vapor or alkaline degreasing methods! You'll save on chemicals and solvents, cut maintenance and downtime, eliminate expensive installations, save on floor space, and release labor for other work. But perhaps most important, you'll clean faster, cut rejects, and eliminate bottlenecks.

Whether you're interested in mass-production cleaning or degreasing of mechanical, electronic, optical, or horological parts or assemblies ...rapid, quantity cleaning of "hot-lab" apparatus, medical instruments, ceramic materials, electrical components or optical and technical glassware...or in speeding up metal finishing and chemical processing of all types—you'll find this new SonBlaster will do your work faster, better and cheaper. Write for more details now, and we'll include a free questionnaire to help determine the precise model you need. Address: Dept. EI-20.

Consult with Narda for all your ultrasonic requirements. The SonBlaster catalog line of ultrasonic cleaning equipment ranges from 35 watts to 2.5 KW, and includes transducerized tanks as well as immersible transducers which can be adapted to any size or shape tank you may now be using. If ultrasonics can be applied to help improve your process, Narda will recommend the finest, most dependable equipment available for immediate delivery from stock—and at the lowest price in the industry ($175 up)!

For custom-designed installation and unique electro-acoustic applications, including cleaning, soldering, welding, drilling and non-destructive testing, consult our subsidiary, Alcar Instruments, Inc., at the address below.

the narda ultrasonics corporation
625 MAIN STREET, WESTBURY, L. I., N. Y.
Subsidiary of The Narda Microwave Corporation

Circle 84 on Inquiry Card, page 101

Circle 54 on Inquiry Card, page 101

(Continued from page 126)

zontal deflection type tubes using a square-wave drive voltage are:

(1) Testing can be done at higher screen voltages without the danger of damaging the tube.

(2) Good correlation is obtained both with the static methods used previously, and with television receivers application requirements.

(3) The equipment is relatively simple to adapt to production testing.

Many changes have been made in peak zero-bias plate and screen current testing methods in the past several years and it is entirely possible that the methods described in this paper are not those which will be used a year from now. However, until a better test is devised they are believed to be the most desirable test for selecting horizontal deflection amplifier tubes.

TEST MISSILE

Inertial guidance system designed and developed by Autonetics guided this X-10 test missile at supersonic speeds over hundreds of miles. Same system guided Navaho.

 Circle 55 on Inquiry Card, page 101

READ-OUT DOWN TO .002 V. dc

DU MONT 405

THE 2 in 1 DUAL INPUT VTVM

Like having two VTVM's connected into a circuit for comparison readings — the 405 permits instantaneous switching between two inputs — either ac or dc — without disturbing a single probe in the circuit. The same switch provides a Meter Zero position for convenient, fast calibration; again, without disturbing test probes.

And that's not all! The 405 offers full-scale sensitivity of 100 millivolts, dc or ac, resulting in accurate read-outs down to .002 volts dc, or .01 volts ac.

Add these outstanding features to the following, and you'll quickly discover why the 405 is **today's best buy** in a VTVM . . .

PRICE $265
INCLUDING UHF, VHF AND DC PROBES

$305.00
With UHF, VHF, Attenuator and dc probes

Prices F.O.B., Clifton, N. J., U.S.A.

Write For Complete Information...

- Full scale ranges of .1, .3, 1, 3, 10, 30, 100, 300 and 1000 volts dc. Accuracy ±2% full scale. Full scale ranges of .1, .3, 1, 3, 10, 30, 100* and 300* volts ac. Accuracy ±3% full scale.
- Measurements from dc to 700 mc.
- Ohmmeter, 7 ranges, calibrated 500 ohms-500 megohms. Maximum short-circuit current 8.5 ma.
- Completely isolated ground circuit permits safe off-ground measurements up to 1000 volts dc.
- Very low drift. Less than ±5 millivolts maximum on any scale.
- Regulated dc and filament supply.
- Amplifier output available for accessories.
- Illuminated, mirror-backed, 4" scale.
- Compact. Weighs only 12 lbs.
- Built-in probe storage compartment.

*With Cat. No. 4050 Attenuator probe.

DU MONT® INSTRUMENT DIVISION
ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U.S.A.

 Circle 98 on Inquiry Card, page 101

News of Reps

REPS WANTED

For missile and aircraft application, an active and expanding line of **explosive-actuated devices for rocket-motor starting, missile destruction,** electrical disconnection, valving, and various types of mechanical actuation has openings for reps. Territories are open in the Northwest, Southeast, Midwest, and Southwest. Send Complete organizational details. (R9-1, Editor, Electronic Industries.)

Maitland K. Smith Co. with headquarters at 208 14th St., N.W., Atlanta, Ga. is now rep for "Press-Fit" Terminals and subminiature R-F connectors for the Sealectro Corp.

W. K. Wiedekind Co. is now rep in the Pacific Northwest and the **Abbott-Allison Co.** are representing Trans Electronics, Inc. in New England.

Fred F. Bartlet & Co., 160 Morlyn Ave., Bryn Mawr, Pa. is now representing North Atlantic Industries, in the Mid Atlantic states of Pennsylvania, Maryland, So. New Jersey, Virginia, Delaware and Washington, D. C. They are handling the company's line of instrumentation for avionics, automation and control systems.

M. J. Seavy & Co., 30 Church St., New York, N. Y. has been appointed rep by Radiation Counter Labs., Inc. They will handle their line of nuclear instrumentation and data processing equipment in the states of New York, New Jersey and Eastern Pennsylvania.

Tele-Radio Systems Ltd. is now sales engineering rep in Eastern Canada for Secode Corp.

Dougherty Enterprises, 149 Kaimi St., P. O. Box 1014, Lanikai, Hawaii is now rep for the Drake Mfg. Co.

Cushman Precision Industries, Sales Div. is now rep in the Eastern Seaboard area for Victor Mfg. Corp. Inc.

Paul Wallace Co., 3529 Manana, Dallas 20, Tex. is rep in Texas, Oklahoma, Louisiana, and Arkansas for Electro-Pulse, Inc. They handle the company's line of pulse generating and electronic counting equipment.

J. R. Dannemiller Assoc. is rep in Ohio, Michigan, and Western Pennsylvania for F-R Machine Works, Inc.'s line of precision microwave equipment.

Morton L. Friedman Co., 2814 W. Balmoral Ave., Chicago, Ill. is now covering Illinois and Eastern Wisconsin for the Jersey Specialty Co. Inc.

News of Reps

Cashin-Tipton and Assoc., 3270 Rosecrans St., San Diego 10, is now factory rep for Cinema Engineering Div., and sub-rep for Aerovox-Pacific as well. Area to be covered is San Diego County.

James Eckersley, 3150 S.W. Hamilton St., Portland, Ore. will handle all of the Erie Resistor Corp.'s products in the Northwest territory.

Zak & Cowen, 7730 Carondelet Ave., St. Louis, Mo. is rep in the states of Missouri, Kansas, and Eastern Nebraska for Daystrom Transicoil.

Carl A. Stone Assoc., 325 San Antonio St., Palo Alto, Calif. is now rep in Northern California for Technitrol Engineering Co.'s line of computer components, electronic and medical instruments and computer systems.

McCloud & Raymond, 5403 E. Evans Ave., Denver 22, Colo. and **Ammon & Woods**, 5602 E. Mockingbird Lane, Dallas, Tex. have been named reps for the Elco Corp.'s complete line.

James A. Lynch has been named Vice-President for the **Louis A. Garten Assoc.**, electronic manufacturer's reps located in West Orange, N. J.

J. W. Marsh Co. of Los Angeles, and **Burt C. Porter Co.** of Seattle, Wash. are now reps for the Chester Cable Corp.

Pan-Mar Corp., 1270 Broadway, N.Y.C. is now exclusive export sales rep for Hallmark stereophonic record sound systems and records.

Solartron, Inc. has been named exclusive U. S. sales rep for Ericsson Telephone Ltd. and Goodmans Industries Ltd.

The Fisher Berkeley Corp. has appointed **Harry N. Reizes**, 1473 Sylvia Lane, East Meadow, L. I., N. Y. as rep in metropolitan New York, upstate New York, and Northern New Jersey, and **Robert S. Reiss Assoc.**, 70 Jessie Dr., West Haven, Conn. as rep in New England for their line of intercom equipment.

Ralph H. Eder, 7028 N. Clair Court, Milwaukee 17, Wis. has organized a new firm which will call on customers through Wisconsin.

George F. Landfear, 165 Franklin Ave., Nutley, N. J., has just opened up a new rep office. He will cover Southern New York, New Jersey, and Eastern Pennsylvania as rep. He is specializing in sales and service of electronic test equipment.

New Tech Data

(*Continued from page* 94)

Silvered Mica Capacitors

The Electro Motive Mfg. Co., Inc., Willimantic, Conn. has just issued a 6-page, 2-color folder entitled "Reliability Study of Silvered Mica Capacitors . . . and How Debugging Assures Greatest Dependability and Longest Life." Complete electrical and mechanical information is included in this folder along with other technical information.

Circle 172 on Inquiry Card, page 101

Miniature Connectors

A 29-page test report detailing the laboratory testing of miniature electrical connectors is offered by The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. The report describes a complete series of tests for electrical, environmental and physical characteristics.

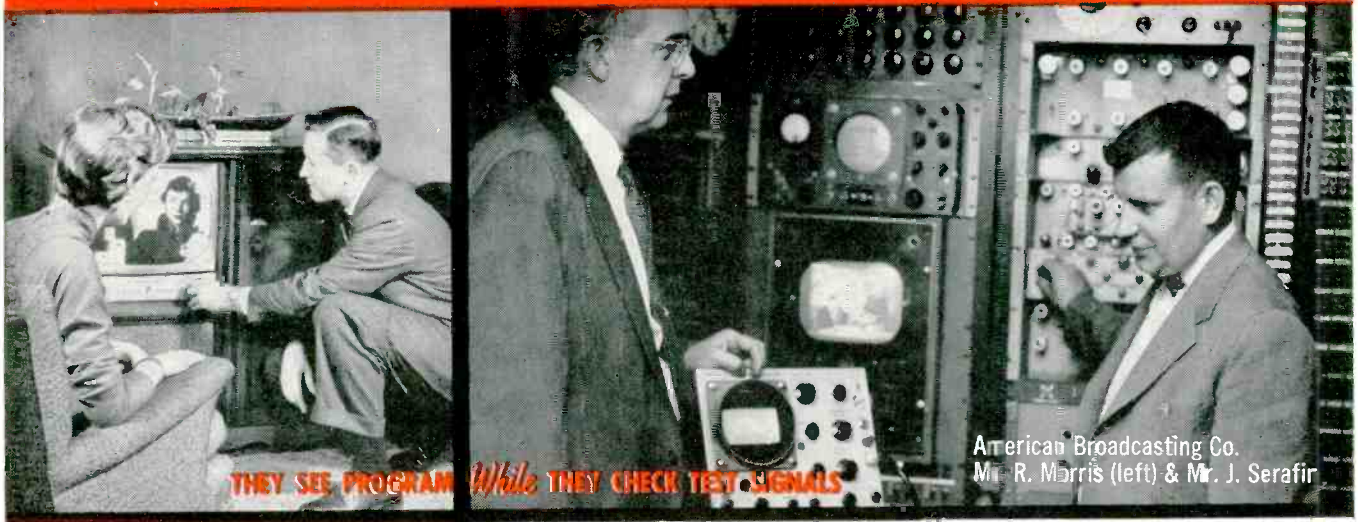
Circle 173 on Inquiry Card, page 101

Perforated Metals

A 2-color, 4-page brochure issued by F. L. Berglund Co., 2201 W. Main St., Alhambra, Calif., describes with tables and photographs their line of perforated sheet metal. Booklet describes the various types of material and hole shapes available.

Circle 174 on Inquiry Card, page 101

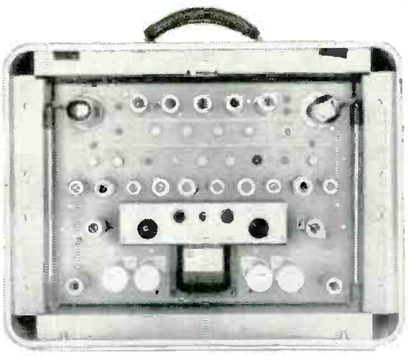
New – SEND TEST SIGNALS DURING PROGRAMMING



TELECHROME MFG. CORP.

VERTICAL BLANKING INTERVAL TEST SIGNAL KEYER

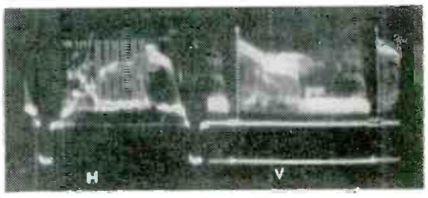
MODEL 1008-A



VERTICAL BLANKING INTERVAL TEST SIGNAL KEYER

Portable or standard rack mounting. Self-contained power supply.

Test signal is thin line between frames. All test signals can be transmitted during vertical blanking portion of program.



Video picture with multiburst test signal inserted, as seen on ordinary wave monitor.

The Telechrome Model 1008-A Vertical Blanking Interval Keyer is a self-contained portable unit that makes possible transmission of television test and control signals between frames of a TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signals. The keyer will operate anywhere in the TV system and operates from composite video, sync, or H & V drive. The test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.

These continuous reference signals may be used in connection with various Telechrome devices for automatic correction of video level, frequency response, envelope delay, differential gain and differential phase.

IMPORTANT:

Checking after programming is costly and at best highly inefficient since conditions constantly vary. The Telechrome Vertical Interval Keyer minimizes post-program checking and overtime expenses. It provides instant indication of deteriorating video facilities so that corrective measures can be undertaken immediately—manually or automatically during programming.

Now in use by CBS, NBC, ABC, BBC ITA (Brit.)

1003-C VIDEO TRANSMISSION TEST SIGNAL GENERATOR

Completely self-contained, portable. Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite synch. Variable duty cycle. Regulated power supply. 12¼" standard rack mounting or in carrying case; integrates with above model 1008-A Test Signal Keyer.

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Circle 52 on Inquiry Card, page 101

Reliability

(*Continued from page 72*)

tures originally developed for military tubes.

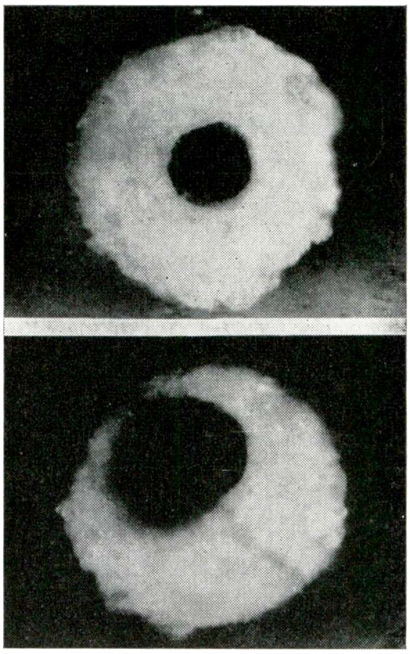
Receiving tubes are ten years ahead of transistors in the design, production and control of the complex inter-related electrical characteristics so vital to reliable performance.

The principal extra values are:

1. Minimization of lint and dust. The program calls for dacron-uniformed operators and factory air-conditioning and filtering. Previously these conditions were used only in the manufacture of special high reliability tubes for military application.

2. Adoption of an accelerated heater cycling test. Insuring proper performance under wide variations in household line voltage.

3. Attaining greater uniformity by use of a new G-E developed method of testing for shorts or opens within a finished tube by using dc instead of ac.



Cross-section views of heater wire compare results of new (top) and old methods of applying ceramic coating. Extreme off-center wire would have been detected in manufacturing tests.

4. Building receiving tubes to meet life tests twice as rigid as the JAN specifications for tubes in the entertainment class.

5. A new method of controlling the insulation coating on heater wire to prevent "hot spots."

Tapered pins on new octal-base tubes save time and avoid socket damage in manufacture of new equipment and in replacement of tubes in hard-to-reach spots in existing equipment.

6. Tapering the ends of pins on octal tube bases to save time for both equipment manufacturers and service technicians in inserting and removing tubes, and to prevent socket damage.

7. Extending stiff military-type glass strain specification tests to these tubes.

8. Development of a new anode material and a new type grid wire material that permits greater dissipation of heat. Tubes so constructed can run at higher levels of overload before reaching the failing point.

9. Use of a new hard-to-remove branding ink to prevent removing the warranty date code either by accident or by deliberate erasure by tube counterfeiters.

"Service Designed" Tubes

1B3-GT	5Y3-GT	6DQ6-A
1H2	6AF4	6DT6
1J3	6AF4-A	6EA8
1K3	6AL5	6EU8
1X2-B	6AQ5-A	6EW6
2AF4-A	6AU4-GTA	6J6
2CY5	6AU6-A	6SN7-GTB
3BN6	6AX4-GT	6T8-A
3BU8	6BK7-B	6U8-A
3BZ6	6BN6	6V6-GT
3CB6	6BQ6-GA	7EY6
3DT6	6BQ7-A	8CG7
4BN6	6BU8	8CX8
4BU8	6BZ6	12AT7
4BZ6	6BZ7	12AU7-A
5AQ5	6CB6-A	12AX4-GTA
5BK7-A	6CD6-GA	12BY7-A
5CG8	6CG7	12BQ6-GA
5CL8-A	6CG8-A	12DQ6-A
5EA8	6CL8-A	12SN7-GTA
5EU8	6CX8	17AX4-GT
5U4-GB	6CY5	17DQ6-A
5U8	6DN7	19AU4-GTA
5V3/5AU4		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ANTENNAS, PROPAGATION

Helix Antennas, G. Gulcz. "Roz. Elek." Vol. 4, No. 1. 63 pp. Two kinds of helix antennas are distinguished: radiating in the normal mode (perpendicularly to the axis of helix) and radiating in the axial mode (along the axis of the helix and according to the flow of the high frequency energy along the helix). (Poland.)

The Influence of Top-Capacitance in the Case of Highly Inductive Aerial Coupling, H. Robel. "El Rund." June 1958. 4 pp. The theoretical fundamentals for the consideration of top capacitance are pointed out in this article. (Germany.)

Investigations Into Diversity Reception According to the Method of Antenna Selection, R. Heidester and K. Vogt. "Nach. Z." June 1958. 5 pp. The known diversity methods with receiver selection are compared with a method with antenna selection. (Germany.)

- Photocopies of all foreign articles are available at 50 cents per page, remitted with order. **Unless otherwise indicated, articles appear in language native to country of origin.**
- *Articles marked with an asterisk are available as free reprints.
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* * *

For more information on domestic articles, contact the respective publishers directly. Names and addresses of publishers may be obtained upon request from the above address.

Wave Propagation in a Wave Guide Using Corrugation and Apertures, G. Piefke. "Arc. El. Uber.," Vol. 12, No. 1, January 1958. 9 pp. The influence of corrugation or apertures applied at periodic intervals in a circular wave guide is investigated. The spacing of the corrugation, i.e. the thickness of the diaphragms plus their spacing is assumed to be far smaller than the guide wave length. (Germany.)

The Conductance of Dipoles of Finite Thickness and Length, K. Franz, P. A. Mann, J. Vocolides. "Arc. El Uber.," Vol. 12, No. 2, February 1958. 5 pp. A family of dipoles is calculated which has the same conductance at a given frequency. In order to calculate the conductance a finite number of integrals must be evaluated and an ordinary differential equation has to be solved. This can be performed easily by a digital computer. The compensation network is independent of the dipole shape. (Germany.)

Propagation of Radio Waves, Charles Guilbert. "Toute R," No. 223, February 1958. 4 pp. This article describes propagation by dispersion, the effect of super impression, frequency modification, and radio astronomy. The various subjects are briefly discussed and the effects are explained by means of diagrams. (France.)

Far-Field Radiation of a Cheese Aerial, R. F. Kyle. "E. & R. Eng." July 1958. 3 pp. This article describes the measurement of the aperture distributions of an X-band cheese aerial and the method of computing the radiation pattern from these figures. The computed pattern is compared with one measured in the field. (England.)

Phase-Coherent Back-Scatter of Radio Waves at the Surface of the Sea, E. Sofaer. "P. BIEE." July 1958. 12 pp. Soon after the completion of the B.B.C.'s television transmitting station in Devon and the establishment of a full-scale service, complaints were received from coastal areas around Plymouth that the transmission was subject to rhythmic variations in amplitude. The investigations which followed these reports are here described. The variations are found to be due to phase-coherent back-scatter from the sea, and to depend on the configuration of the surface of the sea. The phenomenon is examined theoretically. (England.)

Surface Waves, H. M. Barlow. "Proc. IRE." July 1958. 5 pp. (U.S.A.)

Investigation of Long-Distance Overwater Tropospheric Propagation at 400 MC, H. E. Dinger, et al. "Proc. IRE." July 1958. 10 pp. (U.S.A.)

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electric Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bull. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El. Uber. Archiv der Elektrischen Ubertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Elektrotechniczne

USA

Auto. Con. Automatic Control
Av. Age. Aviation Age
Av. Week. Aviation Week
Bell J. Bell Laboratories Journal
Comp. Computers and Automation
Con. Eng. Control Engineering
El. Electronics
El. Des. Electronic Design
El. Eq. Electronic Equipment
El. Ind. ELECTRONIC INDUSTRIES
El. Mfg. Electronic Manufacturing
IRE Trans. Transactions of IRE Prof. Groups
I. & A. Instruments & Automation
Insul. Insulation
M/R. Missiles and Rockets
NBS J. Journal of Research of the NBS
NRL. Report of NRL Progress
Proc. IRE. Proceedings of the Institute of Radio Engineers
Rev. Sci. Review of Scientific Instruments

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences, USSR.

OTHER

Radio Rev. La Radio Revue (Belgium)
Kovo. Kovo Export (Czech)
J. ITE. Journal of the Institution of Telecommunication Engineers (India)
J. IECE. Journal of the Institute of Electrical Communication Engineers (Japan)
Phil. Tech. Philips Technical Review (Netherlands)
Eric. Rev. Ericsson Review (Sweden)
J. UIT. Journal of the International Telecommunication Union (Switzerland)

International ELECTRONIC SOURCES

CIRCUITS

***How To Specify Filters, Stanley Boyle.** "El. Ind." Sept. 1958. 5 pp. Filter nomenclature and specifying has been confusing. This article describes the nomenclature and procedure for ordering or specifying filters. It gives the test standards for filters to aid in their selection. (U.S.A.)

***A Look at Modern Network Synthesis, Dr. L. Weinberg.** "El. Ind." Sept. 1958. 6 pp. Results of modern synthesis are given in the form of tables of normalized element values for networks with the following characteristics: maximally flat magnitude, equal-ripple magnitude in one filter band, equal-ripple magnitude in both filter bands, and maximally flat time delay. (U.S.A.)

***Uninterrupted Power Supplies, Alan W. Hill.** "El. Ind. Ops. Sect." Sept. 1958. 3 pp. In considering the design of the main power supply for transmitters or similar equipment the prime factors to be considered are: reliability, equipment cost per kilowatt of power, operational efficiency of the system and the peculiarities of the installation. (U.S.A.)

The Analysis and Design Method of the Transients of Generations Excitation Controlled by Magnetic Amplifier, V. R. Kulikov. "Avto. i Tel." June 1958. 10 pp. The author proposes a method that enables design of the equivalent time constant of a unit which includes the operating winding of magnetic amplifier, single-cycle bridge-circuit of rectification and active-inductive load simulating the excitation winding of the generator. (U.S.S.R.)

Input Circuits of Contact-Modulated Amplifier, D. E. Polonnikov. "Avto. i Tel." June 1958. 10 pp. The main requirements for input circuits of electronic amplifiers in automatic potentiometers are set forth. The table of diagrams of input circuits with contact-modulated is given, and formulae to determine the parameters of the circuits in question are deduced. Peculiarities of the circuits are determined, and there are some instructions as to how to use the circuits under consideration in the amplifiers of automatic potentiometers. (U.S.S.R.)

The Effect of a Random Voltage on a One-Shot Multivibrator with Two Stable States of Equilibrium, A. M. Vasil'ev. "Radiotek." Jan. 1958. 8 pp. Based on special assumptions, the paper treats the effect of a random voltage which is applied to the control grids of a one-shot multivibrator with two stable states of equilibrium. The paper derives functions which determine all of the probability characteristics for the voltage at the output of the multivibrator. The probability of a given state is computed, as well as the average value and correlation function for the output voltage. (U.S.S.R.)

Simulating the Input Admittance of a Tube, A. M. Gasanov. "Radiotek." Jan. 1958. 3 pp. The paper proposes a network which makes it possible to simulate the resistive component of the input admittance of a tube. The electrical design of the network is given. (U.S.S.R.)

Temperature Stabilization of Transistorized Voltage Amplifiers, Iu. R. Nosov, B. I. Khazanov. "Radiotek." Feb. 1958. 8 pp. A condition is derived for thermal stabilization of the gain of transistorized voltage amplifiers and methods are indicated for satisfying this condition. The following topics are treated in detail: 1) thermal variation of the gain; 2) the condition governing thermal stabilization; 3) temperature variation of the currents through the transistor; 4) achieving complete thermal stabilization. (U.S.S.R.)

Transistorized RC Phase-Shift Oscillators, V. M. Lubin. "Radiotek." Feb. 1958. 7 pp. Various circuits for RC phase-shift oscillators are treated. Formulas are given for the oscillation frequency and the amplification criteria. The concept of the potential (ideal) stability coefficient is introduced. (U.S.S.R.)

A Direct-Coupled Transistor Amplifier, N. S. Nikolaenko. "Radiotek." Feb. 1958. 9 pp. The paper studies the circuit, the computation and test results for a direct-coupled transistor ac amplifier. The advantages of this very simple circuit, which contains a minimum of components and makes it possible to operate at an ambient temperature of up to 100 deg C, are demonstrated. (U.S.S.R.)

The Serial Mode in a Multiphase Multivibrator, Ia. E. Belen'kii and A. N. Svenson. "Radiotek." March 1958. 5 pp. The paper treats the so-called serial mode in a multiphase multivibrator. For such a mode the device generates not one but a series of pulses. The operating mechanism of the multivibrator is described, and the basic design relationships are derived. (U.S.S.R.)

The Theory of Critical Overshoot for Multistage Pulse Amplifiers, V. P. Shasherin. "Radiotek." March 1958. 13 pp. The paper demonstrates that the previous formulation of critical overshoot theory for multistage pulse amplifiers is inaccurate. This formulation is refined on the basis of computing the overshoot of the transient responses for multistage amplifiers with a simple compensating circuit. (U.S.S.R.)

A Circuit for the Automatic Frequency Trimming of a Synchronous Oscillator, I. Iu. Klugman. "Radiotek." March 1958. 13 pp. The paper describes the operation of the "four diode" circuit used in the majority of Soviet synchronous oscillators. The condition governing stable operation is introduced for the specified circuit, and the relationship between the circuit parameters and the stability condition is given. The stability condition is verified experimentally. Circuit parameters are computed which guarantee stable operation for optimum control performance. (U.S.S.R.)

General Physical Relations Within Ladder-Type Filters, T. Laurent. "Arc. El. Uber." Vol. 12, No. 1, January 1958. 7 pp. A highly selective filter should be designed as a ladder-type filter consisting of longitudinal and transversal sections. Such a filter system with a minimum of reactance and perfect power transfer in the band-pass can be broken down into image connected elements. Since no perfect power transfer can be realized in practice, the mismatch condition between the filter elements may, under certain circumstances, improve the transmission and matching characteristics. (Germany.)

A Simple Geometric Presentation of the General Lossy Quadrupole, J. DeBuhr. "Arc. El. Uber." Vol. 12, No. 3, March 1958. 6 pp. The lossy four-terminal network can be represented in an elementary manner by a transformation system. The process is similar to the one used for linear loss-less quadrupoles using a mirror system of two straight transformation lines. Since the common Kirchoff quadrupole is associated with a three-dimensional non-eucledian displacement on the surface of a Riemann's sphere, the systems consist no longer of two straight lines, but of four planes which are perpendicular to each other. A presentation in a single plane is possible with the aid of stereographic projection. (Germany.)

The Generation of Extreme Steep Pulses by Use of a Multi-Stage, Non-Linear Amplifier, G. Kohn. "Arc. El. Uber." Vol. 12, No. 3, March 1958. 10 pp. With a given residual capacitance C steep pulses can only be obtained by means of high tube currents ι. The maximum steepness can be expressed as

$$(du/dt\ \text{max.} = F\ \text{max.} = \iota/C.$$

The transconductance of the tube is of minor importance. Described is a three-stage amplifier which is capable of developing pulses with an amplitude of 100 v and a rise time of less than 3 mu sec. (Germany.)

A Double Oscillator with a High Amount of Harmonics used for Frequency Multiplication and Frequency Division, G. Becker. "Freq." Vol. 12, No. 4, April 1958. 7 pp. Outlined are theory and praxis of various oscillators which contain a large amount of strong harmonic oscillations. This type of oscillator lends itself extremely well to the generation of harmonics and subharmonics. The operation of the oscillator is illustrated through oscilloscope presentations. (Germany.)

The Static Properties of a Cathode Coupled Limiter, J. Schulz. "Freq." Vol. 12, No. 4, April 1958. 3 pp. A cathode coupled clipper has some advantages over other limiters, such as diodes, triodes, or pentodes. The clipping action does not depend upon grid current; instead, limiting in both directions is accomplished by cut-off of either one of the tubes. The applied voltage can exceed the limiting voltage by 35 dc without causing grid current. (Germany.)

Negative Impedance Converters, F. Molo. "Alta. Freq." April 1958. 18 pp. This study covers and summarizes the quadripole relations and the equivalent circuits for the basic operations of ideal, semi-ideal and real negative impedance converters. (Italy.)

Bifilar-T Trap, A. Hendry and A. G. McIntosh. "E. & R. Eng." July 1958. 6 pp. Circuits utilizing the bifilar-T trap in the audio-frequency range are described. These include a circuit for the rejection of harmonics, particularly the second, of 1000 c/s signals; a tuned audio-frequency amplifier of a few hundred cycles bandwidth, with high attenuation in a very narrow band at the center of the passband; and a narrow-band feedback amplifier. Formulae are given to permit a designer to modify the performance of the basic bifilar-T circuit. (England.)

COMMUNICATIONS

***Problems of Missiles . . . Reducing Spurious Radiation, Arnold L. Albin and Carl B. Pearlston, Jr.** "El. Ind." Sept. 1958. 5 pp. Efficient r-f spectrum use requires radiation limits on microwave equipment. An experimental program, designed to extend existing limits to cover 1-10KMC, established measuring techniques which are described in detail. (U.S.A.)

On A Certain Commutation Circuit, V. G. Lazarev and Yu. L. Sagalovich. "Avto. i Tel." May 1958. 4 pp. Binary commutation circuits are treated. The synthesis based on using the theory of groups makes it possible to get optimal circuits without hard work. (U.S.S.R.)

The Statistical Properties of Message Sets, D. S. Lebedev. "Radiotek." Jan. 1958. 8 pp. Within the framework of the discrete case the paper refines the relationship between the statistical properties of message sets and the problems involving the transmission of messages from this set over a communication system. Messages are classified, and an attempt is made to develop a new statistical model for phototelegraphic and television messages. (U.S.S.R.)

On the Theory of Transmission Capacity for Binary Transmission, B. A. Varshaver. "Radiotek." Jan. 1958. 11 pp. Based on the general relationships derived by C. E. Shannon for communication theory and V. A. Kotel'nikov's theory for potential (ideal) noise stability, the transmission capacity of a binary channel is determined for various types of modulation. It is assumed that fluctuating noise is present in the channel. (U.S.S.R.)

The Use of Auto-Anode Modulation, A. I. Miroshin. "Radiotek." March 1958. 6 pp. Circuits are given for transmitters using auto-anode modulation. These circuits have been tested under operating conditions in functioning radio stations. The performance of these circuits is discussed. (U.S.S.R.)

The Effect of Weak Pulse Noise on FM Receivers, V. M. Sidorov. "Radiotek." March 1958. 14 pp. The effect of weak pulse noise on an FM receiver is treated for the case where there is an arbitrary frequency deviation at the instant the noise appears. The effect of the types of filters in the receiver on the time variation and spectral density of the pulse noise at the receiver output is analyzed. (U.S.S.R.)

The Use of Controlled Skin Effect for Modulation Purposes, V. S. Etkin. "Radiotek." March 1958. 4 pp. Various resonant oscillatory systems with ferromagnetic elements were studied when they operated as modulators. The elements operated so as to produce both forced and natural oscillation. Experiments were performed on iron, steel and permalloy. The results demonstrated that permalloy is most sensitive and has the least magnetic losses at microwave frequencies. (U.S.S.R.)

Network Coverage of France by FM Transmitters, G. Pointeau. "Toute R." No. 222. January 1958. 2 pp. The coverage of the broadcast transmitters in France is illustrated by maps. Power output and frequency of all stations are given. (France.)

Laboratory Tests on Kahn Theory Concerning Antifading Receptions, G. Bronzi. "Alta. Freq." February 1958. 27 pp. It is referred upon tests already announced concerning antifading receptions according to the theory announced by Kahn. The results of the experimental analysis have been compared and found fully confirming the forecasts of the new theory. (Italy.)

An Automatic Recorder for Measuring Ionospheric Absorption, S. C. Mazumdar. "J. ITE." March 1958. 6 pp. The paper deals with the design of an automatic recorder for measurement of ionospheric absorption which can be evaluated from a comparison of the successive order echoes on vertical incidence pulsed transmission. (India, in English.)

The Süddeutsche Rundfunk's New Studio Centre at Karlsruhe, Helmut Rupp. "Rundfunk." June 1958. 7 pp. The paper describes the background which determined the plans for building the new studio centre at Karlsruhe. It gives an outline of the operation functions of the new studio building and makes mention of the possibilities for materializing this plan, as well as of the stages into which the building work is divided. The paper in particular forms an introduction to a group of subsequent descriptive articles. (Germany.)

Simplified Frequency Diversity Method, H. Volz. "El. Rund." June 1958. 3 pp. After discussing the theoretical gain of various known diversity methods, calculations of the new method are explained with object of receiving two transmitters with the same program. (Germany.)

The Question of Push Button Dialing for Telephone Sets, R. Thyen. "Nach. Z." June 1958. 7 pp. A small number of characteristic examples out of a collection of approximately 220 patents and patent applications relating to push button dialing is taken into consideration in an investigation into the possibilities and consequences of such a dialing method. (Germany.)

The Reliability of Binary Code Transmission by Means of Various Types of Modulation, H. J. Held. "Nach. Z." June 1958. 7 pp. For the most important binary keying methods mathematical formulae for the probability of a faulty binary step transmission are compiled and compared with one another. (Germany.)

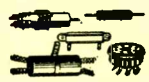
The Design of Manual Switching Systems on the Basis of Traffic Theory, H. Stoermer. "Arc. El. Uber." Vol. 12, No. 3, March 1958. 8 pp. In planning manually-operated telephone exchanges, two essential problems are encountered. On one hand, the number of operators must be large enough to avoid excessive delays for subscribers demanding service. On the other hand, each operator must be provided with a sufficiently large number of connecting facilities so that no delay is caused on account of all facilities being in a busy condition. The article shows that the number of operators and facilities can be determined from the known delay theory. (Germany.)

Noise Performance of a Three-Stage Microwave Receiver, H. V. Shurmer. "E. & R. Eng." July 1958. 4 pp. Analysis of the noise performance of microwave receivers has hitherto been confined to cases where the input signal is fed directly into a crystal mixer or detector followed by an intermediate frequency or video amplifier, respectively. This article extends the treatment to include a receiver in which the crystal valve is preceded by a stage of r.f. amplification, such as a traveling-wave tube. (England.)

Tropospheric Scatter Tests in Great Britain, A. J. Wheeldon. "Brit. C. & E." June 1958. 4 pp. An experimental tropospheric scatter circuit between Start Point and Chelmsford is providing useful data on propagation and on the nature of received signals. (England.)

Review of Electronic Telephone Exchange Progress, T. H. Flowers. "Brit. C. & E." July 1958. 9 pp. This article surveys the electronic telephone exchange techniques that have been developed throughout the world in the last 10 years. The various types of equipment are discussed and possible future trends are outlined; the first British electronic exchange is planned for service in 1960. (England.)

A Mathematical Analysis of the Kahn Compatible Single-Sideband System, John P. Costas. "Proc. IRE." July 1958. 6 pp. This paper is the first published attempt to provide a mathematical evaluation of the performance of the system, based on what has been disclosed so far. (U.S.A.)



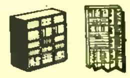
COMPONENTS

Punched Cards Synthesis Method of Switching Systems, V. I. Shestakov. "Avto. i Tel." June 1958. 14 pp. The paper deals with vector-algebraic method of synthesis of sequential switching systems of two-position relays by using special cards. This method is available both for autonomous and nonautonomous relay systems. (U.S.S.R.)

Dynamics of an Electric Relay Servomechanism with the Load Changing Proportionally to Motion, N. S. Gorskaya. "Avto. i Tel." June 1958. 18 pp. The paper treats the dynamics of an electric relay servomechanism with the load changing proportionally to motion. Motion of the servomechanism is described by a complete second-order differential equation. The right part of the equation gives a relay function with a loop and dead zone. A complete solution of this nonlinear problem by means of the point conversion method is given. (U.S.S.R.)

The Transformer—A Two-Terminal Network, W. Klein. "Arc. El. Uber." Vol. 12, No. 3, March 1958. 5 pp. For a rational determination of the quadrupole properties of a linear circuit, the starting point is a multipole admittance matrix for a two-terminal network. It is advisable to present the transformers also as two-terminal networks. This is possible even for negative two-terminal networks. Equivalent networks are derived for various types of transformers. (Germany.)

New Batteries for the Space Age, David Linden and Arthur F. Daniel. "El." July 18, 1958. 7 pp. The limitations and applications of some of the latest developments, including the still-secret thermal cell, are discussed. (U.S.A.)



COMPUTERS

Electro-Mechanical Calculating Device, V. V. Gorsky. "Avto. i Tel." May 1958. 8 pp. An electro-mechanical calculating device and its operation are described. The device may be used to plot Michaelov curve and inverse amplitude-phase characteristics of single-loop systems, to make functional transformation of speed feedback, to calculate certain functions, to find real roots of algebraic equations and so on. (U.S.S.R.)

Sampled-Data Systems with Extrapolating Devices, Ya. Z. Tsypkin. "Avto. i Tel." May 1958. 12 pp. Sampled-data systems with extrapolating devices are considered. Equations of the said systems describing the process at any moment of time are given. The analysis of the system under consideration is illustrated by an example. (U.S.S.R.)

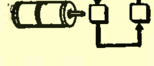
The Way of Forming Transfer Functions of Sampled-Data Control Systems with Extrapolating Devices, S. S. Ermakov and E. M. Esipovich. "Avto. i Tel." May 1958. 7 pp. The paper deals with the way of forming conditional transfer functions of extrapolating devices for digital-to-analog conversion. The transfer function expression depends on the shape of input pulses. (U.S.S.R.)

The Probability of Errors in Binary Code Signals in the Presence of White Noise Interference, H. J. Held. "Avto. i Tel." May 1958. 6 pp. The paper relates to investigations into the effect of so-called error correcting coding methods on the reliability of binary code transmission in a channel affected by white noise. (Germany.)

A Survey of Delay Lines for Digital Pattern Storage, S. Morleigh. "El. Eng." June 1958. 8 pp. In the present article an investigation is made of electromagnetic and ultrasonic delay lines as these may be used over a wide range of delay times. Wire type acoustic delay lines using magnetostrictive transducers, acoustic lines using (a) liquids and (b) solids as delay media, and also both the continuous and lumped-parameter types of electromagnetic delay line are examined. (England.)

Digital Computer Adding and Complementing Circuits, C. D. Florida. "El. Eng." July 1958. 7 pp. The design of transistor operated adding and complementing circuits is discussed with particular reference to d.c. coupled circuits suitable for use with double-gate shifting registers. Examples of circuits are given and illustrated by photographs of waveforms at a digit spacing of 5μsec. (England.)

The Application of Digital Computers to Nuclear-Reactor Design, J. Howlett. "P. BIEE." July 1958. 6 pp. The paper reviews the main computational problems arising in the design of a nuclear power reactor. The numerical-mathematical methods available are described briefly in two broad classes, namely the discrete-particle (Monte Carlo) treatment of the neutron-transport problems and the analytical methods based on the transport equation. (England.)



CONTROLS

On Improving the Quality of On-Off Control, A. I. Cherepanov. "Avto. i Tel." May 1958. 4 pp. The corrective device for an on-off controller is suggested. Its operation and structure are described. Some data of the analysis are given. (U.S.S.R.)

The Effect of the Linear Zone and Saturation Regions on Two-Stage Servomechanism Dy-namics, N. S. Gorskaya. "Avto. i Tel." May 1958. 17 pp. Two-stage servomechanism dynamics is considered. The first stage has a relay control element with a loop and a dead zone, the second one has a relay control element with the linear zone and saturation regions. Nonlinear problem of the effect of the linear zone and saturation regions. Nonlinear problem of the effect of the linear zone and saturation regions on servomechanism free motions is analyzed. (U.S.S.R.)

Error Coefficients and Phase and Amplitude Characteristics of Linear Reproducing Systems, V. G. Vasiliev. "Avto. i Tel." May 1958. 2 pp. The paper deals with the connection of error coefficients with amplitude and phase characteristics of linear reproducing system with lumped parameters. (U.S.S.R.)

Experimental Treatment of Temperature Control, A. A. Kampe-Nemm. "Avto. i Tel." May 1958. 3 pp. The method using thermoelectric corrective device and having properties both of two-position and of proportional-plus-integral control is treated. The corrective device is described in detail. Experimental data show that the device under consideration greatly improves two-position control. (U.S.S.R.)

Speed Control of Synchronous Reactive Motor in Magnetic Recording System, L. A. Pusset. "Avto. i Tel." June 1958. 8 pp. The author analyzes the stability of speed control of a synchronous reactive motor of high accuracy in magnetic recording system. The stability conditions are obtained for a case when a phase discriminator of electronic or electromechanic type is used as a sensitive element. (U.S.S.R.)

The Stability of Periodic Conditions in Control Systems Found Approximately on the Basis of Filter Hypothesis, V. A. Taft. "Avto. i Tel." June 1958. 6 pp. The approximation method of the analysis of the periodic conditions in nonlinear control systems is outlined. A brief comparison of this method is done with the method based on the autoresonance hypothesis. (U.S.S.R.)

The Transfer Function of Motor Control by Changing the Exciting Voltage, E. L. Urman. "Avto. i Tel." June 1958. 5 pp. The transfer function of a motor with the additional series excitation winding is deduced. (U.S.S.R.)

The Stability of Periodic Conditions in Nonlinear Systems with Piece-Wise Characteristic, M. A. Aizerman and F. R. Gantmakher. "Avto. i Tel." June 1958. 3 pp. The method is described that enable finding the linear approximation equation which solves the problem of the stability of periodic solution in the system with piece-wise characteristic. (U.S.S.R.)

The Control by Voltage and Control by Current in Reference to the Negative Differential Resistors, L. Piglione. "Alta. Freq." April 1958. 15 pp. The "control by voltage" and "control by current" mechanisms, for the interpretation of the behavior of the negative differential resistors, are examined from the point of view of the stability by means of the frequency response method. Equations permitting to draw the equivalent circuit by direct measurements, are also given. (Italy.)

A Study of Some Non-Linearities in a Simple Positioning Servomechanism, S. Sampath. "J. ITE." March 1958. 10 pp. This paper considers the specific case of a simple positioning servo-system and describes the study carried out on the electronic differential analyzer recently set up at the Indian Institute of Science, to determine individually the effects of saturation that may be present in the electronic amplifier or the generator field of the servo and of hysteresis in the controlling potentiometer. (India, in English.)

Combined Analog-Digital Control Systems. Michael H. Nothman. "El. Mfg." June 1958. 9 pp. Some practical hybrid sub-systems for combined analog-digital controls. (U.S.A.)

How Systems Engineering Affects Missile Design, Robert J. Bibbero. "Auto. Con." June 1958. 4 pp. An article which can serve as a guide line to systems engineers who must analyze and evaluate the relative merits of different procedures and techniques in missile control design. (U.S.A.)

GENERAL

***Systems Development Engineering In The Western Area,** John Holland. "El. Ind." Aug. 1958. 4 pp. The 'system' concept, and systems engineering, has seen wide application to the aircraft industry and military weapons planning. Systems development engineering is now being extended to many other fields, as well, particularly in the line of digitally controlled milling machines, and automated petrochemical processing plants. (U.S.A.)

***Writing the Report,** Jack W. Pearson. "El. Ind." Sept. 1958. 3 pp. Though some engineers think it a profitless chore, report writing through its disciplining process, actually is most helpful in making them better engineers. (U.S.A.)

Electrical Devices for Solving Algebraic Equations, N. N. Mikhaelov. "Avto. i Tel." May 1958. 14 pp. The paper deals with the survey and classification of the existent root finders. They are evaluated as to their ability of automatic finding of roots. New devices are proposed for finding roots of characteristic equations. (U.S.S.R.)

The Effect of the Asymmetry of the Exciting Slot on the Accuracy of a Limiting Attenuator of the Capacitive Type, E. S. Zhavoronkova. "Radiotek." Jan 1958. 11 pp. The paper studies the effect of the mechanical tolerances of the mechanical slot on a limiting capacitive attenuator. It is demonstrated that the amplitude of the E_{01}-wave excited by the slot does not depend on frequency, and that the limiting of the H_{11}-wave is proportional to the square of the frequency. The magnitude of the systematic error is computed for the capacitive attenuator. (U.S.S.R.)

The Suppression of Pulse Noise Using a Nonlinear Transformation of the Shape of the Noise Frequency Spectrum, A. A. Gorchabev. "Radiotek." Jan. 1958. 6 pp. The paper treats various types of nonlinear transformations for spectra. These transformations precede amplitude limiting. The paper demonstrates the practicality of using converters having a resonant characteristic. Theoretical and experimental results are compared. (U.S.S.R.)

The Operation of an Induction Motor with an Asynchronous Frequency Converter, B. K. Basova, V. N. Bogoiavlenskii, A. A. Ianshin. "Iz. Akad." November 1957. 12 pp. The paper studies a stage containing a shorted induction motor operating in a torque mode. A design method for the system is developed for constant power output of the induction motor. The geometric locus for the currents is determined, and the basic energy relationships are derived for various operating modes of the asynchronous frequency converter. (U.S.S.R.)

On the Acoustical and Technical Behaviour of the Reverberation Plate, Walter Kuhl. "Rundfunk." June 1958. 6 pp. The paper describes the construction and method of operation of a device for producing artificial reverberation. It consists of a large, thin plate of tinned steel which is electro-dynamically excited to oscillatory bending, this oscillation being in its turn picked up by means of a piezo-electric microphone. (Germany.)

Automatic Detection of Signs, K. Steinbuch. "Avto. i Tel." May 1958. 8 pp. The paper relates to the possibilities of detecting with the aid of automatic devices printed, type-written or hand-written signs. (Germany.)

Mechanical Isolation of Vibration Through the Use of Elastic Foundations, G. Benz, H. Heidenhain, W. Weidenhammer. "Freq." Vol. 12, No. 4, April 1958. 6 pp. The article deals with the theory of vibration and explains the principles of active and passive vibration eliminators. Elastic foundations are especially effective with heavy tool machinery. (Germany.)

A Caribbean V.H.F. Survey, J. W. Burgett. "Brit. C. & E." June 1958. 6 pp. This article acts as a reminder that the setting-up of a v.h.f. system is not solely a matter of buying and installing radio equipment. The author tells of his experiences in carrying out a v.h.f. survey—"access to one site was only possible by boat and then by foot or donkey along a 2½-mile track and 639 steps. (England.)

Temperature Transients in Gas-Cooled Thermal Nuclear Reactors, J. H. Bowen and E. F. O. Masters. "P. BIEE." July 1958. 12 pp. The paper examines the transient behaviour of the Calder Hall type of reactor in terms of the design and operating parameters. (England.)

Advances in Fog Signalling, J. H. Rowe. "Brit. C. & E." June 1958. 2 pp. (England.)

Magnetic Reader Speeds Travelers-Check Processing, K. R. Eldredge, et. al. "Con. Eng." July 1958. 5 pp. Bank of America is using a magnetic reader to process cashed travelers checks. Here is a description of how the device works, the circuitry that converts Arabic numerals to electric signals, and the techniques which prevent errors. (U.S.A.)

A Systematic Approach to Reliable Design, Harry V. Cooper. "El. Eq." July 1958. 3 pp. Educated guesswork and calculated risks often lead to decisions based on expediency, with subsequent lack of reliability in complex systems. They can be all but eliminated by the design techniques outlined here. (U.S.A.)

The Micro-Module Design Concept in Electronics, A. W. Rogers. "El. Mfg." July 1958. 4 pp. Development of the Signal Corps Micro-Module concept and program is discussed in this article; typical micro-parts are described and case histories given. (U.S.A.)

Radio Telescope Sees 2 Billion Light Years, C. N. Kington. "El." June 20, 1958. 6 pp. Largest and most sensitive radiation detector locates, identifies and tracks astral bodies emitting low-energy radio waves and measures geometric properties of solar bodies. (U.S.A.)

INFORMATION

***Data Communications Feel . . . The Impact of Information Theory,** Alan F. Culbertson. "El. Ind. Ops. Sect." Aug. 1958. 5 pp. Individuals have been exchanging information from the dawn of mankind. In the mid-twentieth century, a theory evolved to cover the process. That theory and its effect on communications are described here. (U.S.A.)

MATERIALS

***Corona Discharge—The Failing of Dielectrics,** Clelland D. Nail. "El. Ind." Sept. 1958. 4 pp. Ion and electron bombardment have been considered as independently accountable for failure of insulating materials during sustained corona discharge. Experimental evidence indicates that the latter is primarily responsible. (U.S.A.)

The Evaporation of Barium from the Surface of Certain Metals, P. M. Marchuk. "Radiotek." December 1957. 12 pp. The paper studies the basic laws governing the evaporation of mono-atomic barium films from the polycrystalline surface of pure tungsten, tungsten which is electrolytically coated with rhenium, carbided tungsten and platinum-coated tungsten. Values are computed for the basic parameters characterizing the process: the heat of vaporization, the average lifetime of barium atoms on the investigated surface et al. (U.S.S.R.)

The Migration of Barium Over the Surface of Certain Metals, G. F. Mitianskii. "Radiotek." December 1957. 6 pp. A cylindrical thermionic electron gun with a high vacuum is used to perform a comparative study of barium migration over the surface of pure tungsten, carbided tungsten, tungsten electrolytically coated with a layer of rhenium, and tungsten coated with a layer of platinum. (U.S.S.R.)

Thermochemical Restoration of Barium from Its Oxide by Means of Various Activators, Iu. S. Vedula, V. N. Gavriliuk. "Radiotek." December 1957. 6 pp. An experimental study is made of the saturated vapor pressure of barium above the reactions of BaO (a product of the thermal decomposition of BaCO) with Mo, W, Si, Ta, and Ti as functions of temperature. (U.S.S.R.)

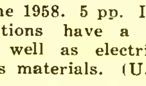
The Present State of Crystal Oscillator Engineering, H. Awender. "Nach. Z." May 1958. 13 pp. The paper explains the nature of oscillator crystals, their use, their signifiance for telecommunication engineering and their construction. Piezo-electric raw materials, the results of substitute research and synthetic processes for crystals are discussed. (Germany.)

The Properties and the Construction of Quartz Crystals with High Q-Factors, G. Becker. "Arc. El. Uber.," Vol. 12, No. 1, January 1958. 11 pp. Design details are given concerning shape, processing, support, binding, and electrode configuration. The described device is used in an electronic clock. Also given are temperature coefficient, frequency aging, stability, etc. (Germany.)

Magnetic Tape for Data Recording, C. D. Mee. "P. BIEE." July 1958. 10 pp. The occurrence of mistakes, i.e. drop-outs, in the recording and reproduction of pulse signals on magnetic tape is investigated. The mechanisms of recording and reproduction are discussed for return-to-zero and non-return-to-zero recording, and their susceptibility to dropouts is assessed. (England.)

Magnesium Parts in Electronic Equipment, Hemenway R. Bullock. "El. Mfg." July 1958. 6 pp. Design considerations, analyses and case histories for fabrication of light-weight electronic equipment where space-weight-strength problems are critical. (U.S.A.)

Conductive Adhesive for Electronic Applications, Timothy J. Kilduff and A. A. Benderly. "El. Mfg." June 1958. 5 pp. Improved silver-epoxy formulations have a dual purpose: mechanical as well as electrical connection between various materials. (U.S.A.)



MEASURE & TESTING

***A System For . . . Oscilloscope Camera-Positioning,** Paul L. Kerley. "El. Ind." Aug. 1958. 2 pp. A system for taking multiple sweep exposures on each print is described. Complete information is given for the construction and operation of such a system. (U.S.A.)

***Transformerless Bridge Null Detector,** C. C. Street. "El. Ind. Ops. Sect." Aug. 1958. 2 pp. A vacuum tube approach makes possible the elimination of the transformer in audio and ultrasonic bridges. The purpose is to eliminate effects of transformer winding capacitance on bridge balance. (U.S.A.)

***New Dynamic Method—Testing Horizontal Deflection Tubes,** G. M. Lankard. "El. Ind." Sept. 1958. 4 pp. The new, wide-angle cathode-ray tubes have made static methods of testing horizontal deflection tubes inadequate. The unique method of dynamic testing described here makes use of a peak-reading voltmeter. The voltmeter method allows non-technical personnel to make these tests. (U.S.A.)

***Comparison of RC Sweep and Ideal Sawtooth,** Donald Moffat. "El. Ind." Sept. 1958. 3 pp. Two methods for finding the straight line from which the exponential deviates are discussed. In each case, the results are plotted as error vs time curves. The relation of non-linearity to change in slope is also covered. (U.S.A.)

On the Theory of a Superheterodyne Which Operates in a Linear Mode, V. Ia. Khevrolin. "Radiotek." Jan. 1958. 15 pp. The paper treats the theory of the electrical processes that occur in a linearly operating superheterodyne. A simplified method is proposed for computing the gain. Conditions are derived for stability and stable amplification. An error is pointed out in the formulation of this condition in other papers. The conditions for high selectivity are derived. (U.S.S.R.)

Graphical Analysis of Thermally Stabilized Emitter Repeaters, V. S. Davydov. "Radiotek." Feb. 1958. 5 pp. A method is given for the graphical analysis of junction-transistor emitter repeaters; the method makes it possible to determine the effect of the circuit elements on the position of the operating point, as well as the variation of the input impedance due to temperature fluctuations, from the family of static characteristics. A comparison is made between the properties of five different types of emitter repeaters, and recommendations are given for the design of thermally stabilized stages with a low noise level. (U.S.S.R.)

The Distribution of Electrical Charge on Linear, Plane, Closed-Loop Conductors, L. A. Druzhkin. "Radiotek." March 1958. 5 pp. The paper treats the problem of electric charge distribution on linear conductors by means of a special function λ and parameter φ. A criterion is given for checking the selection of the vector-parametric equations for the curves representing the axial lines of linear conductors. It is demonstrated that a solution of the problem leads to a simplified analysis and to the possibility of determining the potentials and fields for the conductors. (U.S.S.R.)

Mass-Spectrometer Method for Determining the Composition of Residual Gases in Electronic Instruments Having a Porous Metal-Film Cathode, Iu. G. Ptushinskii and B. A. Chuikov. "Radiotek." December 1957. 5 pp. The paper investigates the qualitative composition of residual gases and its variation over a period of up to 500 hours in laboratory electronic instruments with an operative porous metal-film cathode containing an oxide-barium filler. For an over-all pressure of 10^{-7} mm merc there is an appreciable amount of hydrogen, helium, carbon monoxide, oxygen; there is an insignificant amount of chlorine. (U.S.S.R.)

Instrumentation As Applied to the Production of Communication Equipment, V. Kirschner. "Freq.," Vol. 12, No. 4, April 1958. 7 pp. Exact and rapid testing are important factors in achieving low production costs. The article outlines the various test instruments used in the production of communication equipment, as well as trouble shooting. (Germany.)

A Proposed Sound Level Indicator Which Indicates the Subjective Loudness of Pulse-Type Peak Noise of Any Wave Form, H. Niese. "Hochfreq.," Vol. 66, No. 4, January 1958. 14 pp. Described is a sound level indicator which contains stereophonic microphones to eliminate the influence of the sound pattern. A delay network in the two lines simulates the reaction delay of the human ears. (Germany.)

An Impulse Heterodyne Method for the Measurements of Frequency and Phase, as Well as Locked Phase Frequency Transformation, G. Becker. "Freq.," Vol. 12, No. 3, March 1958. 8 pp. The article outlines a differential method which greatly increases the accuracy of the heterodyne technique. The two-beat frequencies must be of rational relation, but can be a multiple of each other. The method lends itself very well for a comparison of standard frequencies. Applications of the method are illustrated. (Germany.)

Deflection Measurements of the Power Factor of Capacitors by Bridge Methods, J. Srzednicki. "Rox. Elek." Vol. 4, No. 1. 23 pp. The measuring ability of bridge instruments, with phase detectors as indicators of the bridge output voltage, destined for deflection measurements of the power factor in capacitors, is analyzed in the paper. (Poland.)

Experimental Tests on Some Configuration Lenses for Microwaves, P. F. Checcacci and V. Russo. "Alta. Freq." April 1958. 16 pp. The paper is concerned with the construction and the experimental tests of three microwave optical systems. Two of such systems belong to the conflection refraction type and the third is a conflection doublet. Radiation patterns and wave-front plots are given, from which it results that the three collimating systems are well corrected and in fair agreement with the theory. (Italy.)

Apparatus for the Measurement of the Velocities of Sonic Pulses in Flawed Materials, R. F. Seaborne and N. B. Terry. "J. BIRE." June 1958. 10 pp. An equipment is described for the measurement of elastic pulse velocities in materials which present a high attenuation to the elastic waves. (England.)

The Design Performance and Use of Fission Counters, W. Abson, et al. "P. BIEE." July 1958. 8 pp. The basic design criteria for electron-collection fission counters are discussed; data are presented concerning the effect of thickness of fissile material on sensitivity and the effect of electrode spacing and gas pressure on pulse height. (England.)

The Optical Approach in Microwave Measurement Technique, José I. Caicoya. "Brit. C. & E." July 1958. 8 pp. The author makes a survey of some interferometers and grating spectrometers for millimetric waves, and this survey is used as an introduction to the description of his "high-order-mode interferometer." (England.)

Modern Oscilloscope Practice. "E. & R. Eng." June 1958. 14 pp. Performance and circuitry. (England.)

Thermistors, K. R. Patrick. "E. & R. Eng." July 1958. 8 pp. A review of their properties and applications. (England.)

Two Automatic Impedance Plotters, R. S. Cole and W. N. Honeyman. "El. Eng." July 1958. 5 pp. This article describes two methods by which impedances at microwave frequencies can be automatically presented. It indicates the theory of the two systems and gives the practical details of each together with a comparison of the two. (England.)

A Sensitive Defocusing Photo-electric Pressure Transducer, J. R. Greer. "El. Eng." July 1958. 4 pp. A design for what is believed to be a novel type of photo-electric pressure transducer using germanium photocells is described, and it is shown that as a result of very high optical efficiency, symmetrical outputs of over 20V may be obtained for pressure differences of a few centimeters of water. The transducer is both mechanically and pneumatically robust, and is stable over long periods. (England.)

The Hall Effect and Its Application to Microwave Power Measurement, H. M. Barlow. "Proc. IRE." July 1958. 3 pp. (U.S.A.)

Ergmeter Measures Bursts of Energy, Louis A. Rosenthal. "El." June 20, 1958. 3 pp. Bolometer bridge converts input signal to heat by integrating input power with respect to time. Heat upsets the bridge balance and produces output signal that is amplified and applied to peak holding voltmeter whose output corresponds directly to energy. (U.S.A.)

Automatic Test Methods for Missile System Checkout, J. I. Davis. "Auto. Con." June 1958. 4 pp. (U.S.A.)

What About Digital Transducers?, E. J. Kompass. "Con. Eng." July 1958. 6 pp. Here are the answers to some what's and why's about an important new trend in measurements techniques. (U.S.A.)

Computer Analyzes Brain Waveforms, Carl J. Zaander. "El. Eng. Edition." July 18, 1958. 5 pp. Brain-wave analyzer uses Schmitt trigger and flip-flop circuits to chart behavior of irregular electrical waveforms emitted by the brain. (U.S.A.)

Data Reduction for Regulus, "Auto Con." June 1958. 4 pp. (U.S.A.)

RADAR, NAVIGATION

Metal Reflectors Used as Landmarks in Navigational Guidance Systems, G. Megla. "Hochfreq.," Vol. 6, No. 4, January 1958. 8 pp. The author discusses various ways reflectors can be used for navigational aids. The low cost of reflectors would permit the construction of air-highways and control points. Also suggested are rotating units for seaways. (Germany.)

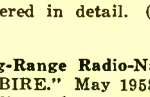
The Design of Primary and Secondary Radar I.F. Amplifiers, N. N. Patla. "J. ITE." March 1958. 10 pp. The practical designs of circuitry in primary and secondary radar I. F. amplifiers are considered in detail. (India, in English.)

Dectra: A Long-Range Radio-Navigation Aid, C. Powell. "J. BIRE." May 1958. 16 pp. The paper first outlines the operational requirement for a navigational aid covering the air routes on an ocean crossing such as the North Atlantic. After a short reference to the Decca phase comparison technique, the tracking and ranging functions of the Dectra system are described with special reference to the time-sharing technique on which the tracking pattern is based. (England.)

Radome Thickness Gage is Frequency Stabilized, A. H. Weber, Jr., et al. "El." June 20, 1958. 3 pp. Microwave thickness gage uses frequency-stabilized klystron to determine electrical thickness and dielectric constant of radomes. (U.S.A.)

Radar Reflectors of Reinforced Plastic, Ralph L. Mondano. "El. Des." May 28, 1958. 3 pp. (U.S.A.)

Radar Interference and Its Reduction, Donald B. Brick and Janis Galejs. "Syl. Tech." July 1958. 13 pp. The effects of interference on radar operation are discussed with primary emphasis on r-f radiated interference. A summary of the various types of interference, that is, active, passive, radiated and conducted, is given. (U.S.A.)



SEMICONDUCTORS

***New Transistor Design—The "Mesa"!,** C. H. Knowles. "El. Ind." Aug. 1958. 6 pp. Higher frequency of operation, higher power handling capabilities, and exceptional reproducibility are the features of this new micro-miniature transistor, the smallest being commercially manufactured. (U.S.A.)

***Increased Cooling For Power Transistors,** C. Booher. "El. Ind." Aug. 1958. 3 pp. The role of operating temperature on the life span of transistors and the threat of "thermal runaway" is focusing new attention on the methods of dissipating heat. Experimentation with a wide variety of shapes indicates that one "best" unit proves most effective in keeping operating temperature at maximum power below recommended ceilings. (U.S.A.)

***Capacity Neutralization of H-F Transistors,** L. S. Greenberg & R. C. Wonson. "El. Ind." Sept. 1958. 5 pp. The stability and distortion considerations of i-f transistor amplifiers requires that the small signal, short circuit, reverse transfer admittance parameter be neutralized. The capacity needed for neutralization can be derived and its relation to the standard collector capacity outlined. (U.S.A.)

Approximate Transient and Frequency-Phase Responses for the Intrinsic Current Gain of a Junction Transistor, T. M. Agakhanian. "Radiotek." Feb. 1958. 11 pp. Approximate expressions are derived for the transient and frequency-phase responses for the intrinsic current gain of a junction transistor in three different fundamental circuits. (U.S.S.R.)

The Conditions Governing Self-Excitation in Junction-Transistor Oscillators; the Oscillation Frequency, P. D. Berestnev. "Radiotek." Feb. 1958. 8 pp. Expressions are derived for the conditions governing both the self-excitation and the frequency of oscillation in oscillators with transformer, autotransformer and capacitive feedback. Suggestions are made for selecting the elements in the phase compensation network as a function of the transistor parameters and the frequency of oscillation. (U.S.S.R.)

On the Theory of the Transient Response of a Transistor, A. A. Greenberg. "Radiotek." Feb. 1958. 3 pp. Transient responses are derived for a transistor which is current controlled. Various circuits are treated. The analytical form of the transient responses made it possible to take into account the collector capacitance and the load impedance of the transistor. (U.S.S.R.)

The Manner in Which the Dependence of the Frequency Properties of the Transistor on its Electrical Operating Mode Affects the Wave-Front Duration, I. I. Litvinov. "Radiotek." Feb. 1958. 5 pp. The paper treats this effect for the case of pulses generated by relaxation oscillators with a single reactance. (U.S.S.R.)

On the Parameter h_{11}/z_{11} for a Transistor; Generalized Impedance and Gain Characteristics, V. K. Labutin. "Radiotek." Feb. 1958. 10 pp. The paper studies a new transistor parameter on the basis of which new generalized characteristics and diagrams are derived for the impedances and gain coefficients. These characteristics make possible a convenient description of the amplification properties of a transistor for small-signal low-frequency operation. The use of the generalized characteristics and diagrams facilitates the design of transistor amplifiers. (U.S.S.R.)

The Relationship Between the Parameters of the Transistor for Different Types of Connections, Kh. I. Cherne. "Radiotek." Feb. 1958. 10 pp. Formulas are derived for determining any transistor parameters for any circuit connections on the basis of four known parameters. (U.S.S.R.)

The Correlation Between the Parameters of an Electronic Tube and Those of a Transistor, M. G. Margolin. "Radiotek." Feb. 1958. 7 pp. A universal equivalent circuit and system of parameters is proposed for computing both vacuum-tube and transistor amplifiers. The system of h-parameters is used as the basis for this system. (U.S.S.R.)

Increasing the Useful Power Output of a Tuned Transistor Amplifier by Increasing Its Efficiency. Part II, L. S. Berman. "Radiotek." March 1958. 4 pp. An additional tank circuit, tuned to the second harmonic, is used to increase the efficiency of a tuned transistor amplifier. As a result the useful output power is increased by a factor of approximately 2.5 without exceeding the allowable power dissipation. The paper demonstrates the possibility of amplitude modulating the tuned amplifier while maintaining constant efficiency. (U.S.S.R.)

A Storing and Switching Transistor, W. Munch and H. Salow. "Nach. Z." June 1958. 7 pp. A storing switch can be produced by inserting a tungsten point into the collector contact of a npn-barrier transistor during the alloying process. The resulting input characteristic is similar to that one of a thyratron. (Germany.)

Some Criteria for the Thermionic Instability of Transistors, F. Weitzsch. "Freq.," Vol. 12, No. 3, March 1958. 7 pp. Treated are the problems associated with instability of transistor circuits due to temperature coefficients. Answers are provided to the following two questions: a) What are the parameters which cause thermic instability in circuitry?; b) What kind of circuit elements are needed to suppress thermic instability. A thorough mathematical analysis supports the article. (Germany.)

The Tecnetron, A Solid-State Triode for High-Frequencies, M. Teszner. "Toute R," No. 223, February 1958. 2 pp. Described is a three-element solid-state device capable of operating at frequencies up to 1,000 MC. (France.)

Manufacture of Silicon Transistors, James T. Kendall. "E. & R. Eng." June 1958. 6 pp. An assessment of the present state of technology. (England.)

Solid-State Photocell Sees Through Haze, Paul Weisman and Stanley L. Ruby. "El." June 20, 1958. 2 pp. Interruption of high-energy beam from radioactive source changes resistance across cadmium-sulphide detector Transistor amplifier converts variation into signal capable of actuating limit switches and positional devices. (U.S.A.)

A Method for Sharpening the Output Waveform of Junction Transistor Multivibrator Circuits, A. E. Jackets. "El. Eng." June 1958. 4 pp. The transistor multivibrator circuit provides a simple means of generating rectangular waveforms. The design of such circuits was discussed in a previous article and it was shown that the output waveforms are marred by the recharging of the coupling capacitors. This article, an extension of the previous work, presents a method of designing the circuit to reduce this recharging time and thus sharpen the output waveform at the collector of one transistor. However, this improvement in waveform is only obtained at the expense of the other output waveform. (England.)

Evaluating the Effects of Temperature on Junction Transistors, W. Bye. "Brit. C. & E." June 1958. 3 pp. The temperature dependence of transistors can be calculated in advance from a knowledge of the properties of the semi-conductor materials used. Exact figures can, however, only be obtained from actual tests on the completed transistors. Some interesting methods and test gear have been developed for this purpose and are described. (England.)

Designing Transistor Circuits-Switching Dynamics, Richard B. Hurley. "El. Eq." July 1958. 4 pp. The dynamic behavior of transistor switches is considered. (U.S.A.)

Designing Transistor Circuits-Switching Statics, Richard B. Hurley. "El. Eq." June 1958. 5 pp. Common sandwich-structure junction triode transistors can yield nearly ideal output efficiencies, making them useful as on-off switching devices. Parameters to be considered and typical switching circuits are examined here. (U.S.A.)

Transistorized I-F Strip Design, Robert E.

Murphy and Robert S. Mautner. "El. Eq." June 1958. 3 pp. Improvements in transistor technology have made these units useful in i-f amplification. The design history of a missile-system amplifier illustrates many of the problems met and their solutions. (U.S.A.)

Overlap Method Makes Fast Pulses in Transistor Circuits, Mark Smith. "El. Des." May 28, 1958. 2 pp. Overlapping a pulse and a delayed pulse can provide very high pulse repetition rates with very steep rise and fall times. The technique employs delay lines to provide very high quality pulses. (U.S.A.)

TELEVISION

A Method for Measuring Random Fluctuations in Television, Dietrich Waechter. "Rundfunk." June 1958. 3 pp. The paper describes a method of comparison for the correct subjective appreciation of random fluctuations in a television picture. The method involves superimposing on the picture to be examined a measuring area to which is applied noise that can be adjusted as required. In this way it is possible to take account of the absolute magnitude of the noise, as well as the spectral distribution of energy, which is of great importance for the visual impression of interference. (Germany.)

Contribution to the Problem of the Portable Television Cameras for Outside Broadcasting, Herbert Fix. "Rundfunk." June 1958. 9 pp. The paper summarizes the present state of the art as it concerns the design and application of portable outside-broadcast cameras. (Germany.)

After-Glow Problems with Color TV Tubes, I. Bormemann. "El. Rund." June 1958. 3 pp. After-glow problems play an important part in the transmission of movable TV and color TV pictures. With the help of the center of gravity principles in its analytic form the mixture process at the utilization of two and three components of different brightness is investigated. (Germany.)

Video-Amplifier of TV Receivers with Wire Wound Anode Resistance, K. Hecker. "El. Rund." June 1958. 3 pp. The author discusses the problems leading to the difficulty that the conventional methods for the measurement of inductance fail in case of very heavily damped inductance. (Germany.)

Present-Day Problems in Color Television, An Attempt at a Survey, G. A. Boutry. "Rundfunk." June 1958. 6 pp. The paper deals with the inter-dependence of physiological optics and television engineering, the necessity for preparatory wave propagation studies in the European Area and the misunderstandings that occur in the discussion of the complex utilization of a color television channel. (Germany.)

Synchronization in TV Receivers in the Presence of Noise, E. Luedicke. "Arc. El. Uber." Vol. 12, No. 1, January 1958. 4 pp. The paper discusses methods by which susceptibility to noise of the horizontal and vertical sweep control of TV receivers can be considerably reduced. (Germany.)

A Simple Procedure for Mixing the Color Carrier of Variable Frequency with the Black and White Picture Carrier, G. Bolle. "Freq." Vol. 12, No. 4, April 1958. 5 pp. Outlined is a device which permits the diagnosis of visibility of the color carrier in the black and white picture. The frequency of the generated signals can be varied from 3 to 4.5 MC. The disturbance generated by this signal is equivalent to the color carrier of constant amplitude. (Germany.)

Some Aspects of Television Tuner Production, S. H. Perry. "J. BIRE." June 1958. 6 pp. The need for accurate assembly to achieve economic mass production of television tuners is discussed in relation to the particular turret tuner. Some manufacturing methods which achieve the required accuracy are indicated. (England.)

Mass Production Techniques for Television Tuners, P. C. Ganderton. "J. BIRE." June 1958. 10 pp. The problems of temperature compensation over the wide frequency ranges are considered. A system of testing which uses a central generator of "wobbulated" signals for the various bands is briefly described and details are given of methods of coil and chassis alignment. (England.)

A Flying-Spot Film Scanner for Color Television, H. E. Holman, et. al. "P. BIEE." July 1958. 14 pp. Film moving with uniform velocity is scanned by a series of displaced rasters in such sequence that the system is applicable to 50 or 60 c/s conditions. Three photo-multipliers provide color analysis of the image, element by element, and directly produce a video-frequency signal, so avoiding any necessity for accurate optical registration. A particular equipment is described. (England.)

Novel Color Television Display System, R. W. Wells. "Brit. C. & E." July 1958. 3 pp. Experiments carried out by the author have proved that a working color television display device can be made using a projection tube in conjunction with a Faraday cell and fixed Cellophane filters. The advantages and limitations are discussed. (England.)

Problems in Electroluminescent Television Display, Robert M. Bowie. "Syl. Tech." July 1958. 4 pp. The "Sylvatron," which is a device combining the principles of the electroluminescent lamp and the variation in electrical conductivity of photoconductive materials, has frequently been suggested as the basis for "picture on the wall" television display. The general scheme is analyzed from the standpoint of the problems involved in bringing this idea to fruition. (U.S.A.)

ΔG = ΔG/enjμpδ

THEORY

Analysis of Free Oscillations of Neutral Plane Without Damping of Its Own and With a Relay Autopilot, V. Yu Ruthkowsky. "Avto. i Tel." May 1958. 13 pp. A relay system, the linear part of which is described by the simplest third-order equation, is considered. The control system dynamics are analyzed by means of the method of point transformation of surfaces. The analysis yields the equations of surfaces describing the space of attraction, equilibrium state and stable limit cycle. (U.S.S.R.)

Analytical Method of Synthesis of Linear Control Systems When There Are Noises and Dynamic Precision is Specified, K. I. Kurakin. "Avto. i Tel." May 1958. 10 pp. Analytical method of approximation of transcendental transfer functions of automatic control systems is proposed. The functions were obtained with the help of fraction-rational functions (10, 14). The practical application of the method in question is illustrated by a number of examples. (U.S.S.R.)

Determination of Optimum System Using General Criterion, V. S. Pugachev. "Avto. i Tel." June 1958. 21 pp. A method is described which enables determination of the optimum system using general criterion of Bayes' type in the class of all systems possible for which this criterion is available under some general suppositions about signal and noises. The solution of the problem is reduced to finding certain linear operators and minimizing certain function or functional. (U.S.S.R.)

The Effect of a Pulse Train Modulated by a Random Process on an Inertial Pulse Detector, G. P. Tartakovskii and Iu. M. Sergienko. "Radiotek." Jan. 1958. 6 pp. The paper demonstrates the equivalence between an inertial pulse detector and a linear pulse circuit with negative feedback. The transfer function is derived for this circuit. The spectral density of the random process is determined at the output of the detector according to the known statistical characteristics of the pulse signal at its input. (U.S.S.R.)

The Focal Length of an Aperture of Finite Diameter through which a Cylindrical Stream of Electrons Travels, K. Poeschl and W. Veith. "Arc. El. Uber." Vol. 12, No. 1, January 1958. 4 pp. The paper derives an improved formula for the focal length of an aperture through which a cylindrical stream of electrons travels. The formula takes into consideration the focal length reduction effects of the aperture, as well as the space change created by the electrons. (Germany.)

Analysis of the Apparent Noise Levels from Periodic Vibrations, H. Niese. "Hochfreq." Vol. 66, No. 4, January 1958. 10 pp. Analyzed is the apparent loudness of sine-wave, square wave, and pulse modulated tones. The experiments show that periodic vibrations with a modulating frequency of less than 100 cycles indicate an apparent increase in loudness. This is on account of harmonic frequencies. It is attempted to calculate this effect by the use of certain assumptions. The results provide a basis for the construction of an objective sound level indicator. (Germany.)

Theory of Band-Pass Filters with Zero Points, E. Trzeba. "Hochfreq." Vol. 66, No. 4, January 1958. 13 pp. The article provides a general treatise on this subject. It elaborates on the probability of creating resonance points in a band-pass filter. The conditions for zero points in filters with 2-4 resonance circuits are described. The conditions are explained with the aid of graphs and loci. (Germany.)

Analysis of Non-Linear Helmholtz Resonators, F. Barthel. "Freq." Vol. 12, No. 3. 11 pp. The increase in static and acoustic drag (aerodynamic resistance) which can be measured in resonators with orifices of 2-15 mm diameter can be calculated on the basis of the Bernoulli equation, assuming the proper jet contraction. However, the relations only apply for orifices having a depth of 0.1 mm or less. (Germany.)

Ternary Switching Algebra, E. Muehldorf. "Arc. El. Uber." Vol. 12, No. 3, March 1958 11 pp. Starting from the known theory on binary switching algebra and logic, this paper develops a ternary switching algebra that allows a systematic treatment of circuits for signals with a ternary code. (Germany.)

The Solution to Boolean Equations, Zemanek. "Arc. El. Uber." Vol. 12, No. 1, January 1958. 10 pp. In Boolean algebra, the counterpart to the equation concept is an equivalence. Assuming an obvious generalization, one arrives at the concept of fulfilling an expression having one or more unknowns. Ways are devised for "fulfilling" the expression. (Germany.)

Analyzing Combinational Circuits by Boolean Matrices and Karnaugh Maps, Boris Beizer and Stephen W. Leibholz. "El. Mfg." June 1958. 11 pp. A step-by-step technique for understanding a multi-path switching circuit by deriving the boolean function which represents it and a method for visualizing and simplifying the boolean expression for any logical circuit. (U.S.A.)

A Ferromagnetic Resonance Frequency Converter, K. M. Poole and P. K. Tien. "Proc. IRE." July 1958. 10 pp. This paper presents the theory and supporting experimental results of a frequency converter that operates on the same basic principles as the ferromagnetic amplifier developed last year. (U.S.A.)

The design of Inductive Post-Type Microwave Filters, M. H. N. Potok. "J. BIRE." May 1958. 10 pp. By application of the results of theoretical analysis and experiment it is shown that microwave filters can be designed to have a desired v.s.w.r. within the pass band and a given insertion loss outside it. Steps leading to an optimum design of three- and four-cavity filters are discussed in detail. (England.)

The Probability of Specified Losses at Mismatched Junctions, John H. Craven. "J. BIRE." May 1958. 4 pp. Probability contours are presented for specified losses ($<$ 1 db to 6 db) at junctions between networks or lines for a range of v.s.w.r. from 1 to 10. (England.)

The Design and Application of a Synchronous Converter, Part 1, I. C. Hutcheon. "Brit. C. & E." July 1958. 5 pp. This article—Part 1—describes the design of a low-level chopper termed a "synchronous converter." It differs from the conventional d.c.-a.c. vibrator for power-supply applications in that it will handle extremely small signals without introducing errors. Hence the design problems are not inconsiderable. (England.)

TRANSMISSION

***Echoes Cause FM Intermodulation, Harold E.** Curtis. "El. Ind Ops. Sect." Sept. 1958. 2 pp. In multichannel FM systems a mismatched transmission line between the antenna and equipment causes r-f echoes. The effect of this echo is to generate intermodulation between channels. A method has been derived to calculate the degree of intermodulation introduced. (U.S.A.)

Circular Transmission of Remote Control Data When Combinatorial Selecting is Used, K. P. Kurdukov. "Avto. i Tel." May 1958. 8 pp. Various ways of selecting are described when time data separation is used. The possibility of circular transmission of data with combinatorial selecting is proved. The paper includes some recommendations as to how to use interconnected pulse code together with combinatorial selecting. The efficiency of such a code is denoted. (U.S.S.R.)

On the Stability of the Field Intensity over Sections of Radio-Relay Lines, A. I. Kalinin. "Radiotek." Jan. 1958. 7 pp. The paper treats the problem of plotting curves for the stability of the field intensity over sections of radio-relay lines; the graphical approach is based on a) the known dependence of the attenuation multiplier on the vertical permittivity gradient, and b) the statistical distribution of the values of this gradient in the region of the specified section of line. Equations are derived for the optimum field intensity stability curves. Numerical results are given for the climatic conditions prevailing in the central band of the European territory of the USSR. (U.S.S.R.)

Long Cable Links for Television, D. W. Harling. "Brit. C. & E." June 1958. 6 pp. This article surveys the techniques now being used in this country for the cable transmission of television signals to the various switching, control, and transmitting centers. (England.)

Computing the Critical Wave of Lowest Mode for Rectangular Waveguides with Longitudinal Rectangular Grooves and Projections, A. Ia. Iashkin. "Radiotek." March 1958. 7 pp. A system of equations is derived which correlates the cross-sectional dimensions of a waveguide with the critical wavelength. The derivation is accomplished by interleaving the solutions for the individual rectangular regions into which the entire complex waveguide section can be subdivided. The computed data is given in the form of graphs for waveguides with two longitudinal grooves and projections. The computed results are compared with experimental results. (U.S.S.R.)

Equivalent Diagrams and Impedances of Transformers Working in Transmission Systems of the "Four Wire-Ground" Type for Group Symmetrical Components, Z. Kowalski. "Roz. Elek." Vol. 4, No. 1. 29 pp. The calculations of asymmetric lines of the "four-ground" type especially during fault conditions (short circuits, conductor breaking) can be carried out by the method of group symmetrical components. The aim of this paper is to present methods for calculating equivalent impedances of transformers working in the CPZ transmission systems and to give their equivalent diagrams for group symmetrical components. (Poland.)

Helical Waveguides—Closed, Open and Coaxial, G. M. Clarke. "J. BIRE." June 1958. 3 pp. The application of helical waveguides to electron-beam amplifiers employing slow wave structures is described. The performances of the various possible configurations are discussed. (England.)

Sound Attenuation in the Ducts with Inner Walls Lined With Absorbing Material, R. Piazza. "Alta. Freq." February 1958. 10 pp. The author recalls the most important elements concerning the problem under study and the general results obtained by following the most elementary (monodimensional) theory based on the hypothesis that pressure is constant in the cross section, an hypothesis which makes it possible to compare a duct to an electric line. (Italy.)

Transmission-Line Discontinuities, K. W. H. Foulds. "E. & R. Eng." July 1958. 5 pp. A detailed explanation is given of the effects of reflections from discontinuities in transmission lines. (England.)

TUBES

***New Developments in Wide-Band Microwave Tubes, Dr. D. A. Dunn.** "El. Ind." Aug. 1958. 7 pp. Among the most important areas of microwave tube research and development are the new methods of beam focusing and the new circuits for high power wide-band amplifiers. New data are available too on the present limitations on power output, tuning range, bandwidth and noise figure. (U.S.A.)

The Physical Properties and Design Elements of a Porous Barium-Tungsten Cathode, N. D. Morgulis. "Radiotek." December 1957. 8 pp. The paper treats the complex of physical phenomena which are associated with the operation of a porous or pressed cathode of the barium-tungsten type: the degree of nonuniformity of emission from the cathode surface, the dynamic equilibrium of the active surface film of the heated cathode, ion bombardment and the effect of chemically active gases, the diffusion of barium vapor through the plug of the cathode onto the outer emitting surface, etc. The elements required for computing these phenomena and the degree to which they effect the operation of the cathode are given. (U.S.S.R.)

The Effect of Ion Bombardment on the Thermionic Emission of a Porous Metal-Film Cathode, Iu. G. Ptushinskii. "Radiotek." December 1957. 9 pp. The paper studies the effect of ion bombardment on the thermionic emission of a porous metal-film cathode. The sputtering coefficient is determined for a barium surface film. The dependence of this coefficient on ion energy in the 50-1800 ev range is also analyzed. A study is made of the effect of ion current on the nature of cathode de-activation at temperatures close to the working temperature. (U.S.S.R.)

The Chemical Effect of Oxygen on the Thermionic Emission of a Porous-Metal-Film Cathode, Ia. P. Zingerman, V. Ia. Soltyk. "Radiotek." December 1957. 7 pp. An experimental study is made of the chemical effect of oxygen, nitrogen and hydrogen on the thermionic emission of a porous metal-film L-cathode with an oxide-barium filler. The experimental data on the effect of oxygen do not contradict the assumption that a barium film is present on the oxide surface of the cathode. (U.S.S.R.)

On the Mechanism by Which Activator Vapors Reach the Surface of a Porous Metal-Film Cathode, I. M. Dykman. "Radiotek." December 1957. 5 pp. The paper studies how activator vapors reach the emitting surface of a porous metal-film cathode. Two mechanisms are discussed: a) Knudsen flow through the pores, and b) migration over the surface of the pores. The relative effect of each mechanism is discussed. The magnitude of the flow of atoms (molecules) of the activator through the porous cap of the cathode is determined, and the possibility of determining the pressure differential of activator vapors across the cathode plug is indicated. (U.S.S.R.)

Diffusion of Strontium Vapors Through the Plug of a Porous Metal-Film Cathode, Iu. G. Ptushinskii, B. A. Chuikov. "Radiotek." December 1957. 6 pp. The method of radioactive tracers was used to study the diffusion of strontium vapors through the plug of a porous metal-film cathode. It is demonstrated that this diffusion is basically achieved via the migration mechanism. The strontium vapor pressure differential across the plug is determined. (U.S.S.R.)

A Small Porous Filamentary Metal-Film Cathode, P. M. Marchuk, E. A. Lozovaia. "Radiotek." December 1957. 4 pp. The paper determines the values for the basic parameters which characterize the thermionic emission and the service life of a small filamentary porous metal-film cathode. (U.S.S.R.)

Electron Emission and Rate of Vaporization of Barium from Porous Metal-Film Cathodes with an Oxide-Barium Filler, Ia. P. Zingerman, V. A. Morozovskii. "Radiotek." December 1957. 8 pp. A method is described for using a mixture of oxides of alkali-earth metals and various "activators" (substances which restore barium from its oxide) in the capacity of an original filler for porous metal-film cathodes. Data is cited for an experimental investigation of the dependence of thermionic emission and barium vaporization rate as functions of the tungsten plug density, the type of activator and the continuous operating time of the cathode. (U.S.S.R.)

Modern Design Tendencies in Valve Development, H. Katz. "Nach. Z." June 1958. 5 pp. A survey is given of the presently existing problems in the development of new valves. The requirements and possibilities for cathodes, grids and materials for valve envelopes are mentioned specifically. (Germany.)

Linearization of the Frequency Modulation Characteristics of Reflex Klystrons, E. Schuon and H. J. Butterweck. "Arc. El. Uber.," Vol. 12, No. 3, March 1958. 10 pp. A reflex klystron can be frequency modulated in a simple and wattless manner by superimposing the modulating voltage onto the reflector. The limits of the range which can be utilized for frequency modulation are given by the curvature of the modulation characteristic. This characteristic can be greatly linearized by special circuitry. (Germany.)

Design of Broadband Ceramic Coaxial Output Windows for Microwave Power Tubes, Robert R. Moats. "Syl. Tech." July 1958. 5 pp. (U.S.A.)

The Screen Efficiency of Sealed-Off High-Speed-Oscillograph Cathode-Ray Tubes, R. Feinberg. "P. BIEE." July 1958. 3 pp. The factors which affect the screen efficiency of a high-speed-oscillograph cathode-ray tube are summarized, and the nature of the shape of the luminance pulse produced by a short-duration square-wave screen excitation is explained. (England.)

Ultrasonic Welder

(*Continued from page* 58)

eliminating the danger of overheating. The welder is instrumented with an electronic cycle timer, and a Bourdon-tube force gage.

A spot-type welder, the unit can be operated on an ordinary 230 v. circuit, and consumes a maximum of 3.5 KVA of power even when joining 0.050-inch 1100 aluminum sheet. Ultrasonic welding requires a great deal less electrical power than resistance welding, often as low as 5% of that required by ordinary resistance welding. Since no electrical bus-bars or special transformers are required for the installation, this unit is mounted on casters so that it can be easily moved to and operated in various plant locations.

Ultrasonic welding is a solid state joining process in which the materials to be joined are subjected to high frequency alternating vibrations, which are generated by the transducer in the welding head system and transmitted through the coupling members to the work being done. The resulting joints are accomplished without fusion, and, in many materials, exceed the strength of similar joints made by standard resistance welding methods.

An outstanding feature of Sonoweld lies in its ability to join dissimilar metals and alloys, and extremely thin gauges of materials which defy conventional welding methods. Materials that have been bonded together, either to themselves or to other metals include aluminum, copper, nickel, stainless steels, molybdenum, tantalum and niobium. Thicknesses to 0.050-inch of 1100-H aluminum and 0.025-inch of type 316 stainless steel have been bonded together in this size welder.

First British Computer Show

The first Electronic Computer Exhibition ever held in the United Kingdom will be staged in London from Nov. 28 to Dec. 4. More than 40 British manufacturers, including all the leading firms, are exhibiting.

The exhibition is to be highly specialized, covering only electronic computers and allied equipment.

Man-Machine Relationships: A New Field for Engineers and Scientists

A new field for Operations Research Specialists, Engineers, Computer Programmers and Behavioral Scientists has arisen from SDC's work on relationships of men and machine systems.

It involves two major projects: **1** *creating and conducting large-scale training programs in present and planned air defense systems; and* **2** *operational computer programming for SAGE.*

Attaining the most effective interaction between men and machines in these programs is of prime importance. It requires intensive effort in an unusual combination of technical and scientific areas. As such, it is a new field of endeavor.

Both programs also have these elements in common: • they are constantly changing in problems • they are long-range in nature • they are essential to the welfare of the United States. The close interrelationship of these programs, the widely diversified specialists engaged in them, and the dominating influence of man-machine relationships make SDC's work unique. Operations Research Specialists, Engineers, Computer Programmers, Behavioral Scientists — all find their assignments reflect the unique qualities of this new field.

The growing complexity of SDC's work has created a number of positions in these fields. Inquiries are invited. Address: R. W. Frost, 2428 Colorado Avenue, Santa Monica, California, or phone collect at EXbrook 3-9411 in Santa Monica.

SDC

SYSTEM DEVELOPMENT CORPORATION
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An independent nonprofit organization, formerly a division of The RAND Corporation

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Company Image Plays Key Role In Job Hunt

Company image, recognized as an important factor in finance and sales, also plays a key role in attracting technical men to an organization.

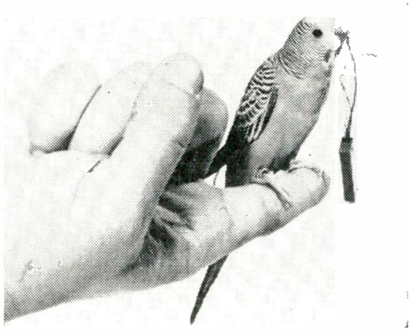
Long before he actually enters the job market, an engineer has unconsciously chosen certain organizations as potential employers and eliminated others from his consideration. This selection process is based, to a large extent, upon the company image he has built up—and the image itself is based on a multitude of factors, including not only company achievement and products, but also personnel policies and employment practices.

These findings were made by Deutsch and Shea, Inc., New York City, technical manpower consultants.

Actual contact with a company is not necessary to the development of a strong and detailed image among engineers, the study indicates. Rather, technical men tend to build their images of various companies on information and rumor gained through contacts with other professionals, on use of company products, on articles and advertising in newspapers and magazines, on convention displays and from a variety of other sources.

Particularly important in forming a company image are the impressions technical men obtain of a company's growth potential, the interest of the work in which it is engaged, its past achievements, and its stability. But, the study reveals, a feeling among engineers that a company's employment practices or personnel policies are poor — particularly as these affect the professional man —can cancel out brilliant technical achievements by the company and create an unfavorable image in terms of employment.

NEW POT SALESMAN



Something "new and small" was needed to introduce their new line of miniature potentiometers, so Bourns Labs came up with "Trimpot," their parakeet. He was introduced at WESCON.

Martin Co. Sets Up Space Flight Division

Martin Co. has created a new space flight division to direct a six-company team developing the Air Force Dyna-Soar boost-glide aircraft.

George S. Trimble, Martin vice-pres., will serve as general manager of the division with headquarters in Baltimore.

Working on the project with Martin are Bell Aircraft Corp., Bendix Aviation Corp., Minneapolis-Honeywell, American Machine & Foundry Co. and Goodyear Aircraft Corp.

Electronics Plant To Hire 300 Personnel

Ryan Aeronautical Co. announced its plans to hire 300 engineers, technicians and supporting personnel at its electronics division's new San Diego, Calif. site.

The expansion is planned to meet the increasing military demand for continuous - wave airborne Doppler radar systems produced by the company.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 103.

Florida Electronics Booms In Recession

A recent survey by the Florida Development Commission shows that the $150 million-a-year electronics industry has become an important stabilizing element in the state's economy with significant gains in the last three months in contracts, employment, and plant expansions.

Employment in the eight biggest companies increased by 1,695 in April, May, and June, and three firms reported their expansion programs were ahead of schedule.

Two plants, Electro-Mechanical Research of Sarasota and Merit Coil and Transformer of Hollywood, announced that since the early part of the year they had finished moving their operations to Florida. A third, Milgo Electronic of Miami, said that current business surpassed all previous work since 1955 and that the company now had contracts from as far away as California.

The Commission said that while some sectors of the national and state economies had suffered employment losses, the Florida electronics industry showed modest but steady gains.

Eight of the biggest companies had a total employment of 8,895 on July 1 as contrasted with 7,200 last April 1, and nine of the medium sized firms, with from 50 to 200 employees each, reported a total gain of 123 for the same period.

The Commission had reported in an April survey that more than 10,000 Floridians were on electronics payrolls completely separate from those located at Cape Canaveral. This figure must now be revised upward, the Commission said.

Evidence that the non-military potential of the industry is growing came from two of the larger companies, General Electric at St.

(*Continued on page* 152)

Writing the Report

Though some engineers think it a profitless chore, report writing, through its disciplining process, actually is most helpful in making them better engineers.

By **JACK W. PEARSON**
Chrysler Corp Missile Div.
Warren, Michigan.

THE necessity of preparing reports encourages the engineer to keep careful records, without which much of his work would be wasted. It forces him, if he will write a good report, to think clearly about what he has done and to organize his work and accomplishments. Fuzzy thinking, incompleteness, and wasteful digressions not readily apparent during the project work will often be revealed by the disciplining process of writing a report.

The report writing period should be welcomed by the engineer as a creative pause during which he can review, analyze, and organize what he has done.

Report writing needn't be a difficult task. If the recommendations in this article are followed, writing the report will be an easy, rewarding work that will result in a permanent record of the engineer's accomplishments to which he can refer with pride throughout his professional career.

Logical Training Helps

The training and temperament of an engineer makes him especially capable of writing good technical reports. He is trained to be logical, consistent, and precise—to organize his efforts into a usable form for a specific purpose. These are qualities needed by the technical writer.

Unfortunately, few engineers have anything to say during their formal education. As a result, they labor, unwillingly, at writing reports while in school and later, when they do have something to say, are undisciplined in preparing technical reports to communicate their ideas. This paper suggests a method of preparing a technical report that will enable the engineer to produce a coherent, well-organized report with a minimum of wasted effort.

The method of preparing a technical report recommended in this paper is divided into three phases: the planning phase, the writing phase, and the editing phase.

Planning the Report

The planning phase of preparing a report usually takes the most time, but, if well done, makes the next two phases easy. During the planning phase, the notes, data, and other material of the report should be assembled, classified, and organized for presentation in the most suitable manner.

The assembly and classification should be done first. When all the materials for the report have been gathered, they should be analyzed for classification. Headings and subheadings must be composed for each classification.

If there are many headings and subheadings, it is helpful to print each of these on a separate 3 x 5 in. card and add a few key words or phrases that will recall the important ideas or data to be included under each heading or subheading.

Headings and titles should be carefully worded. Don't refer to observations as conclusions or to conclusions as causes. Don't call the tracing of a signal voltage a curve just because it looks like one. Headings and titles must accurately indicate what is to follow if the reader is not to be confused.

Classification

During the classification period, decisions should be made on how the material of the report shall be presented. For some reports, expository and/or descriptive prose will do the job. For other reports, visual aids such as tables, charts, schematics, graphs, nomographs, and photographs should be freely included to convey information to the reader.

If some data are important to the report, but are so extensive that coherence would be interrupted if these data were placed in the text, they should be placed in an appendix.

Care should be exercised in selecting communicative means so that the ideas of a report are offered in a concise, understandable form without needless repetition or childish simplicity. When a brief statement will do, illustrative materials need not be used. When, however, a schematic will eliminate the need for lengthy, descriptive prose, it should be used.

The great familiarity that the engineer has with the work of the project may hamper him during the classification period. He has spent so much of his time on the relatively unimportant details that the important ideas begin to lose their proper place in his mind. They may result in important ideas being buried in a mass of details. Careful consideration of the purpose and scope of the report during the classification period will help the engineer to keep ideas and data properly graded in his mind.

After classification, the headings and subheadings with key words or phrases should be logically organized into a writer's outline that conforms with whatever report form is suitable, or is required by the authority for whom the report is being prepared.

A report is logically organized when cause and effect and/or the chronology of events are in such order that the reader may most easily follow the development of whatever is being reported. If 3 x 5 in. cards have been used to record headings and subheadings, these cards may be sorted and re-sorted until they follow coherently the required form. Then they can be numbered to prevent later confusion.

Almost all report formats that the engineer will use provide for some sort of introductory section and some sort of concluding section. Because the introduction and conclusion of a report are so critical, they deserve a few special comments.

The Introduction

Most introductions will begin with the subject, purpose, and authorization of the report. This is often followed by a statement of the investigative methods used and the results obtained. The introduction is usually concluded with a statement of the plan of the report.

For some reports, a very brief historical sketch of the background of the work being reported should be included in the introduction to properly prepare the reader. The requirements of an introduction will vary from one report to the next, but each introduction should awaken the reader's interest and focus his attention exactly on the subject. It should make clear the precise subject to be discussed and disclose the plan for its treatment. The ideal introduction will adequately prepare the reader for the most careful and critical examination of the body of the report.

Tips on Writing Reports

1. Gather and carefully classify all the materials and information of the report. Decide what visual aids will be used.

2. Compose headings and subheadings for the material and information to be presented in the report.

3. Organize the headings into a logical, coherent writer's outline consistent with the selected report form. Add enough key words or phrases to recall all that will be included under each heading.

4. Think about how each heading and subheading will be treated until the report is fully in mind.

5. Write a brief abstract to test one's readiness to write.

6. Write the rough draft, in one great effort if possible, without stopping to criticize parts already written.

7. Edit the rough draft so that the report conforms with accepted English usage, and is in impersonal, concise, accurate language that the reader can understand.

8. Write a legible, double-spaced copy for the typist.

The Conclusion

The ending of a report is almost as important as the beginning. Many reports are concluded with a summarizing statement or paragraph emphasizing the important points discussed in the body of the report.

If it is an interim report, a statement of the work to be done during the next period is often added. Final reports are often concluded with a series of conclusions or recommendations covering all the work of the project. These conclusions or recommendations should be as specific as possible.

The ideal ending of a report will refresh the reader's mind with the important information that he is to learn from the report and leave him with a satisfied feeling of completeness. It is important that the writer's outline provide for an adequate introduction and conclusion.

When the writer's outline is complete, it will be a detailed table of contents of the report, sprinkled with enough key words or phrases to recall all that is to be discussed or included under each heading or subheading. Writing the report, then, will consist of completing the treatment of each heading or subheading.

The engineer should be careful not to begin writing too soon. An abortive attempt to write the report may result in a rough draft that is incomplete and difficult to edit. When the engineer is satisfied that his writer's outline is complete and is in the most coherent, logical order, he should think about what will be included under each heading until he has the report fully in mind.

(*Continued on page* 156)

In this land long reputed for its technical excellence, how does the engineer fare? His complete role, from educational training to technical, social, and economic position, is informatively presented.

The Engineer in Germany

By DR. HENRY B. WEISBECKER
Simmonds Aerocessories, Inc.
105 White Plains Rd.
Tarrytown, N. Y.

WHILE the author has obtained first-hand information in Germany, many of the statements apply as well to the other countries in western Europe. In these countries the engineer occupies a somewhat different social and economic position.

Education

There are two major levels to which the German engineer may aspire. A full-fledged engineer is a *Diplom Ingenieur.* The name implies not only evidence of a completed course of study but also recognition by the state (somewhat similar to our Professional Engineer). However, this title is obtained only by passing a universal state examination given to all those who complete their course of study at a *Technische Hochschule*, or technical college.

The *Technische Hochschule* teaches all kinds of technical specialties and is operated separately from the *Universität* which handles all other fields. The two institutions are both run by the state—there are no private institutions of higher learning. There are *Technische Hochschule's* in many of the larger cities of the country.

Admission to these schools is by competitive examination, where the demand exceeds the facilities, as in the engineering fields. The demand arises not only from the German students but also from a flood of students from the Near, Middle, and Far East and other areas that have no technical schools of their own. The students are attracted by Germany's old reputation for technical excellence.

Tuition rates are low by American standards, of the order of $25 to $50 per term. However, because of the lower standard of living, this sum represents a considerable expense for the native student.

The only way to attend the schools is full-time in the day. Night courses leading to a degree do not exist. "Working one's way through school" is only possible during the relatively long vacation periods. The economic difficulties of the student in supporting himself while in school (4 to 4½ years) prevent many an otherwise qualified applicant from achieving his aspirations, and scholarships are rare.

The level at which the *Diplom Ingenieur* leaves school may be likened in the degree of professional competence to our degree of Master of Engineering. However, to enter the *Technische Hochshule* the student must first have completed the *Gymnasium.* Education here is at a much higher level than in our high schools in that a large cultural background is required, as well as some acquaintance with what in our system is college mathematics. After achieving the rank of *Diplom Ingenieur* the degree of *Dr.-Ingenieur* may be added.

The parallel path open to the technically interested person is that leading to *Ingenieur.* This is a man somewhat between our bachelor and a highly trained technician. These people are not required to complete the *Gymnasium.* Therefore the procedure is different from American practice; one cannot become an *Ingenieur* first and then continue to *Diplom Ingenieur*. The choice of which course to pursue must be made at the high school level and is irrevocable thereafter.

Earnings

The earnings of a German engineer converted into dollars are roughly only 25% of the earnings of an American engineer in a similar position. Prices may

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The Engineer In Germany

(*Continued from page* 150)

be considered at 50% of American ones, so the German engineer has a standard of living ½ that of the American counterpart.

This evidences itself in these ways: A car to an engineer is a luxury. If he has one at all, it generally cannot be anything more expensive than a Volkswagen. Ownership of houses is rare. More typical is residence in oven-heated apartments without hot water. The latter comments apply not only to the engineer but to the population in general. The only exceptions being entrepreneurs, executives, etc. The typical work week is now 45 hours, either in the form of the nine-hour day or with a half day on Saturdays.

Social Position

Despite the engineer's relatively low economic position he enjoys a higher social position and a great deal of respect for his technical competence. Where we give our engineers no special distinction, the Germans, with their fondness of titles, address theirs as *Herr Ingenieur*, *Herr Diplom Ingenieur*, *Herr Dr.*, or *Herr Direktor* (if he has risen to the status of an executive). The engineer is recognized as on a social level with a lawyer or doctor.

The professor at a *Technische Hochschule* occupies a more exalted position, too, than in America. He is highly respected in the community, addressed as *Herr Prof.* Each department has only one professor who has administrative duties and delivers most of the lectures. He has some assistants and perhaps instructors who supervise laboratories, give classes in problem solving, and correct papers. The lectures take place in large auditoriums with perhaps several hundred students in attendance.

Technical Level

Although the German engineers possess an excellent knowledge of theory and practice, they are somewhat behind us in technical know-how. During the Hitler-era, little electronic development could be conducted.

Today the military has no appreciable budget for research and development. Since most American development is performed with military funds, we have made a great deal of progress with which Germany cannot at this moment compete. The Germans, therefore, content themselves to some extent with the application of techniques developed in America.

What development is carried on is largely related to civilian products. German radios and television sets are of excellent quality. Color television has not, however, been introduced as yet. There is still some doubt as to which color system will eventually be adopted.

Broadcasting is only by state-operated stations. There is only one station in each city, which may, at times, broadcast two programs—one on AM and one on FM.

There is only one television channel in each city. All German stations are linked into a network most of the time, and the programming is shared by the stations.

Florida Electronics

(*Continued from page* 147)

Petersburg and Sperry Electronic Tube at Gainesville.

Both plants reported that they were adding more than 200 employees "as soon as possible" and that work was proceeding apace in their respective fields of manufacturing electronic devices for atomic energy and communications applications.

★ ★ ★

RCA Adds Night Shift At Semiconductor Plant

RCA plans to hire 400 women for a third shift at its Somerville, N. J., semiconductor plant.

The first of the new employees reported to work August 11. RCA hopes to have the shift in full operation by October.

The new shift, from midnight to 7 AM, was made possible by a New Jersey state statute which permits the employment of women in factories during the midnight-morning hours.

Personals

Mathias Klein & Sons has announced the following election results: **Mathias A. Klein, Jr.**, as vice president and **Richard T. Klein** is now secretary of the company.

Dr. Morton R. Shaw has been appointed Supervisor of Product Engineering for Corning Glass Works' electronic components department. **Charles J. Lucy** is replacing him as Supervisor of Applications Engineering.

Robert T. Blakely is now staff engineer in the executive office of the Burroughs Corp. His headquarters will be at Control Instrument Company in Brooklyn, N. Y.

Dr. Walter Welkowitz is now Director of Engineering for the Vibro-Ceramics Div. of Gulton Industries, Inc. He joined the company in 1955. His current duties will include the direction of all engineering and research activities in the fields of industrial ultrasonics and medical-electronic instrumentation.

Dr. W. Welkowitz

Dr. R. Burtness

Dr. Roger W. Burtness is now Manager of Engineering and Research for Stewart-Warner Electronics. He joined the company in 1956.

J. M. McCarty has been appointed Marketing Manager for Chicago Aerial Industries, Inc. **Sam Scimaca** replaces him as Chief of Design Engineering.

James H. Atherton has been named Chief Engineer for the United States Radium Corp.

William Q. Nicholson is now associate technical director and manager of the engineering plans and programs for B-J Electronics.

A. E. Lawson, Jr., is now the Chief Engineer of Fenwal Electronics, Inc.

Paul Dulong has been made Manager of the Engineering Services Department of Epsco, Inc.

Philip A. Weygandt has been appointed to the post of district engineer in the midwest sales office of Clevite Transistor Products.

George G. Brown has joined United States Testing Co. as Director of Engineering.

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Industry News

Keith S. Sorenson is now Asst. Sales & Advertising Manager at Communications Accessories Co. Mr. Sorenson was formerly with Lear, Inc., and Motronics Corp.

Lester W. Tarr has retired from the Presidency of Cinch Mfg. Corp.

Carmen Ramich has been named Manager of Industrial Tube Sales for the Westinghouse Electronic Tube Div.

Everett J. Long has been appointed Director of the Transducer Div., Consolidated Electrodynamics Corp.

E. J. Long

A. A. Sroka

A. A. Sroka is the new National Sales Manager for the Instrumentation Div. of Ampex Corp.

Dr. Arthur Bramley is the new Technical Specialist at Stromberg-Carlson. Dr. Bramley was formerly with A. B. DuMont Laboratories where he served as Senior Research Engineer and Head of the Solid State Physics Section.

Jay J. Newman will now serve as Manager, Defense Planning, RCA Semiconductor and Materials Div.

Thomas P. Collier has joined Motorola Inc. as Director of International Operations. Mr. Collier was formerly Vice-President of Bruce Payne Assoc., Management Consultants.

Dr. Kurt Schlesinger is now with Varian Associates as the first key member of the newly organized research team.

Eugene D. Pettler has joined Technology Instrument Corp. of Calif. as sales Manager. Mr. Pettler was formerly a District Manager of Consolidated Electrodynamics Corp.

Marlin Kirk has been appointed Sales Manager of Potter & Brumfield Canada, Ltd.

David A. Sokolov has been appointed to the new position of Manager — Field Engineering, Government and Industrial products for CBS-Hytron.

At Electronics Corp. of America **B. Howard Dean** has been appointec Manager, Military Contracts.

C. R. Robertson has been appointed Sales Manager of Weller Electric Corp.

Thomas F. Watson is the newly appointed Regional Manager at the Western Regional Office of Arnoux Corp.

Robert A. Marshall is now General Sales Manager of Federal Electric Corp., service organization of IT&T. Also at FEC, **Warren F. Morgan** has been appointed Vice-President in Charge of Marketing.

Recent Varo Mfg. Co. Inc. changes: **Austin N. Stanton** to Chairman of the Board; **Robert L. Jordan,** to President; **George F. Lewis** to Vice-President; and, **Vice-Admiral James H. Doyle,** USN (ret.) to Vice-President.

Dr. Harry D. Huskey is coordinating the activities of a newly formed Advanced Programming Development Group for the Bendix Computer Div. Dr. Huskey is also an Associate Professor in electrical engineering and mathematics at University of California at Berkeley.

H. D. Huskey

I. M. Slater

Ira M. Slater is now Manager, Sales Engineering, Vibrator Div., P. R. Mallory & Co., Inc.

Philco appointments: **John B. Hunt** to Assistant General Manager of the G & I Div. and **William M. Gourley** to Manager of Engineering Administration, G & I Div.

At RCA: **R. E. Wilson** to Manager, Communications Manufacturing; **A. John Platt** to Manager, Audio-Visual and Sound Sales; **C. M. Lewis** to Manager, Systems Marketing, Industrial Electronic Products. The following District Sales Managers appointments in the RCA Victor Television Division's Field Sales: **D. R. Roark,** Eastern District; **C. J. Walker,** Central District; and **D. J. Gentile,** Western District.

Aerojet-General appointments include: **Bernhardt L. Dorman** to Vice-President—Test Engineering; **Richard D. Geckler** to Vice President—Solid Rocket Plant; and, **John S. Warfel** to Vice President—Avionics.

William S. Spring and **George B. Mulvin** are now Eastern and Western Region Sales Managers, respectively, for Magnetics, Inc.

Charles A. Tepper is the newly elected President of Industro Transistor Corp. The sales program will remain under his direct supervision.

Frank M. Girard will now serve as District Sales Manager of the Mobile Communications Div. of A. B. Du-Mont Labs., Inc.

Martin A. Warskow joined Airborne Instruments Laboratory as a Consultant to the Dept. of Aviation Systems Research. Mr. Warskow was formerly associated with The Port of New York Authority.

Charles Theodore has just been elected Vice-President in Charge of Sales for Ling Electronics, Inc.

C. Theodore

P. de Beixedon

Philip de Beixedon will now serve as Planning Director for Pacific Automation Products, Inc., Mr. Beixedon was formerly with Holmes & Narver.

George W. McLellan is the new Coordinator of the Technical Information Service in the Div. of Public Affairs at Corning Glass Works.

John C. Washington has been named Manager of the Los Angeles District for the Weston Instruments Div. of Daystrom Inc.

Sylvania appointments: **Maxwell C. Scott** is now Assistant Manager of Buffalo operations; **Fred B. Atwood** to the newly created position of Manager of the receiving tube finishing plant in Williamsport; and, **Alwyn L. Carty, Jr.** to Special Sales Representative for Buffalo operations.

Neal W. Welch, Vice President in Charge of Sales of the Sprague Electric Co. has been appointed Chairman of the Fixed Capacitor Section of the Parts Div. of EIA.

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Report Writing

(*Continued from page* 149)

How does the engineer know when he is ready to write? A good way for the engineer to test his readiness to write is to prepare a short, three or four sentence abstract of the report. This test abstract should state, in expository terms, the essence of the report. Abstracts should be expository, not merely describe what a report contains. If the engineer can write, without confusion, a brief, expository abstract of his report, he is probably ready to write the full report.

Writing the Report

If the planning has been thorough, writing the report will take relatively little time. While writing the first draft, the engineer should avoid stopping to read what he has written. If he stops, he will be tempted to criticize and to edit, which, in turn, will interrupt his thoughts, perhaps causing him to lose coherence. The important thing, while writing the first draft, is to get everything that is to be said on paper, double-spaced, in a well-organized, coherent order.

The engineer should try to write the first draft in one great creative effort. This first rough draft will be rough indeed, but the details of sentence structure and grammar can be easily repaired during the editing. Keep in mind that if the organization or coherence is poor, editing alone cannot salvage a report. But, if a rough draft is well organized, and if everything that is to be said is there in reasonably intelligible language, the editing can be done by anyone who knows the rudiments of English usage.

Editing the Report

Editing the report is an exercise in self-criticism. Pompous, flowery, individualistic expressions that divert the reader's attention to the writer away from the ideas of the report must be ruthlessly edited from the report. Because writing is so personal and creative, such rigorous editing often requires more self-discipline than the inexeperienced report writer is able to muster. The engineer will understand that a technical report is written to communicate ideas as efficiently as is practicable. Everything must be subordinated to this purpose.

While editing, the engineer should be alert to incompleteness. A technical report is complete when everything that is needed to understand the report is in its proper place in the report, and when everything not needed is out of the report.

The engineer is so familiar with the work of the report that he sometimes does not detect gaps in continuity. His mind deceptively supplies the missing information as he reads the report so that, to him, the report reads smoothly. But his reader is not so familiar with the work and must labor to understand what is being reported. The engineer should be alert to this deception. If in doubt, he should over-explain. It helps to detect gaps in continuity if the engineer will let as much time elapse as is practicable between writing and editing.

The technical report should be edited to conform to accepted English usage, and to be impersonal, concise, complete, accurate, and suited to the intended readers. As he edits, the engineer should keep the following questions constantly in mind.

1. Is the sentence clear and unambiguous?
2. Is the sentence properly constructed?
3. Is each word in the sentence the best word to do the job?
4. Has every unnecessary word been eliminated?
5. Is the sentence in its logical place in the composition?
6. Are the sentences varied in length and kind?

The Russian Menace

(Continued from page 1)

So, what it may mean to us is the possibility that if this economic drive is not checked, we may wake up some day to find that Communism has captured the minds of so many millions of people in Asia, Africa and perhaps South America that we will be reduced to the status of a second-rate power.

(5) WHAT CAN WE DO ABOUT IT? In spite of our efforts to merchandise the American Way of Life, our stock is selling at a new low in the under-developed countries of the world. And without realizing the danger, these people are listening to the siren song of Soviet salesmanship.

We must make a united national effort to reverse this trend before it is too late. This will not be easy and success will not come cheaply.

Let's begin by agreeing that this is war. Economic war, if you like; a war not of our choosing,

(Continued on page 158)

(*Continued from page* 157)

but one designed to ruin us nonetheless.

Don't take our word for it if you don't want to. Secretary of Commerce Sinclair Weeks has declared that the Soviet economic drive is more dangerous than the atomic missile threat because "even Khrushchev admits nuclear combat would destroy both victor and victim."

Henry Cabot Lodge, U. S. Ambassador to the United Nations, has said "Not tomorrow but today, this very minute, we are in an economic struggle, which Mr. Khrushchev describes as a war, with the Soviet Union. We can be thankful that no American blood is being shed; but the stakes can be just as high as in any war that American soldiers ever fought. . . ."

In view of these facts and these solemn warnings, one thing should be clear: If we continue to insist on guns and butter plus pie in the sky, we risk becoming dirt under Communist boots. We must maintain our military defenses and be ready for the sacrifices of this second-front economic war too.

ELECTRONIC INDUSTRIES Advertisers — September 1958

* In Operation Edition Only.

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

For product information, use inquiry card on page 101

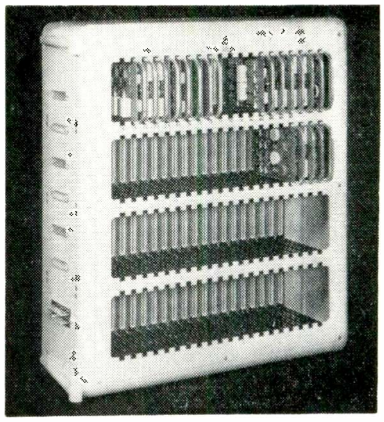
PC's for Canadian PO's

(Continued from page 63)

office, operators put a coded address on the back of each envelope. The rest of the job is electronic or electromechanical.

As the letters pass down a conveyor, the coded addresses are scanned by a photocell reader which relays a message to the electronic memory. The memory determines which bin the letter should fall into; passes this information to the computer, which operates the proper electromechanical gates on the conveyor.

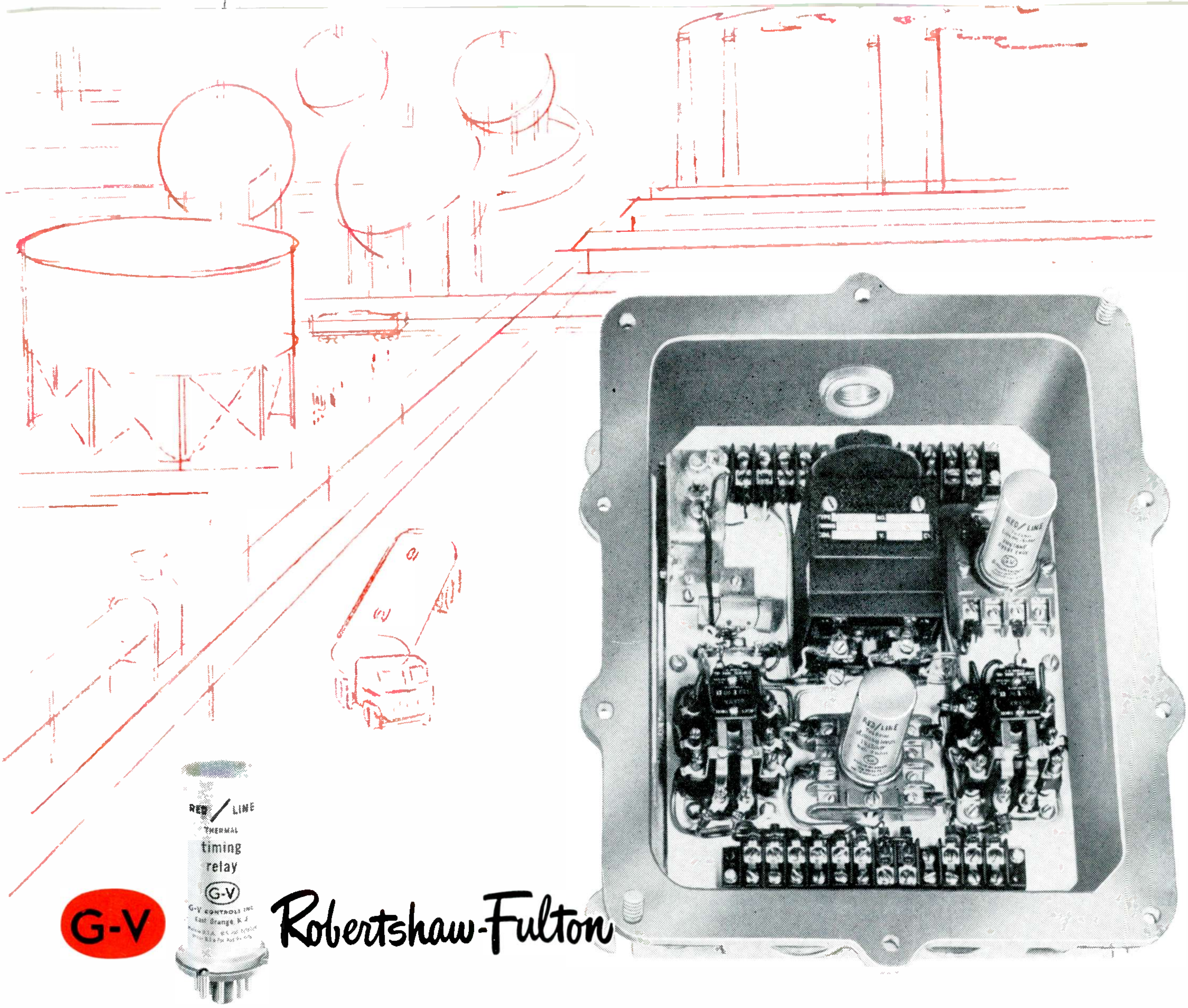
The computer contains only transistors and cores. All the circuits are printed on Formica FF-91 copper-clad laminated plastic, manufactured by Formica Corp., 4614 Spring Grove Ave., Cincinnati 11, O. Ferranti engineers chose FF-91 because it contained the most consistent bond strength of the materials tested and cleaning of the copper surface preparatory to



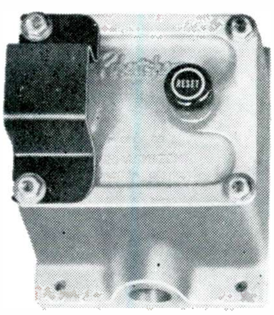
Housing for some of the printed circuits.

printing the circuits was accomplished more rapidly. Also, FF-91 possesses a satisfactory combination of toughness, good electrical properties and good machinability.

The computer was designed by Ferranti engineers to meet the requirements outlined by the Canadian government. Post office engineers, under the project supervision of Dr. M. M. Levy designed the conveyor system. W. J. Turnbull, Deputy Postmaster General, conceived the project and had given it his constant support.



G-V stands guard with Robertshaw to detect harmful vibration...



Abnormal and persistent vibration in rotating equipment usually means costly trouble. Robertshaw-Fulton's Vibraswitch Detectors and Model 651 control units detect vibration and shut down valuable equipment before damaging trouble develops.

Two G-V Red Line Thermal Time Delay Relays are used in each control unit. One blocks out the vibration detector while the protected equipment is starting up. The second times the duration of vibration and permits shut-down only if trouble persists.

Absolute reliability of every component is vital in a protective system of this sort. G-V Red Line Delay Relays meet this requirement for reliability... at surprisingly low cost. Apply them in your equipment and be safe.

Write for Publication 131.

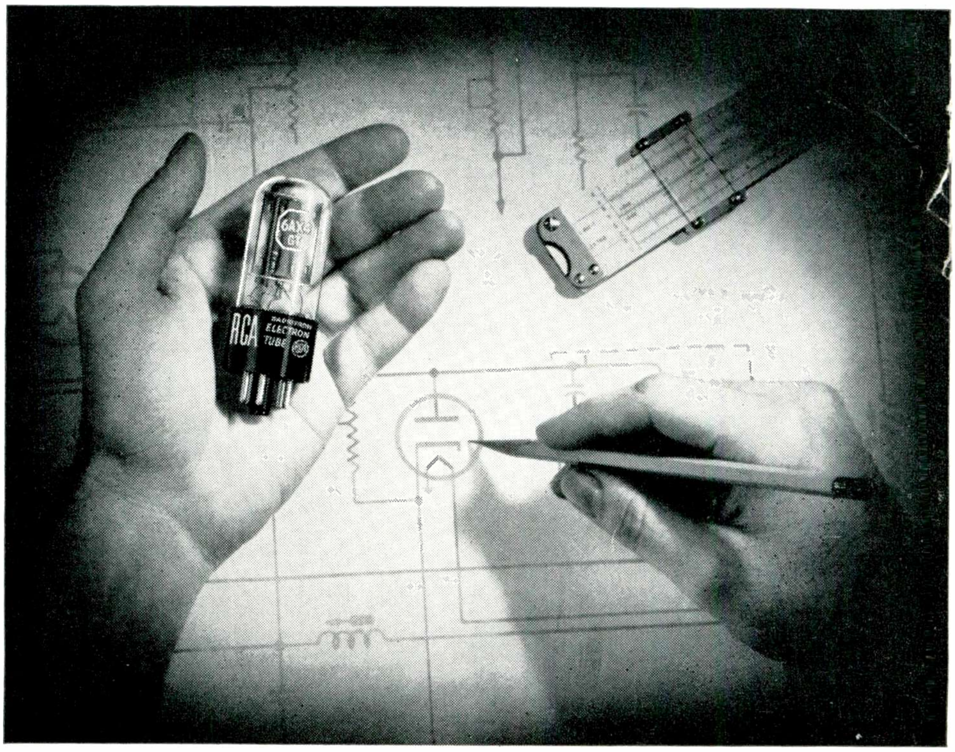
G-V CONTROLS INC.
50 Hollywood Plaza, East Orange, New Jersey

G-V®

Circle 2 on Inquiry Card, page 101

How RCA-6AX4-GT —A Preferred Tube Type—

Improves The Reliability Of Damper Circuits!



Popular RCA-6AX4GT offers high reliability, long life and improved performance for hard-working damper circuits—typical of the benefits you gain when you specify RCA Preferred Tube Types.

In recent years, damper tubes for TV receivers have been subjected to increased demands of performance. RCA now offers and recommends the improved 6AX4GT, a Preferred Tube Type, designed for reliable performance under the severe requirements of modern TV receivers. RCA's ability to produce reliable tubes at low cost is at the heart of the Preferred Tube Types Program.

The RCA-6AX4GT exemplifies the benefits offered by the Preferred Tube Types Program. Outstanding among its features are: built-in safety factors that minimize internal breakdowns and reduce field service and replacement problems.

Heater wire has been especially developed to improve welds, thereby reducing early-hour failures due to an open circuit at the weld-point. Heater-spacer assemblies are pre-fired to eliminate contamination during tube production. And micas are specially sprayed to control plate-to-cathode leakage.

These important improvements, together with stringent quality controls and cycled operational tests that simulate in-home use, combine to produce a *highly reliable tube* deserving of its place on the Preferred Tube Types List—*and in your designs!*

For reliable circuit performance, design around RCA's Preferred Tube Types. Ask your RCA Field Representative for the up-to-date list of RCA Preferred Tube Types. Or, write RCA Commercial Engineering, Section I-50-DE, Harrison, N. J.

RCA Field Offices

EAST:
744 Broad Street
Newark 2, N. J.
HUmboldt 5-3900

MIDWEST:
Suite 1154
Merchandise Mart Plaza
Chicago 54, Illinois
WHitehall 4-2900

WEST:
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SPECIFY RCA PREFERRED TUBE TYPES

RCA

RADIO CORPORATION OF AMERICA
Electron Tube Division — **Harrison, N. J.**