ELECTRONIC DESIGN

High-Strength
Flexible
Conductor . . . p 26

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Editorial

New Waste of Engineer's Time—Hucksters

How an engineer's time is spent is vital to our nation. His time shouldn't be flagrantly wasted. Plenty of people besides the engineer's company are vying for a little of his time each working day—salesmen, magazine editors, and advertisers to name a few. Now all of these people are committed to serving the engineer's needs and, as such, ideally can help him. Of course, the person who gets the engineer to act on his product or service helps himself, and it therefore gets confusing as to who's helping who.

But the engineer's time is the all-important factor. If everybody who wanted his time or attention got it, there would be no time left for engineering. Therefore, salesmen are valuable when they can help solve a problem. Editorial material is valuable when it is pertinent (and easily readable). Advertising or direct mail literature that quickly shows how a product or service will help the engineer are valuable. There seems to be more sales literature, ads, and the like around than editorial material or salesmen themselves, and this medium runs the risk of wasting most of the engineer's time.

Unfortunately some advertisers are not content to simply make their point. They want to monopolize the engineer's mind and time. They're willing to use any ruse to hold his attention—the most obvious result is wasted time. Suspense, drama, sex, brain teasers, puzzles, in no way related to technical topics, are the devices used by much direct mail literature. They are designed to distract the mind away from technical considerations. Admittedly they are clever, witty, and humorous—qualities we admire in an ad. The difference is, a good ad (or editorial) gets its message across quickly—the teaser stuff may taken an hour or more. Don't get us wrong—we like clever devices. But let's imbibe on them at home—not in the shop.

Lest competitors feel they, too, must resort to such devious sales messages, let's put a stop to it now. How can this best be done? We suggest you address a letter of constructive criticism to the advertising manager of the offending company. Frequently that which you consider objectionable or insulting to your intelligence is the misguided brainstorm of some high executive. Unless reasonable and sincere letters of protest are received, the offensive campaign will go on. You will be doing the culprit company and the industry as a whole a good turn if you act.—JAL

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.

Monitor consoles for TACAN Data Link. System can be answer to air traffic control problems.

Air Traffic Control

TACAN Data Link could be the soothing ointment for the CAA's perplexing problems of supersonic air travel and increased traffic at airports. Developed by Federal Telecommunication Laboratories, Nutley, N.J. for the U.S. Navy, the Data Link system has been declassified and made available to aviation authorities for civilian air traffic control. An aircraft with the TACAN Data Link unit added to its TACAN or VORTAC set automatically reports position, altitude, course, and speed to the ground terminal. Reports are transmitted automatically from the aircraft instruments at regular intervals and at a high rate without utilizing overcrowded voice channels. Consequently, the aircraft position made available to the controller is up to date and accurate to a fraction of a mile.

In addition to furnishing automatic reports, the Data Link may be used for transmitting clearances or commands from the Air Traffic Control center to individually addressed aircraft. Thus, without the use of voice radio channels, with the addition of more radio spectrum, and without the language problems encountered in international flight, substantially all the communication necessary for orderly traffic control can be accomplished.

"Pure Signal" Cathode-Ray Tube

Television video amplification circuitry is eliminated by using a "Pure Signal" cathode-ray tube which operates directly from the crystal detector. The tube, developed by the Multi-Tron Laboratory, Inc., Chicago 44, Ill., uses a "multiple beam" principle. Capable of being transistor driven, it opens the way for all-transistor TV. According to the inventor, Nicholas Glyptis, Research Director of Multi-Tron, specifications equal or excel RETMA requirements in every picture characteristic. The tubes can be mass-produced in any existing cathode-ray tube plant without delays or production dislocations. Defocusing on highlights, common to conventional CRT tubes, has been reduced to a minimum.

The picture tube can be employed in present set designs without retooling or changes in major components such as a yoke, flyback transformer and vertical output transformer. High voltage anode and focusing potentials are normal. Since no video amplification circuitry is necessary, set manufacturers can eliminate from 20 to 25 components in current chassis designs. Cathode currents of from 600 to 1500 μamp are possible with a corresponding highlight brightness of over 60 ft lamberts.

"Pure Signal" tubes are available to set manufacturers on a licensing basis. Test tubes for engineering development work are available on a term lease basis to any set manufacturer.

The "Pure Signal" tube could give much needed relief to harassed set manufacturers, caught between the anvil of rising production costs and the hammer of increasing consumer price resistance. It promises production cost reductions of approximately $2 per chassis unit—quite a saving when you think in terms of millions of sets.

Direct operation from the output of the diode detector is possible with this new cathode-ray tube, eliminating the entire video amplifier section. Nicholas Glyptis, *right*, Research Director of Multi-Tron, shows 17 component parts that can be removed from any standard TV receiver by using the "Pure Signal" tube.

Engineering Review

Sun Converters Get More Efficient

A solar energy converter panel capable of developing 25 watts was recently demonstrated by the Hoffman Electronics Corp. of Los Angeles. The panel was composed of a group of silicon solar cells capable of converting 10% of the energy of the sun striking them into usable electricity. The use of the cells in conjunction with storage batteries permits a continuous flow of power from an unattended source. By choosing a given number of silicon cells, a desired amount of power can be obtained.

It was stated at the demonstration that 22% of the sun's energy could theoretically be converted by silicon cells into usable electricity. Possible uses would be powering unmanned radio transmitter and receiver stations, telephone relays or highway warning flasher systems.

New Quarterly Magazine

The first issue of a new technical magazine, The Western Electric Engineer, was published recently by the Western Electric Co.

Appearing quarterly, the magazine will contain articles on many branches of engineering at Western Electric, the manufacturing and supply unit of the Bell Telephone System. It will go to Western Electric's engineers and will also be available to technical and scientific people outside the company.

Dual-Channel Radar

In order that a radar set may be repaired while still in action, new sets developed by ARDC and the Bendix Aviation include a dual-channel feature which allows a technician to work on one unit of a set while the set remains operational on an identical unit.

The Air Force has contracted for the radar sets, which will also feature transmitters significantly more powerful than those now in use, as well as more sensitive receivers. More efficient blanking circuits for the elimination of stationary targets will also be incorporated in the system.

Telemetering System for Industry

A digital data transmission and control concept called Electro-Span has been developed by the Pacific Division of the Bendix Aviation Corp. Designed to give remote control and measurements of

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such variables as the liquid level of petroleum tanks, power systems, weather stations, pipelines or water stations, the telemetering system allows the collection of data from several distant points to one central control station.

Accuracy in this system is accomplished by means of digital data transmission. Where speed is not of prime importance, transmission of a sequence of dc pulses can be sent along such common communication channels as telegraph circuits, telephone lines, vhf radio or microwave links. If speed is desired information can be transmitted simultaneously by means of different combinations of a group of eight tones. These audio signals are fixed at the odd frequencies to eliminate the possibility of error due to overtones. Digital-analog converters allow coding into digital form of such variables as shaft position, temperature or pressure and allow a transmitted code to accomplish a necessary action.

The digital form of either system cannot be affected by transmission distortion, frequency or phase shift. Accuracy of 1/8 inch in 64 feet in measuring the liquid level of a tank, or one part in more than 6000, is now possible. Data collected at a central location can be decoded and read out in several forms,—lamp indicator, automatic electric typewriter, punched card or tape, and graphic chart.

Looking Inside Heaters By X-ray: X-ray photos of industrial heating elements form a fluorescent-like pattern as they undergo careful examination at the industrial heating division of Westinghouse Electric Corp., Meadville, Pa. A magnifying glass is being used to check X-rays of the tubular heaters. Corox heater uses include water heaters, automatic washers, deep fat fryers, griddles and electric irons in addition to industrial uses.

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CIRCLE 6 ON READER-SERVICE CARD FOR MORE INFORMATION

George L. Larse (right), Group Engineer, Instrumentation and Development, discusses development of high performance FM sub-carrier oscillators for application in advanced telemetry systems with Electronic Research Engineers Hans Becker (left) and Jay Cox.

Engineering Review

Two-Dimensional Lighting

The establishment of an organization devoted exclusively to developing the promising light source, electroluminescence, has been announced by the Westinghouse Lamp Division.

First discovered in 1936 by Georges Destriau, French scientist and Westinghouse consultant, electroluminescense, which has the trade name "Rayescent" provides a two-dimensional area light source. Light is given off by a coating of phosphors suspended in oil between a metal and glass plate which light when electricity is applied.

The advantage of such a system is the broad source of illumination and the easiness in blending it in with ceilings and walls.

British Exports Increase

Exports of British electronic equipment of all kinds in 1956 totalled $112.8 million, a new record. Export of transmitters, radar and navigational aids, and electronic equipment for industry reached a new high, and the striking increase of recent years was continued in the sound reproducing equipment section, including record players, tape recorders, electronic amplifiers, loudspeakers and whole public address systems.

Miniature Writing

Dr. Johannes Heidenhain, German authority on the subject of smallness, has devised a system of inscribing tiny lines on glass or quartz. Nothing is visible to the naked eye, except that the glass appears to be a trifle dirty. One reticle made by Dr. Heidenhain is 14 square inches in area and contains 450,000 separate lines and characters. The lines themselves are so precise that, even when magnified 1000 times, they appear perfectly straight and clearly defined. As a storage system in computing machinery, the new reticles could serve an important purpose and they will be of value in systems being devised to translate Russian books into English

Standardization Awards

The first of two awards to be given annually for outstanding service to standardization and to standardization literature has been made by the Standards Engineers Society. Both awards for 1956 were made posthumously to Dr. Dickson Reck, editor of the new book, National Standards in a Modern Economy. These awards have been made available by the American Society for Testing Materials for presentation annually by the Standards Engineers Society.

Dr. Reck at the time of his death was carrying out a research program under the Standardization Fellowship sustained by the Sarah Mellon Scaife Foundation at the Mellon Institute.

Group Investigates Microwave Switching

Formation of a new research and engineering group for the study and improvement of high power microwave switching devices was announced this week by Richard M. Walker, vice president in charge of engineering at Microwave Associates, Inc., Burlington, Mass.

The new group is working on fundamental research and engineering directed toward improved techniques and devices. Walker explained that the emergence of new radar systems incorporating advanced magnetrons of enormous power output has created difficulties in switching this power effectively.

This problem of microwave switching results from a lack of knowledge of the exact behavior of gaseous discharge in a high power switching device. The group therefore has already outlined a priority program directed toward understanding the mechanisms existing in TR tubes at high power levels in the various radar bands.

Correction:

The paper given on Communications Systems Techniques at the February 26th session of the R.I.R. Conference was by B. T. Newman of General Electronic Laboratories, Inc., not General Electric Laboratories, Inc.

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Engineering Review

Basement Death Ray Labs Needed

Free lance inventors who have lately been dulled and depressed by the usual challenges to their imagination might find inspiration in the following list of nine problems proposed by the National Inventors Council, U. S. Department of Commerce. The Council calls these "blue sky" problems; that is, they demand a sky-is-the-limit type of thinking. If you have an idle basement laboratory, you might well put it to the use of the armed services and solve the following:

Death Ray or Wave. Equipment of usable size capable of producing death rays effective at 500 yards—without excessive power input. Investigations so far indicate that a completely new approach is needed.

Snow Track Eraser. A practical means of destroying the tell-tale tracks of men or vehicles across snow fields. Object is to restore original contour of snow field to avoid air detection.

Non-magnetic Compass. A device small enough to be carried by a man on foot which can determine true north, independently of the earth's magnetic field. Better still, it should enable a man to determine his position accurately.

Vehicle Black-out Devices. Inventions to mask the light, noise and radiation from combat vehicles operated under cover of darkness.

New Type of Communication. An ingenious new method of transmitting intelligence, non-detectable except by the desired receiver. The military is seeking a new principle which does not use electrical impulses, electromagnetic wave or sound waves.

Universal Track. A new method of traction for land vehicles for use on all types of terrain. Present steel tank tracks wreck paved roads.

Explosive Mine Detector. A method for locating explosives buried at shallow depths below the earth's surface. Present detectors locate the explosive's container or signal the presence of a hole in the ground.

Method for Converting Light into Electrical Energy. An invention which

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will convert a small amount of light into enough electricity to operate electrical equipment. Far greater power output is needed than has been supplied by solar batteries. Mail your solutions to the National Inventors Council which is the official clearing house for inventions of potential value to the Government. Complete list of hundreds of technical problems affecting national defense can be obtained by writing NIC, U.S. Department of Commerce, Washington 25, D. C.

Communication by Light

A system which utilizes a device similar in theory to the Kerr type cell is capable of audio or television communication through the electrical modulation of a light beam. Developed by Baird-Atomic, Inc., the system uses a basic dough-nut shaped device about 2 inches in diameter through which the light beam is passed. In the center of this unit is a synthetic crystal place which when activated by an electrical signal acts as a shutter in modulating the light beam.

The light beam can be produced in pulses of the microsecond range as well as being modulated at frequencies ranging from dc to the video region. The relation between light transmission and voltage applied follows a sine squared relation. From this characteristic the shape of the transmitted light wave can be derived for a pulse, a sine wave, or any other shape of applied voltage.

The system was recently demonstrated at a meeting of the American Research and Development Corp., where it was stated that because of the small point light source, a beam could be projected over several miles without a detectable loss of energy, depending on the weather conditions. Demonstrated at the meeting was a transmission by light of a local television program from a conventional receiver to a remotely-positioned photomultiplier tube, from which it was fed into the video section of a second commercial TV receiver and reproduced. The demonstration showed no loss of performance.

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Engineering Review

On Reliability . . . A Four-Point Program

Speaking before the third National Symposium on Reliability and Quality Control in Washington, D. C., January 15, Angus A. Macdonald, Director of Engineering for the Communications and Industrial Electronics Division of Motorola, Inc., gave a four-point program to assure better equipment reliability. The four-points are: 1. Better training for design engineers; 2. avoidance of excessive detail in specifications for basically new equipment; 3. improved product evaluation prior to full-scale production, and 4. continuity of production and use—i.e., a better feedback loop from the user to the designer.

Experience Needed

According to Mr. Mcdonald, "It is the design engineer's basic philosophies and ingenuity which permit the incorporation of a wide safety margin, or, failing that, result in a marginal design. It is almost impossible for an immature engineer to design a basically sound piece of equipment. Even though all components are properly chosen and are used within their ratings, the basic design may still be unreliable if the design philosophies do not make maximum use of adequate system margins and go-no-go circuitry. It is necessary to devote considerable time and effort toward indoctrinating new engineers in the design philosophies which are gradually established in a mature electronics field.

Keeps Specs. Flexible

"Detailed equipment specifications, to some extent, relieve the manufacturer of responsibility for equipment performance and place this responsibility in the hands of the specification writer. Where the purchase of new equipment is governed by specifications, rather than experience and competitive performance tests, these specifications are usually written around specific design details instead of providing a comprehensive review of all performance requirements. It is then practically impossible to avoid writing in requirements which actually hurt reliability. Frequently, the desire to achieve all things for all users and to make all users happy results in specifications that require excessive complexity in the equipment—a sure path to poor reliability.

Evaluation

"An adequate product evaluation program . . . should be planned to serve as a check on the validity of the basic design, rather than as a proving ground where fundamental design modifications are tried out. It is probably safe to say that a sound design will require only minor modifications as the

equipment progresses through environmental tests, pilot runs and field evaluation tests.

Feedback

". . . lack of continuity of production and use of the equipment, or a broken feedback loop from the user back to the designer, will also contribute to poor reliability. In a normal commercial operation, a continuing responsibility for equipment performance is forced upon the manufacturer by the fact that he must successfully compete over a long period of time if he is to make a profit. Checks and balances are imposed upon the procedure used to bring out new products so that the product reaches the market as a high point of maturity. Unfortunately, military procurement will not permit continuing production or a complete feedback loop from the user to the designer. Whereas the manufacturer assumes responsibility for equipment performance in commercial markets, in military markets responsibility for performance of the equipment in the end use is assumed by the user.

Ground Broken for Modern Texas Plant

Texas Instruments Inc.'s new $4 million semiconductor components plant represents the first U.S. industrial application of hyperbolic paraboloid thin-shell pre-stressed concrete construction. The thin-shell ceilings, somewhat similar to an inside-out umbrella, will give occupants a feeling of spaciousness and calm because of their great span and sound-diffusing ability.

A 7-ft area between the floors of the two-story building will contain all utilities and mechanical services with the result that the work area is kept relatively clear. Another feature of this functionally attractive building is the cell construction which allows the easy addition of units as the need arises to expand the plant. Air conditioning will be accomplished by both electrostatic and mechanical means; humidity will be kept at precisely 20 per cent, and a slightly positive air pressure will be maintained so that any leakage in the building will be from inside to outside.

Engineering Review

Flying by Electronics

A universal digital operational flight trainer, called UDOFT, is being developed by Sylvania Electric Products Inc., under the joint sponsorship of the U.S. Air Force and the Department of the Navy. The trainer, utilizing digital instead of analog computers as in previous training systems, is capable of simulating a wide variety of aircraft, including the most recent supersonic jet fighters.

Previously, the use of analog computers meant that a new trainer had to be devised with each change in the type of aircraft to be simulated. The digital system proves more flexible since merely by programming the computer the system can be altered to meet the new demand.

Conditions such as engine failure, air turbulence and storms can be translated by the system into the appropriate readings on the cockpit instruments. The trainee must meet each new situation by manipulating his controls, and how well he has solved the particular flight problem is revealed by the change in the instrument readings brought about by the computer.

Runway Flasher Lights: These units will be installed along the runways of two major airports in Los Angeles and Washington D. C. to improve the centerline approach system for landing planes. Although a standard group of 20 of these lights is momentarily capable of 700 million candlepower, nevertheless the short duration of the flash, 15 microseconds, does not blind the pilot but allows his eyes to maintain their sensitivity. The string of lights will flash successively twice each second, with the light farthest from the airport flashing first.

The lights have already been ordered from Westinghouse Electric Corp. by the Civil Aeronautics Administration who intend to use them to improve air navigational facilities throughout the nation.

Artificial TV Reflections

A novel instrument demonstrated at the Television Society of England simulates the effects of reflections from moving aircraft on a radio signal. Reflections from moving aircraft are, of course, very troublesome in television reception and this equipment was specially designed for use in the study of reflection control.

A mercury variable delay line is employed for the injection of a "reflected" signal. This signal can be continuously varied in amplitude and phase, relative to a direct steady signal. The instrument was developed by the Mullard Research Laboratories and, in addition to its uses in television receiver design, it should have many applications to fm and vhf communication equipment where similar problems are encountered.

Railroading by Radar

One of the biggest problems in railroading is the assembling of cars from scattered points without bumping them into each other too hard or in the incorrect order. In the past new trains have been formed by heading cars over a hill, which is known as the "hump," and letting them roll towards their respective trains in the yard below. In order that the cars would not collide too heavily, retarder brakes were placed under the tracks and operated by a man who guessed the speed of the rolling car. This method often proved unreliable with subsequent damage to the merchandise within the car.

By using automatic equipment, such as that developed by Union Switch & Signal, this guesswork is replaced by a radar device called Doppler Radar, which utilizes a Klystron made by Varian Associates. The beam from the radar is aimed at the rolling freight car and relays such information as speed and distance to a computer, where other variables such as wind, weather and acceleration factors are computed in. The resulting information is applied to the retarder brakes beneath the tracks which ease the car to the correct speed and allow it a safe and gentle collision with its train.

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Transatlantic TV Made Possible by Sunspots

The possibility of receiving television programs from the other side of the Atlantic has aroused great interest recently in view of the approach of the maximum phase of the 11-year cycle of sunspot activity. Already some success has been achieved by NBC who have, on occasion, been able to resolve recognizable pictures from the BBC television transmitters at Crystal Palace, London, by using a British receiver and a special aerial system at their receiving station at Riverhead, Long Island.

The limiting factor is the maximum usable frequency (muf) which is rarely high enough to sustain propagation across the Atlantic at the frequencies used by television transmitters. However, around the sunspot maximum period there are occasions when the muf rises into the 40 mc region and even occasionally into the 50 mc region. At these times the lowest frequencies used for television in the UK (45 mc vision, 41.5 mc sound) may be receivable in the United States. The reception of reasonable pictures is a more difficult and chancy matter because of multi-path reception which causes ghosting.

Isotope Boron-10 Now On The Market

Kilogram amounts of the metallic form of the isotope boron-10 are now available for civilian use. The dark gray substance, resembling powdered graphite, is valued at nearly three times the price of refined gold, and had previously been restricted to AEC requirements.

Although less than 3 lb a day are now being produced by the Hooker Electrochemical Co., who is the only full-scale manufacturer, apparently this creates a surplus which may be sold on the civilian market.

Boron-10, which represents no potential hazard due to radioactivity, has the ability to absorb neutron particles. This makes it useful as an agent in

control rods for nuclear reactors, as well as a useful shielding agent. The relatively minute quantities of boron-10 required to provide neutron shielding equivalent to large amounts of lead or concrete may simplify reactor design, may permit far smaller and lighter reactor housing, and thus may greatly broaden fields of application. It is 20 times more effective than lead and 500 times better than concrete.

TV Industry

The meteoric rise of the television business from 137,000 units in 1947 to 7 million units in 1956 is an example of how creativity can add to our way of life and our economy, according to Allan G. Williams, general sales manager of Motorola Inc. The operation of television receivers alone in the United States in 1955 consumed $481,000,000 worth of power. Speaking before the North Central Electrical League at its recent meeting in Minneapolis, Minnesota, Williams pointed out that TV, is a clear illustration of how a new product can enter the business scene and through creativity succeed and prosper.

Looking into the future. Williams pointed out that the electronics industry is just in its infancy. Mural wall television, battery operated portable television, wireless paging devices for family use, electrically controlled traffic systems, and improved highway safety through electronics were only some of the "down-the-road" possibilities cited by Williams. Push-button drive-in grocery stores, and waterless washers were other such future possibilities mentioned.

Second AGN 201 Reactor Fired

Aerojet-General Nucleonics, Calif., announced that their second nuclear reactor went into action last month at the new San Ramon production facility. The first reactor was in operation when the second reactor started up. Consequently, this event marks the first time that two reactors have been operated concurrently by a private industry. The first reactor went critical with 656 grams of 20 per cent enriched U-235, and the second AGN 201 reactor followed suit with 657 grams of the same.

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Washington Report

Herbert H. Rosen

Defense Research and Engineering Consolidated

Hereafter, coordination of all research, development, and engineering at the Department of Defense level will be administered by Frank D. Newbury, newly appointed Assistant Secretary of Defense for Research and Engineering. In one sweeping move, DOD Secretary Charles E. Wilson erased from the records the assistant secretariats of Research & Development and of Engineering. The latter was headed by Newbury and the former, by recently resigned Dr. Clifford C. Furnas. Basically, what this new move means is that all Defense research and engineering functions will fall under one man, Newbury. That Newbury is an engineer seems to have caused great concern among the research scientists. But, according to Wilson, he was selected for the job because he has the proven administrative and executive abilities needed.

No details have been worked out yet on how the new office will operate. It is speculated, however, that Newbury's Deputy, William M. Holaday, will be responsible for the research and development activities. He was formerly Furnas's deputy and before that, Director of Research for Socony-Vacuum. It is also thought that there will be more pressure on the research people to find faster solutions to the military technological problems.

At about the same time Secretary Wilson made the above announcement, he also disclosed the fact that the Army's Jupiter IRBM may be on the way out. The original interpretation of Wilson's statement actually had the 1500 mile Jupiter program canceled, but later announcements from the Army and Mr. Wilson corrected that impression. The latest thought is that testing of components and hardware on the Jupiter will continue throughout this calendar year under Army supervision. Then someone in Wilson's office, presumably Newbury, will be expected to advise the Air Force to expend its total effort on either the Jupiter, Thor, or a combination of the two. Certainly, there will not be two land-based IRBM projects in operation come 1958. This leaves only the Navy Polarus as the other "competition" in the field—competition for funds, publicity, time, and manpower.

The cloudy condition surrounding the Jupiter was extended to the NIKE-TALOS controversy, too. Wilson echoed the sentiment that there can be no two missiles that are alike except in principle. Therefore, one must go. Which one is still open to speculation, except that land-based Talos—formerly

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CIRCLE 216 ON READER-SERVICE CARD FOR MORE INFORMATION

Air Force, now Army—looks like it is fighting a losing race. The final decision, at least in writing, is to come from Missile Czar Egar Murphree's office shortly.

FCC Makes First Decisions on UHF/VHF Separation

After a long delay and much wrangling everywhere, the Federal Communications Commission has made its first frequency allocations where the coexistence of VHF and UHF is involved. As a result of the decision, Elmira, N.Y., Springfield and Peoria, Ill., Evansville, Ind., and Fresno-Santa Barbara, Calif., areas are now all-UHF communities. Except for G.E.-owned WRGB, the Vail Mills and Albany-Schenectady-Troy areas are also all-UHF. VHF reassignments, except at existing UHF stations, were made in St. Louis, Mo., Davenport, Iowa, Rock Island-Moline, Ill., and Louisville, Ky. Still using both UHF and VHF are Hartford, Conn., Providence, R.I., and Madison, Wis.

The FCC has also been questioned by the Senate Interstate and Commerce Committee for its stand on pay-as-you-see TV. The unpublished committee report urges that "the FCC act on its pending rule making proposals (Docket No. 11279) at the earliest possible moment." The proposal deals with pay-see TV and has been before the Commission for more than 16 months. Almost at the "leaking" of the report, the president of the NARTB, Harold E. Fellows, came out strongly against any pressure to force the issue. He said that "subscription television would violate the rights of millions of Americans who bought TV sets with the idea that TV programs are free." The congressional committee suggests that one solution to the controversy would be an FCC-supervised test. The Commission would supervise all community and technical aspects of the test, even to the type of programs to be broadcast.

FCC Reacts to Requests From Users of 890 Mc and Above

As of March 29, the FCC will have received written substantive evidence from many of the 150 parties who have some interest in allocation of frequencies above 890 mc. FCC was virtually swamped as a result of its asking industry for comments about the assignment of frequencies above the magic number 890. More than 150 asked to appear and present testimony. These have all been asked to submit the name of each proposed witness and a detailed statement containing the substance of their written or oral evidence.

Very shortly, the FCC will issue a list of witnesses and indicate when they are to appear. And judging from past experience, the hearings should run for many a day. At their end, the Commission will decide if further hearings will be necessary. With so many people seeking so many different uses for the frequencies available—890 to 30,000 mc—the decision will be a hard one to arrive at.

Meetings

April 8-11: Fourth National Electrical Industries Show
71st Regiment Armory, New York, N.Y. Sponsored by the Eastern Electrical Wholesalers Association. For more information, contact William S. Orkin, Co-Producer, The American Electrical Industries Expositions, Inc., 19 W. 44th St., New York, N.Y.

April 11-13: Southwestern IRE Conference and Electronics Show
Houston, Texas. Sponsored by the Houston Section of the IRE. This conference will be augmented by the National Simulation Conference which will be sponsored by the IRE Professional Group on Electronic Computers. For information, write to Ninth Southwestern IRE Conference and Electronics Show, P. O. Box 1234, Houston 1, Texas.

April 15-17: Symposium on Systems for Information Retrieval
Western Reserve University, Cleveland, Ohio. Sponsored by the School of Library Science of Western Reserve University in conjunction with its center for Documentation and Communication Research. This will be a comprehensive demonstration of systems presently in use for the organization, storage and retrieval of recorded information, together with a symposium on information-handling problems and techniques. Further information may be obtained from Jesse H. Shera, Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

April 16-18: Symposium on Nondestructive Tests Developed in the Field of Nuclear Energy
Morrison Hotel, Chicago, Ill. Sponsored by American Institute of Chemical Engineers, American Nuclear Society, American Society for Testing Materials, and Society for Nondestructive Testing. Information resulting from 15 years research and development in testing applications in the nuclear field will be presented. Papers will be in three categories: reactor materials, completed fuel assemblies, and miscellaneous. For information write to American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

April 23-25: International Symposium on the Role of Solid State Phenomena in Electrical Circuits

Auditorium of the Engineering Societies Building, New York, N. Y. Symposium will cover recent developments in application to electrical circuits on systems of unusual physical effects in solids. For information write to the Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N.Y.

April 24-26: Seventh Region IRE Conference

San Diego, Calif. Theme of the meeting is "Electronics in Space." Sessions will be held on electronic aids to air navigation, audio, management, uses of computers, antennas and propagation, nuclear activiation and damage of electronic equipment, electronic devices, electron tubes, microwave, instrumentation, telemetering, data handling and automation, magnetic components, and radio astronomy. For information, write to IRE Seventh Region Conference, U. S. Grant Hotel, San Diego, Calif.

April 25-26: Annual Technical Meeting of the Institute of Environmental Engineers

LaSalle Hotel, Chicago, Ill. For information contact the President of EEI, Henry F. Sander, Vapor Hearing Corp., 6420 W. Howard St., Chicago, Ill.

May 1-3: Electronic Components Conference

Hotel Morrison, Chicago, Ill. Sponsored by the AIEE, IRE, RETMA and WCEMA. Papers to be given on high temperature components, radiation effects, component reliability, passive components, active components, instrumentation and measurements, materials development and general component needs. For information write to J. S. Powers, Electronic Components Symposium, 84 E. Randolph St., Chicago 1, Ill.

Paper deadlines

May 1: Deadline for papers submitted for the Wescon convention August 20-23 in San Francisco. Send 100-200 word abstracts, together with complete texts or additional detailed summaries, to D. A. Watkins, Technical Program Chairman, Stanford Electronics Laboratories, Stanford University, Stanford, Calif. Authors will be notified of acceptance by June 1.

May 1: Deadline for papers submitted for the April, 1958 convention of the American Society of Tool Engineers. ASTE membership is not required. Each proposal should include an outline of the paper, the author's name, his title and affiliation. Send outlines to L. S. Fletcher, Program Director, American Society of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.

Transistors Can Be Reliable

C. H. Zierdt, Jr.
Consultant—Transistor Engineering
General Electric Company
Syracuse, N. Y.

SINCE there is no fundamental reason for transistor electrical characteristics to ever change, the ultimate in transistor reliability may be stated simply as utter failure or no failure. This obviates the necessity of charting and interpreting degradation trends as required by many other components.

The transistor industry has not yet reached this state of grace as one or more of three types of characteristic changes may be observed in practically every transistor lot bought today. These are:

1. Reproducible and reversible cyclical changes of parameters as functions of environmental or operational history.

2. Irreversible permanent changes of parameters (rates of change vary) during test or use.

3. Catastrophic failures which suddenly render transistors completely inoperative.

The first two are manifestations of changes in the atmosphere surrounding the immediate junction areas of transistors. Item 1 is a limitation on equipment design, in that its estimated magnitude must be taken into account initially and compensated for by more stages, more feedback, or other means under the circuit designer's control. Item 2 predicts an end of life of equipment, after built-in circuit allowances have been used up, and may create an intolerable maintenance problem in computers or other equipments using many transistors. To further plague the equipment designer, both types 1 and 2 changes are ordinarily only predictable in terms of shifts in the average of a group of transistors; individual units may vary widely (and even reverse) from the group trend.

Item 3, catastrophic failures, is attributable to mechanical causes, and is best attacked by improving process quality control.

Improvement Report

This article reports significant improvements in Items 1 and 2, and good performance in Item 3, recently made by General Electric's transistor design group.

Stability of transistors has been improved to an extent which renders study of "survival" to arbitrary characteristics end points uninformative and of limited use. The emphasis in reliability studies has changed to observation of small variations in individual electrical characteristics and deviations of individuals from the group behavior. This work has resulted in marked decreases in characteristic spreads, with obvious advantage to the circuit designer. "Slow death" due to continuous slope of change of characteristics with time has been practically eliminated, and the magnitude of reversible cyclical characteristic variations under changing environment or use conditions is drastically reduced. Catastrophic failures of primarily mechanical nature are still experienced in small but disturbingly variable numbers during extreme mechanical testing; their incidence during thermal cycling and dissipation cycling has been made negligible.

Several conclusions and observations of general nature have been made as a result of these studies:

1. The special processing required to assure transistor characteristic stability under high tem-

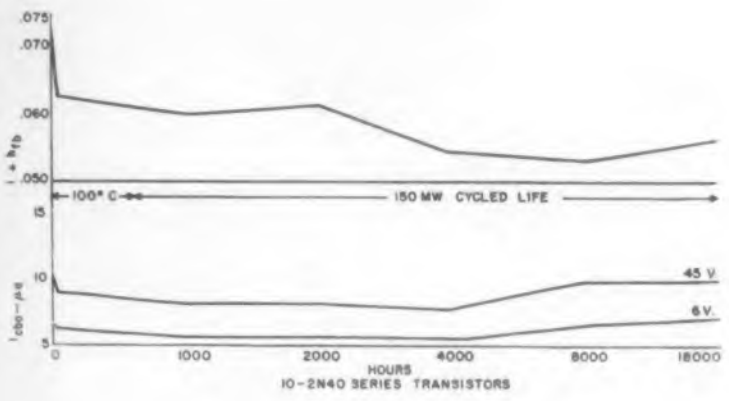


Fig. 1: Characteristic changes vs. time on high temperature and cycled life tests.

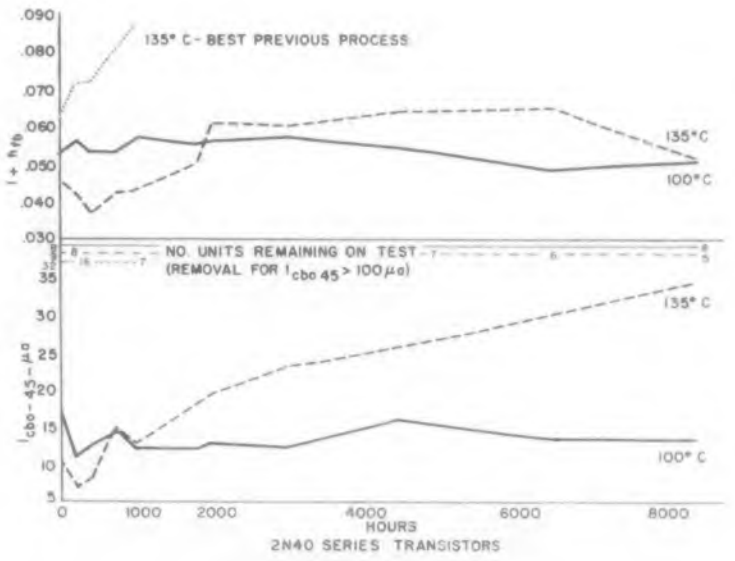


Fig. 2: Special processing—characteristic changes vs. time at high temperatures.

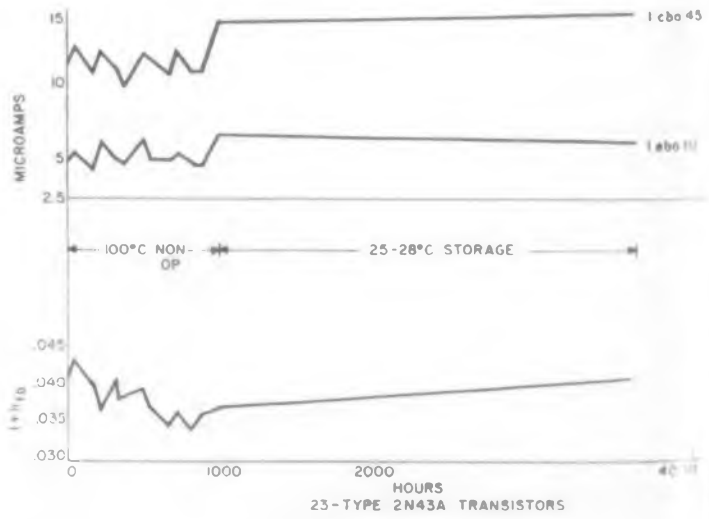


Fig. 3: Special processing — characteristic changes vs. time and temperature.

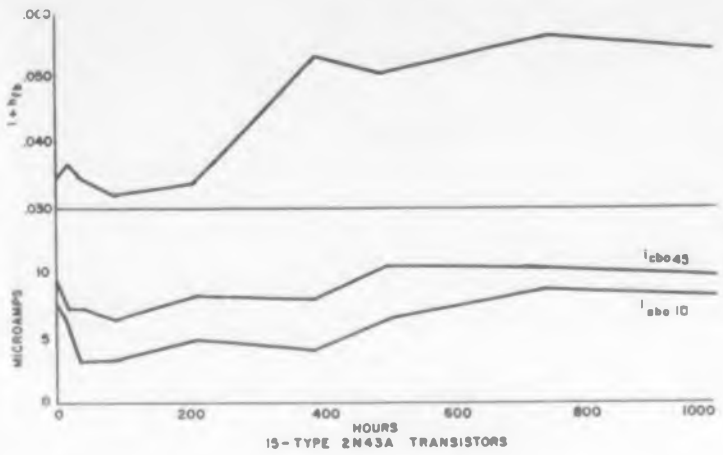


Fig. 4: Production processing—characteristic changes vs. time at 100 C.

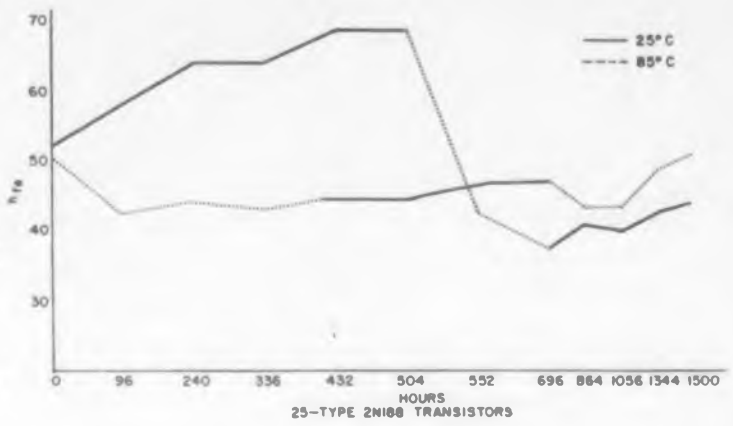


Fig. 5: Characteristic changes with temperature changes.

perature of high dissipation results in a lower average current gain and higher I_{cbo} than are obtained from less stable processing.

2. Availability of stable silicon transistors has been substantially accelerated by proof that the processes which contribute to maximum reliability in germanium transistors are directly applicable to silicon units, with equivalent results.

3. A substantial degree of reliability of germanium transistors in 135 to 140 C storage has been demonstrated, and small lots of silicon transistors show similar results in the 225 to 250 C range. Characteristics of germanium transistors may be maintained well within current specification limits through prolonged 100 C exposure and widely varying ambient and dissipation conditions, with negligible failure rates and without costly long-term aging processes in production. Good cycled-life stability has been demonstrated to 16,000 hours of "on" time (19,000 hours elapsed) on alloy germanium transistors.

4. There exists substantial evidence that transistors need not change in characteristics, within the scope of reasonable extrapolation of data, over many years of continuous service. An exception may have to be made in the special case of nuclear radiation exposure, which may be expected to produce cumulative characteristic changes at rates dependent on the radiation intensity.

Test Data Analysis

Progress has been demonstrated and is reported for silicon and germanium transistors of both grown and alloy types. The major reports are, as might be expected, for the older germanium types: the tremendous accumulation of data has been reduced to "shorthand" form to make this article of reasonable length. Data for the 3 year old 2N40 family (2N43, 44, 45) of germanium transistors, for instance, are chosen from engineering record of tests on more than 35,000 transistors over a 4 year period.

It should be noted that, in many curves, the performance of present production transistors is distinguished from that which may be expected in the same types as laboratory-scale reliability improvements are translated into production practice.

Type numbers beginning "ZJ-" are GE experimental types; "2N-" types are RETMA registered and in production.

Electrical Characteristics Study

Fig. 1 plots the average current gain $(1 + hf_b)$ and I_{cbo} of ten 2N40 series transistors (germanium pnp alloy) started in test May 24, 1954. Of the original lot of 43 transistors, four failed during the first 24 hours of the 624 hour test at 100 C and six had I_{cbo} increases of 2 to 5 times in moving to 150 mw cycled life test (these six subsequently returned to initial characteristics while still on test). All 39 units were run to 9000 hours at 150 mw without noticeable change in average characteristics, and the lot then reduced to the ten units reported here which are still on test after 18,000 hours. Average junction temperature of these units is about 75 C at 150 mw dissipation. Although averages are plotted, no individual unit has deviated from the average performance to any appreciable degree. This performance is most gratifying, considering the elementary processing in use at the time of manufacture of these units. In fact, the only fundamental elements added to processing since that time are a reduction in early failure rate, and reduction of characteristic variations under changing (rather than relatively steady) load and environmental conditions.

To reduce characteristic variations at high ambient temperatures, special processing has been worked out and proved on a laboratory scale, as represented by the curves of Fig. 2. It is noted that the rate of change of characteristics at 135 C has been greatly reduced from that seen with the best previous processing (small curve at upper left). Al-

TABLE I

Test Conditions and End Points

Transistor Type	Acceptance Limits		Test End Points		Cycled Life Test Conditions
	Icbo	1+hfb	Icbo	1+hfb	
2N40 Series	10 ua. 45 v.	.030—.015	18 ua. 45 v.	.035—.010	26 v. — 5.8 ma. at 25° C
2N78 ZJ-7	15 ua. 15 v.		25 ua. 15 v.		15 v. — 6.7 ma. at 25° C
ZJ-12	35 mua. 15 v.		100 mua. 15 v.		15 v. — 10.0 ma. at 75° C

TABLE II

Effects of Gamma Irradiation

Transistor Type	Irradiation Time Total Dose	Observed Effect on Transistors
2N40 Series	24 Hr. 7×10^6 R	hfe increased to 150% of initial value
2N78	24 Hr. 7×10^6 R	hfe increased to 125% of initial value
ZJ-12	200 Hr. 6×10^7 R	< 5% decrease in hfe
ZJ-14	24 Hr. 7×10^5 R	Negligible change in conductivity modulation

though some "failure" and a steady rate of change of I_{co} were seen at 135 C, the rate has been reduced to a level allowing safe storage for relatively long periods at this temperature. Units from the same lot, tested at 100 C, showed no variations of characteristics outside reading error limits over the 8000 hour period.

The apparently improved stability (and process reproducibility) for this special technique were checked by the data of Fig. 3, which shows essentially equal performance over 1000 hours at 100 C, on a different transistor lot, and little change during 2200 hours of subsequent shelf storage. These curves may be compared with those of Fig. 4, which are representative of the best current "military" processing requiring a long period of heat aging to reduce the magnitude of subsequent variations. To meet military specification end limits, it has heretofore been necessary to heat-age transistors for extended periods before shipment. Such aging is not required with the special processing mentioned.

Further information is provided by comparing Figs. 3 and 4 with Fig. 5, which represents typical performance of transistors processed for entertainment use and found entirely adequate for this application. It is noted that the initial variation in characteristics of units so processed is quite large; the amplitude is appreciably reduced by heating cycles with no strong permanent degradation tendency. Such processing is appreciably less expensive and results in higher average current gains of transistors; it is thus intentionally tailored to its market.

Stability of Type 2N78 grown npn germanium transistors on 100 mw cycled life test is comparable to that of pnp alloy units of good characteristics (Fig. 4), allowing a choice of npn or pnp transistors having equivalent life at high temperatures.

A test of Type ZJ-7 grown npn germanium tetrode transistors, after the same special processing applied to 2N40 series pnp alloy units (Figs. 2 and 3) shows noteworthy improvement in survival and stability at 140 C. The expected gain in stability at 100 C is currently being evaluated. Proof of 100 C stability in the ZJ-7 will make available 50 to 150 mc transistors suitable for high temperature storage and use.

The Type ZJ-12 grown npn silicon transistors are currently made with apparently greater stability at higher ambient temperatures. This is believed attributable to the same mechanisms evident in germanium units at lower temperatures (Fig. 5). The special processing used on germanium devices with good results has performed equally well on silicon rectifiers, and is now being tested on ZJ-12 units. Even better stability than that shown has been established over short periods (500 hours).

Excellent stability of important characteristics of Type ZJ-14 alloy pnp silicon unijunction transistors (formerly known as double base diodes) is evidenced. These semiconductor switches have been found useful over wide temperature ranges, with outstanding short-term stability of performance in actual circuits, in application studies. The added evidence of long term stability is welcome indeed.

Mechanical and Atmosphere Study

All transistor types studied have been designed to meet the objective mechanical and environmental test standards of Specification MIL-T-25380 basic section. In general, resistance to salt spray, humidity cycling, altitude, dip soldering, pressure, and temperature cycling tests has been found adequate (if not outstanding) in all transistor types. Typical data is given in Table III (Combined Tests) of this paper, for those tests which have been found to cause some degree of failure.

It has generally been found more difficult to design and produce mechanically stable grown junction transistors than alloy junction transistors, because of geometry and the necessarily microscopic base connections. Equivalent mechanical stability in grown junction devices is usually achieved only at reduced "G" loadings on shock and centrifuge tests.

Alloy junction transistors have proven readily ca-

TABLE III

Combined Test Results — 10 Lots of Type 2N43A Transistors Manufactured 1/15/56 to 5/15/56

Test per MIL-T-25380	Catastrophic Failures		Degradation Failures		Total Failures		Total Catastrophic		Total Degradation		Total Number
	High Icbo	Open Conn.	High 1+hfb	Low 1+hfb	No.	%	No.	%	No.	%	of Units Tested
Intermittent Life — 150 Mw.	3		1	1	5	2.0	3	1.2	2	0.67	250
Temperature Non-op. — 100°C	4				4	1.6	4	1.6			250
Moisture Resistance	2		2		4	1.33	2	0.67	2	0.67	300
Vibration High Accel.	1	2			3	1.2	3	1.2			250
Vibration Fatigue	2				2	0.8	2	0.8			250
Shock 500 G		1			1	0.4	1	0.4			250
Centrifuge 20,000 G	2	2			4	1.6	4	1.6			250
Salt Spray	4	1		2	7	2.8	5	2.0	2	0.67	250
TOTALS	18	6	3	3	30	1.46	24	1.17	6	0.29	2050

pable of meeting the specified shock, vibration, and centrifugal acceleration requirements of MIL-T-25380. Of interest is a recent test of several lots of 2N40 series transistors in an application which requires the units to be unchanged by an 8000 G, 3 ms shock. Sixty to 75 per cent survival was experienced in the early tests, and minor internal structure modifications are now being fabricated for retesting, with better survival expected.

Shelf Life Study

Shelf life tests have established no tendency toward permanent characteristic changes or catastrophic failure in transistors. Some reversible cyclical variation of characteristics has been observed as a function of ambient temperature or dissipation, in mixed test cycles including shelf storage (Fig. 5). This tendency has been reduced as high temperature stability was increased (Fig. 3).

Nuclear Radiation Study

Only the most preliminary nuclear radiation testing has been performed. Table II summarizes the results of tests to date in a Co_{60} source delivering 3×10^5 R/hr of gamma radiation. In all cases, an apparent "saturation" had been reached in the time stated, with the units remaining stable for some time before discontinuation of the test.

These results were obtained after earlier elimination tests which showed that germanium transistors were useless after 5 sec gamma exposure, and silicon units after 30 min of gamma exposure, which processed in certain common ways. Such processing was eliminated from units reported in Table II. The effects seen from gamma irradiation are believed to be surface changes, as they occur at doses well below those at which bulk effects would be expected. There is reason to believe that means of reducing these surface effects will be found quite soon, allowing damage to govern transistor characteristic changes. Bulk damage resistance may also be improved, but the bulk effects are not expected to be eliminated entirely because of their nature (changes in crystal structure).

Combined Mechanical-Electrical-Environmental Study

All degradation rate tests required by Specification MIL-T-25380 were performed on 10 separate Type 2N43A transistor lots (sample size as specified) manufactured between 1/15/56 and 5/15/56. From each lot, 25 transistors were subjected to each test listed. The results are presented in tabular form in Table III. Not more than three catastrophic failures (as defined in the table) were found in any one of the ten lots; several lots had none. The over-all failure rates are gratifyingly low, in view of the variety of test conditions and the close limits on characteristic end points. Consistency (from lot to lot) in electrical tests is excellent; greatest variability is experienced as a result of mechanical testing.

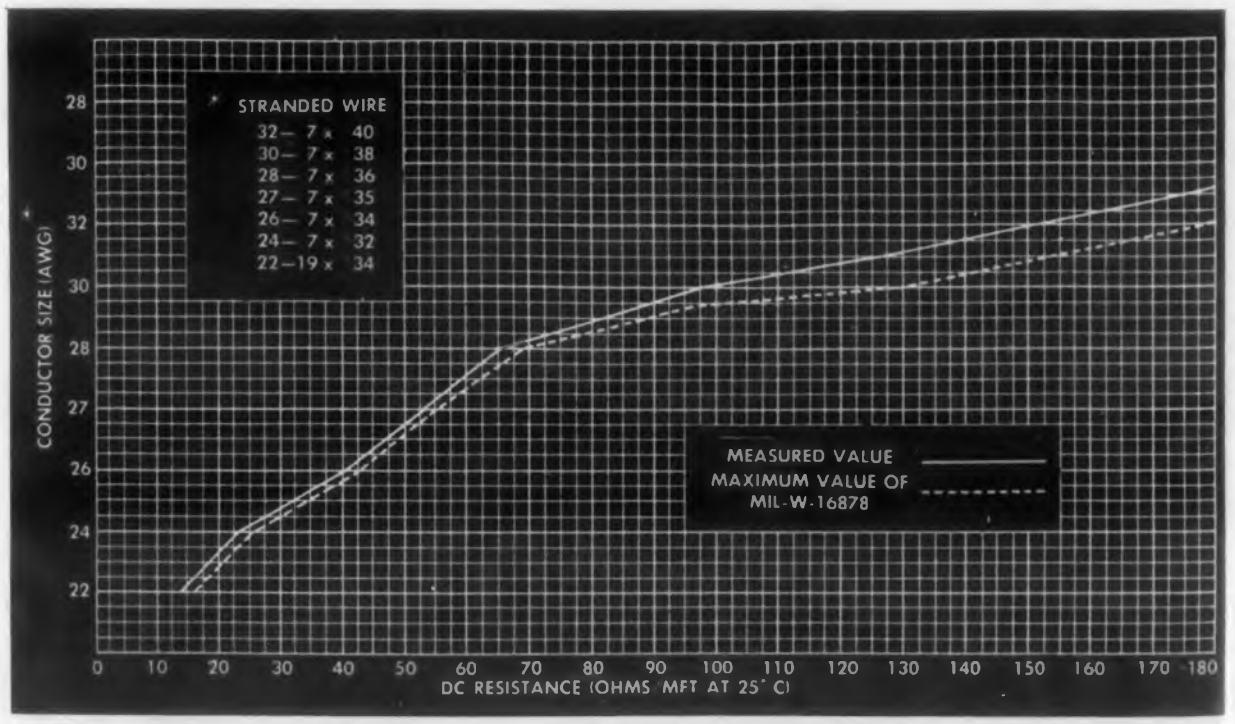
High-Strength

HIGHER breaking strength and longer "flex-life" are properties of this new reinforced electrical conductor. The conventional copper center strand has been replaced with a high strength nonmagnetic alloy. Since Teflon insulated hook-up wire is hard to strip without nicking, this development should be of value in lessening the breakage that too often occurs with Teflon wire.

This mechanically improved conductor, developed by Hitemp Wires, Inc., Mineola, N.Y., meets all the requirements of Military Specification MIL-W-16878. The center strand of silver plated copper has been replaced with an equal size strand of a special high strength nonmagnetic alloy. For example, a 26 gauge conductor (7 strands of 0.0063 in.) consists of six silver-plated copper strands around a single strand of the high strength alloy. This construction is more suitable for the smaller size conductor, such as 24 to 32 AWG since these sizes are more likely to break.

The new conductor construction will not eliminate the possibility of nicking of strands; however, the special reinforcing member acts as a "strain-relief" which tends to make up for the loss in tensile strength and "flex-life" of nicked strands.

The reinforcing alloy used also restricts excessive "solder run-up" without impairing a good electrical soldered connection. This lessens the tendency of insulated leads that have solder under the insulation to break near the termination when subjected to flexure or vibration. The reinforcing strand remains in the exact center and examination will show an excellent flow of solder around it. No evidence of excessive "solder run-up" has been experienced. This means that less precaution need be exercised regarding control of time and temperature than is customary with usual Teflon hook-up wire that has extremely wettable silver-plated strands.



Dc resistance of the various size conductors. The resistance is higher than the standard all-copper conductors; however, it is within MIL-W-16878B specs.

Electrical Conductor

The Breaking Point vs Conductor Size graph clearly shows the increased tensile strength, which is exhibited by the reinforced "High-Strength" conductor. Generally a reinforced conductor offers a 20 to 25 per cent increase in linear breaking strength.

The Cycles Before Breakage table shows the main advantage of the reinforced conductor to be its exceptionally high resistance to flexure fatigue. When tested as indicated in the table, the reinforced conductor showed a 400 per cent improvement over the strand copper conductor.

The application of this type of conductor should be of great value to the airborne equipment manufacturers, since many of these users are forced to go to larger size conductors to counteract the poor breaking strength of a smaller conductor. Reinforced "High-Strength conductors will permit these airborne equipment manufacturers to reduce their weight factor by reverting back to the smaller wire size.

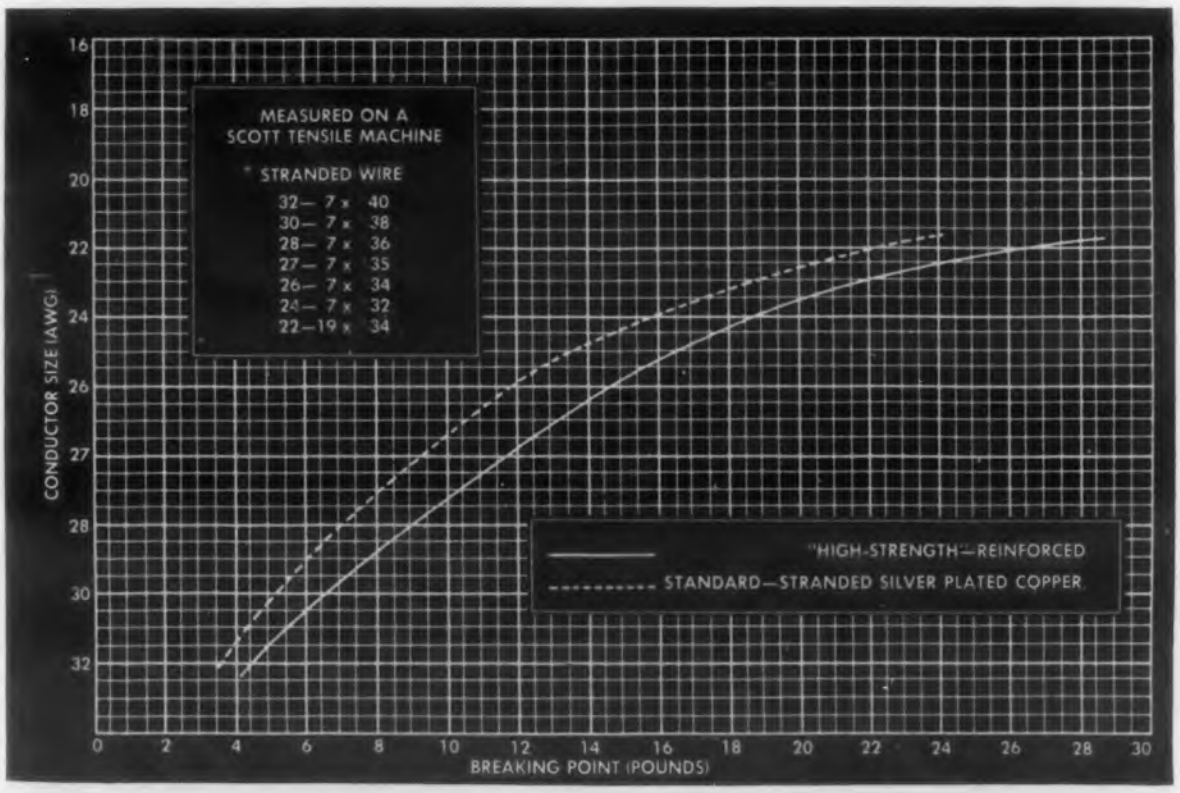
For more data on this product turn to the Reader's Service card and circle 20.

Cycles Before Breakage

22 AWG Conductor (7/30)

Regular	Reinforced
	32
	33
7	25
9	26
7	28
7	22
6	32
AVG 7.2 Cy	AVG 28.3 Cy

Test condition: The stripped and solder dipped ends were gripped directly in spindle holes without pin or turret terminals. The distance between the edge of the hole and the insulation was between 1/32 and 1/16 in. After an initial trial at 45 deg, the angle through which the spindle was oscillated was changed to plus and minus 90 deg.



Comparison of breaking point of standard and high strength conductors.

ENGINEERS

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Background on

Epoxy Foams

Luther Bolstad and Arnold Stenerson

Minneapolis-Honeywell Plastics Laboratory

THE search for rigid light weight insulating materials for electrical and electronic devices have led to the development of a number of epoxy foams. The excellent properties of these foams, the ease of preparing them and their relatively low cost makes these foams suitable for a variety of applications.

Most commercial epoxy resins are made from bisphenol A and spichlorohydrin. The molecular weight varies from 350 to approximately 8000 corresponding to $n=0$ and $n=20$ respectively. The viscosity of the resins increases with increasing n. For $n=0$ the resin is a mobile liquid, for $n=1.3$ the resin is a solid which melts at approximately 115 F; for $n=20$ the resin melts at 300 F.

The epoxy resins used in the foam formulations described here are listed in Table I. The physical and chemical properties given are taken from technical bulletins of the respective suppliers.

The polymer backbone consists of carbon to carbon and other linkages which account for good strength properties. Through the epoxy and hydroxyl groups, reaction with a variety of compounds are possible. Thus, epoxy resins react with amines, acids, acid anhydrides, isocyanates and with polymers such as polyamides, polysulfides and phenolic resins. Depending on the structure of these curing agents and the catalysts used, products varying greatly in properties can be obtained. In the three-dimensional cross-linked state these products have outstanding toughness, good adhesive properties, good thermal and electrical insulating properties, and good chemical inertness. In the expanded form low density is combined with the other good properties inherent in these resins.

Table I—Epoxy Resins

Trade Name	Specific Gravity	Epoxy Equivalent (Equivalents/11 g.)	Viscosity Cps	Supplier
ERL 2774	1.12 to 1.14	.52 to .56	10,500 to 19,000	Bakelite
ERL 3794	1.15 to 1.17	.50 to .54	7,000 to 19,000	Bakelite
ERL 2795	1.12 to 1.14	.52 to .56	500 to 900	Bakelite
Epon 828	1.29	.48 to .57	15,000 maximum	Shell
Epon 1001	1.26	.19 to .22	Solid	Shell
Araldite 6010	1.16 to 1.18	.507 to .518	10,000 to 25,000	Ciba

Table II—Hardeners

Name	Supplier
ERL 2793	Bakelite
Methylene Dianiline	Dow, Cyanamid
Metaphenylene diamine	Shell
Phtha'ic anhydride	Ciba, Allied Dye
1,4,5,6,7,7-Hexacholorbicyclo-(2,2,1) -5 Heptene-2, 3-dicarboxylic anhydride	Hooker (Het anhydride)
Versamide	Velsicol (Chlorendic anhydride)
	General Mills

Table III—Commercial Blowing Agents

Trade Name	Chemical Name	Supplier
Celogen	p,p'oxybis(benene sulfonyl hydrazide)	Naugatuck Chemical
Unicel ND	Dinitroso pentamethylene tetramine	du Pont
BL-353	N,N'-dimethyl-N,N'-dinitroso-terephthalamide	du Pont

Factors in Formulating Epoxy Foams

The constituents used in epoxy foam composition may be classified as: 1. epoxy resin, 2. hardener or curing agent, 3. catalyst, 4. blowing agent, 5. surface active agent, 6. solvent, and 7. flame retardent.

The great number of curing agents for epoxy resins offer many choices in foam formulations. A system may be selected that gels in a few minutes and cures up fast at room temperature. Other systems may have a pot life of several days at room temperature, but cure fast at an elevated temperature. The liquid resins and curing agents can be mixed batchwise or by continuous mixing equipment. The solid resins and hardeners can be dry mixed by a ball-milling operation into ready mixed powders with all foam constituents added. Only heat is required to produce expansion and cure. Such a ready mixed composition may have a pot life of several years. The hardeners used in formulations described in this paper are listed in Table II.

The epoxy resins are expanded by blowing agents to produce foams. A number of organic and inorganic blowing agents are now commercially available. They are stable compounds at room temperature, but are decomposed thermally at an elevated temperature. Some blowing agents can also be activated chemically to decompose at room temperature at almost any desired rate. The organic blowing agents are usually nitroso, diazo, or hydrazo compounds. On decomposition, gaseous nitrogen is produced. Several commercial blowing agents are listed in Table III.

The hydroxyl groups of the epoxy resins react with isocyanates to form urethane linkages. The reaction of isocyanates with moisture or carboxyl groups may be utilized to provide the expanding gas. This system requires a catalyst such as a tertiary amine and is very heat sensitive. The epoxy-diisosyanate foams may be expanded to a density as low as 1 lb per cu ft.

Surface active agents are important in obtaining a uniform cell structure.

Anionic surfactants such as the Pluronics have been found suitable for epoxy systems.

Solvents may be used in foam systems to modify the viscosity of the expanding mass, to function as auxil-

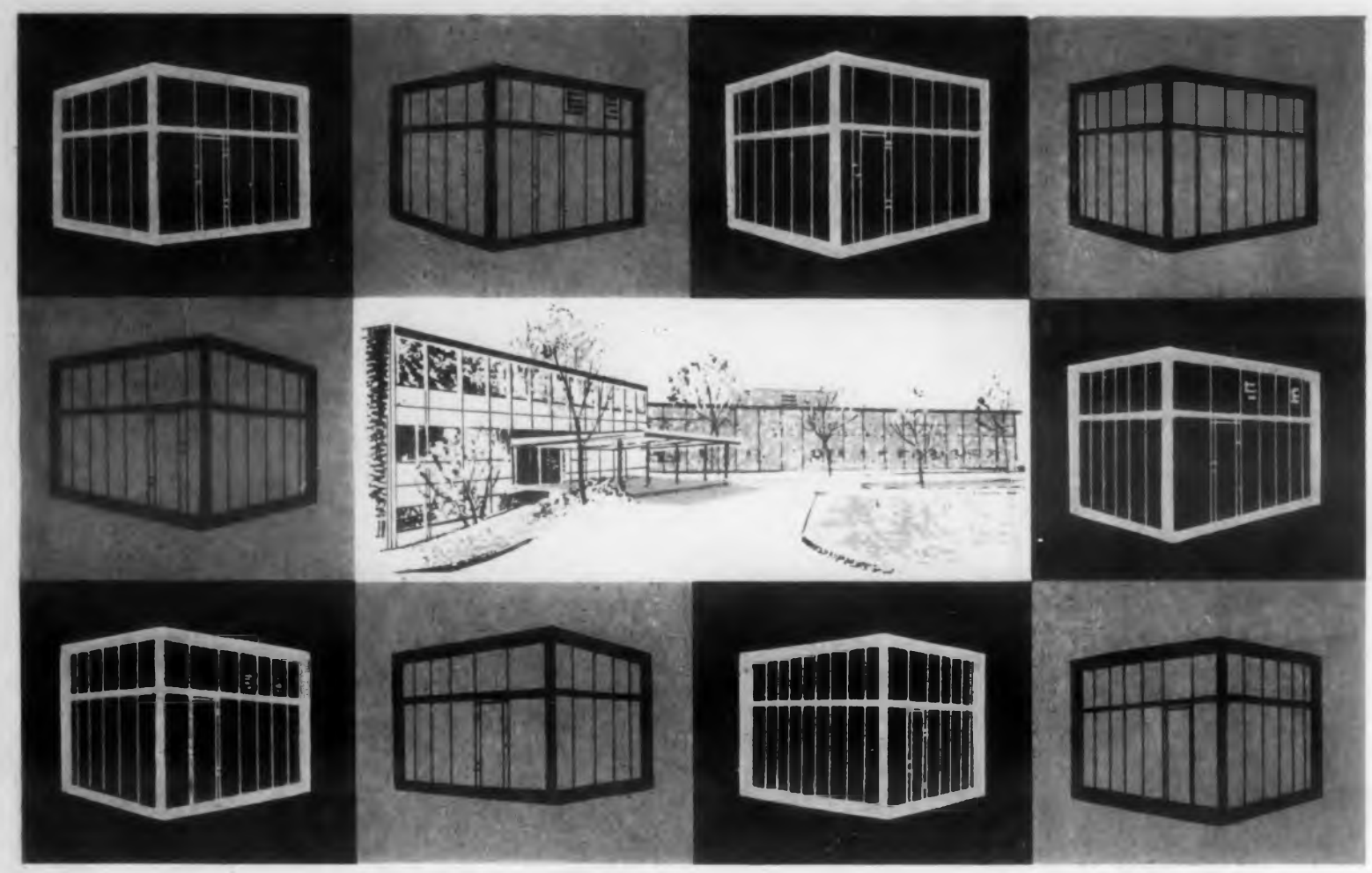


Table IV—Epoxy Foam Formulations

Epoxy Foam No. 1

Epon 1001	100 Parts by Weight
Methylenedianiline	10
Celogen	10
Styrene Oxide	5
Pluronic L-68	0.1

Epoxy Foam No. 2

ERL 3794	100 Parts by Weight
Hetronic Anhydride	80
Tolylene diisocyanate	60
Triethanolamine	10
Pluronic L-64	0.5
Water	2.5

Epoxy Foam No. 3

Epon 828	100 Parts by Weight
Tolylene diisocyanate	50
Diethyl ethanolamine	3
Water	6
Pluronic 1-64	0.5

Epoxy Foam No. 4

ERL 2774	80 Parts by Weight
Methylenedianiline	28
Celogen	2
Plyophen 5023	20
Pluronic L-64	0.1

Table V—Properties of epoxy

Formulation	Density lb/ft³	Compressive Strength, psi	Tensile Strength, psi
1	8.2	125	110
2	3.6	35	45
3	1.4	2	—
4	4.6	50	55

iary expanding agents and to absorb the exotherm of the reaction.

Some foam applications call for a nonflammable material. A curing agent like Hetronic or Chlorendic anhydride, containing a high percentage of chlorine, will impart flame retardency. Neutral fire retardents may also be added. Mixtures of antimony trioxide and chlorinated paraffins have been found suitable both for amine and anhydride cured systems.

The foamable epoxy compositions described here were chosen to illustrate the variety of materials that will react with or can be incorporated in epoxy resins. Their properties are given in Table V. Epoxy Foam No. 1 foams on heating to 250 F. A post cure of at least an hour at 250 F is desirable. The reaction is highly exothermic and if foamed in quantities of 100 gm or more the foam interior becomes charred The product has a density of about 6.8 lb per cu ft and a compressive strength of 80 psi.

Carbon dioxide produced from the water-isocyanate reaction is the expanding agent in Epoxy Foam No. 2. The density of the foam can be varied within limits by the amount of water used.

Typical of isocyanate systems, Epoxy Foam No. 3 starts foaming at room temperature as soon as the reactants are mixed together. Foams having densities as low as 2 lb per cu ft have been prepared.

Epoxy Foam No. 4 expands at 200 F. A post cure of one hour at 250 F is desirable. This foam has an exceptionally fine cell structure and does not have as great a tendency to char from exothermic heat as Epoxy Foam No. 1

The epoxy foams here described are designed for foaming-in-place applications. They are suitable for a variety of uses such as: 1. electrical insulation; 2. encapsulation of electronic circuit components; 3. thermal insulation; 4. acoustical insulation; and core material in light weight sandwich structures.

Based on paper presented at the 13th Annual National Technical Conference of the Society of Plastic Engineers at St. Louis, Mo.

foams listed in Table IV

Heat Distortion Temp., deg F	Electrical Res., ohms to 250 F	300 F
230	10^6	60K
210	10^6	10^6
—	10^6	10^6
275	10^6	500K

Mag-Amp Motor Control

THE Trak Motor Control is a passive device which will regulate the speed of a series wound universal motor within ±5 per cent over the full torque range from 0 to 100 per cent, for a given speed. This stabilized speed setting can be continuously adjusted over a range of about 20:1.

The Model MC-15, manufactured by CGS Laboratories, Inc., 391 Ludlow St., Stamford, Conn., is designed to operated at 60 cy 115 v ac with motors drawing up to 1 amp, but the principle of operation can be applied to any a-c universal motor. Since it is possible to measure the speed of a series motor by measuring the current and voltage fed into the motor, this control does exactly that. Both voltage and current are sensed by a magnetic amplifier, and corrections are continuously made so as to maintain constant speed. Variations in line voltage are automatically compensated for.

Fig. 1 is a simplified schematic of this control. A d-c voltage is produced by the bridge rectifier composed of CR_1, CR_2, CR_3, and CR_4, which powers the motor and provides the negative feedback voltage as well as the positive current feedback component for the magnetic amplifier. The saturable reactor has three windings; L_1 is a center tapped winding whose impedance is controlled by the feedback windings L_2 and L_3. L_2, the voltage sensing winding, is connected to produce a flux in opposition to that generated by L_1. Winding L_3 is a current sensing winding phased such that its flux aids L_1. Potentiometer R_1 decides the speed setting and controls the effect of the voltage feedback winding L_2.

When the control is turned on without its motor connected, the opposing effects of L_1 and L_2 are such that at no time does the magnetic core reach saturation. This results in the amplifier being in a steady state, with a maximum impedance presented in winding L_1. When the motor is connected to the

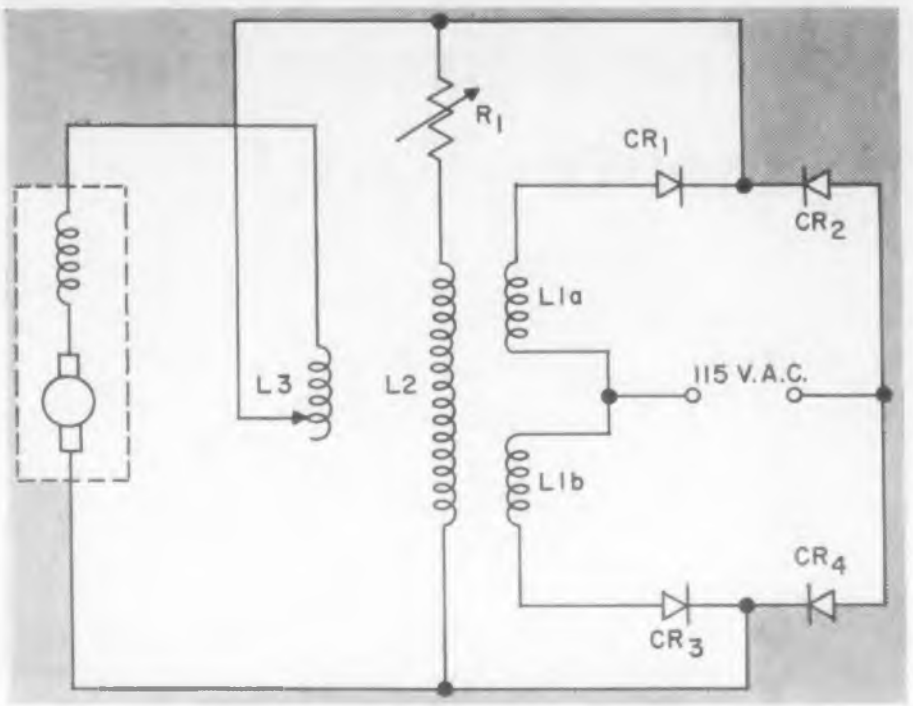


Fig. 1: Simplified schematic of motor control. The bridge rectifier powers the motor and provides feedback current and voltage to the magnetic amplifier.

circuit, the amplifier immediately approaches saturation because of the current through winding L_2. The impedance of L_1 now becomes minimum, and maximum voltage and current are fed the motor for the initial start-up condition. As the motor gains speed, its current and voltage decrease, causing the amplifier to approach its unsaturated state. A critical speed is finally reached when the current and voltage across the motor are of the proper magnitude to place the magnetic amplifier on the border of its unsaturated and saturated states. When this condition is reached, the motor speed is stabilized. Increased load will cause the magnetic amplifier to approach saturation and thereby increase the voltage and current to the motor. Likewise, a decreased load will give an opposite effect.

The speed setting control, R_1, controls the negative feedback of the amplifier. By its adjustment, the point at which the amplifier becomes critical is adjusted, and in turn the regulated speed of the motor can be continuously varied. For flexible application, winding L_3 is tapped to allow selection of the optimum amount of feedback to suit the characteristics of any given motor.

Maximum simplicity is obtained in the installation, the motor being simply plugged into the control which is in turn plugged into a standard 115 v a-c receptacle. Remote operation may be accomplished by an external 2 w speed control.

Since any motor control can only operate within a given motor's maximum ratings, this motor-control combination has a limiting torque for any given speed. The 100 per cent load point is defined as that point at which the motor will give no additional power. All components are passive in this device, yielding maximum component life and reliability.

For further information on this mag-amp motor control turn to Reader's Service Card and circle 27.

Miniature Strip Transmission Line and Components—Part 1

Eugene N. Torgow & John W. E. Griemsmann

Polytechnic Institute of Brooklyn,
Brooklyn, New York

MINIATURE strip transmission line and transmission line components can in many applications replace bulky waveguide and coaxial structures. Intricate machining operations and individual fabrication of each part give way to relatively inexpensive photo-etching procedures and accurate reproduction of components in quantity production. For many applications the advantages in cost and miniaturization offered by strip line construction greatly outweigh the disadvantages of greater dissipation losses and decreased power capacity. Part I of this article deals with the versatility and important characteristics of strip line and strip line components. It refers specifically to miniature strip line, but the general approach is equally valid for all types of strip transmission line having a cross section equivalent to that shown in Fig. 1, regardless of the manner in which the center conductor is supported between the ground planes. Part II describes the construction of various strip line components.

Characteristic Impedance

Basic cross section of a strip transmission line is illustrated in Fig. 1. The line is composed of a thin, flat center conductor parallel to two ground planes and separated from the ground planes by dielectric layers. An approximate expression for the characteristic impedance of this line, based on the assumption of zero thickness center conductor and infinitely wide ground planes, is:

$$Z_0 = \frac{60\pi\, K(k)}{\sqrt{e_r}\, K(k')} \qquad \begin{matrix} k = 1^{-\pi\, b/h} \\ k = \sqrt{1-k^2} \end{matrix}$$

where e_r = relative dielectric constant of the line
$K(k)$ = complete elliptic integral of the first kind
b = width of center conductor, and
h = distance between ground planes.

Maximum center conductor width and maximum ground plane spacing are determined by the highest frequency at which the line is to be operated. In order to prevent propagation of higher order modes at this frequency, it is necessary to keep both of these dimensions less than half a wavelength. Minimum width of the ground planes is determined by the rate at which the field decays away from the center conductor. A total line width equal to four times the width of the center conductor will generally insure that the field strength at the edges of the line will be down at least 30 db. While there is no restriction on the maximum width of the line it is generally desirable to keep the width under a half wavelength at the highest operating frequency in order to simplify the elimination of parallel plate modes whenever they are generated. These modes can then be simply suppressed by the use of shorting bars between the ground planes along the edges of the line.

Specifications

The miniature strip line whose applications will be deseribed has a center conductor width of 0.0325 in. and a ground plane spacing of 0.040 in. A polyethylene dielectric with a dielectric constant of 2.25 is used and the resulting characteristic impedance is 50 ohms. The conductors were made from 1 oz copper foil and were bonded to the dielectric with "Teflon Adhesive" manufactured by the Gilbreth Co., Philadelphia. Total line width is 1/4 in., so that the leakage field is down about 60 db. Shorting bars between the ground planes at the

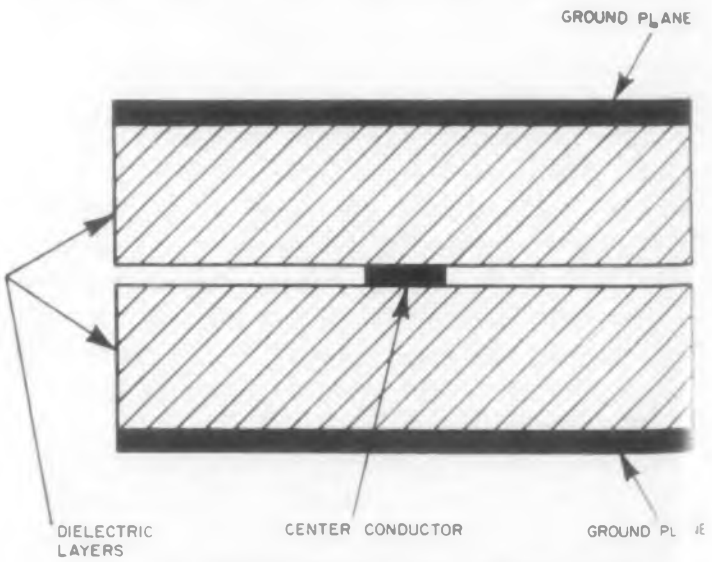


Fig. 1. Cross-sectional view of strip transmission line. Maximum center conductor width and maximum ground plane spacing are determined by highest operating frequency.

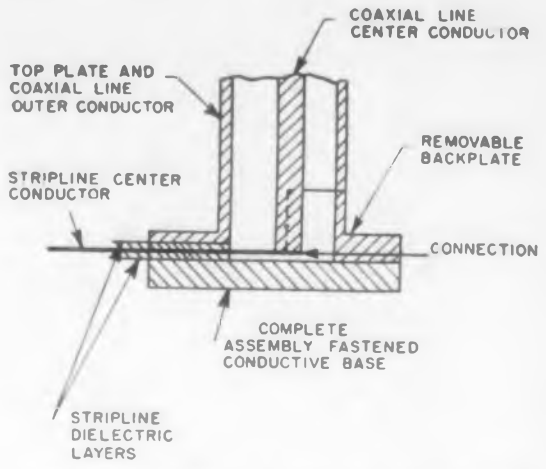


Fig. 2. Assembly drawing of right-angle strip line to coaxial line adapter.

edges of the line suppress parallel plate modes at all frequencies up to 15 kmc. Other modes will not propagate at frequencies considerably higher than this. The useful upper frequency at which the miniature line can be employed is of the order of 10 kmc. Attenuation of the line at this frequency is about 1 db per ft and rises rapidly with increasing frequency. Low-frequency limitation of strip line is due to the increased physical length required for components designed to operate at low frequencies. However, the use of a flexible dielectric material, such as polyethylene or Teflon, permits the line to be formed into spirals or other shapes so that components can be fabricated in more compact forms.

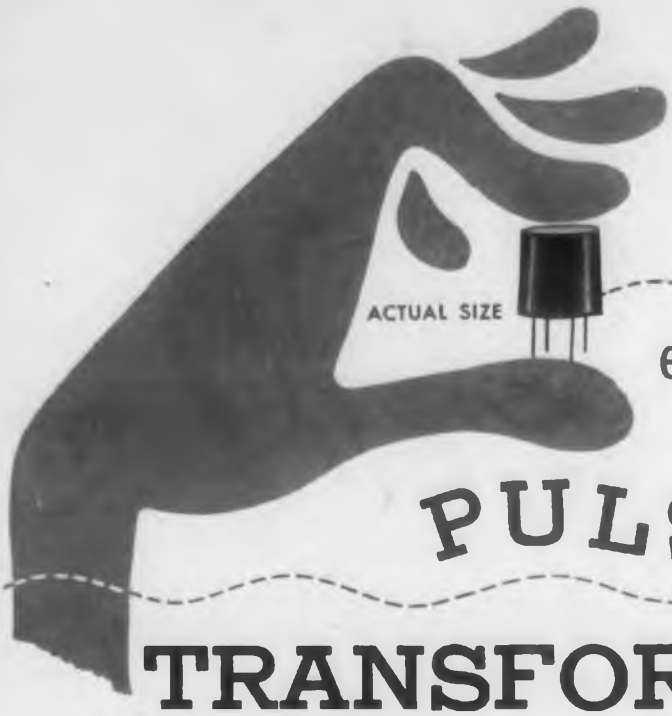
Coaxial Adapters

Adapters for connecting strip line components to coaxial systems can be designed in several ways. With the miniature strip line, the most practical adapter is the right-angle junction illustrated in Fig. 2. This adapter exhibits a voltage standing wave ratio of less than 1.4 below 6 kmc and decreases with decreasing frequency. The standing wave ratio increases above 6 kmc to about 1.8 at 10 kmc.

Matched loads and attenuators can be fabricated by using lossy conductors, such as Nichrome, in the construction of strip line. Since the center conductor is extremely thin, total resistance per unit length approaches a constant as the skin depth approaches the thickness of the conductor. Therefore, at lower frequencies the attenuation of a lossy line of this type tends to become constant. Losses of the order of 6 db per ft can be obtained at 9 kmc when nichrome conductors are used. A long length of line using Nichrome conductors can be formed into a coil to obtain a compact, broadband matched load, when a flexible dielectric is used.

Equivalent Components

In general, any lumped network which can be realized in ladder form can be fabricated as a strip line structure by making use of a simple element by element equivalence between lumped reactance elements and certain strip line structures. This includes a wide

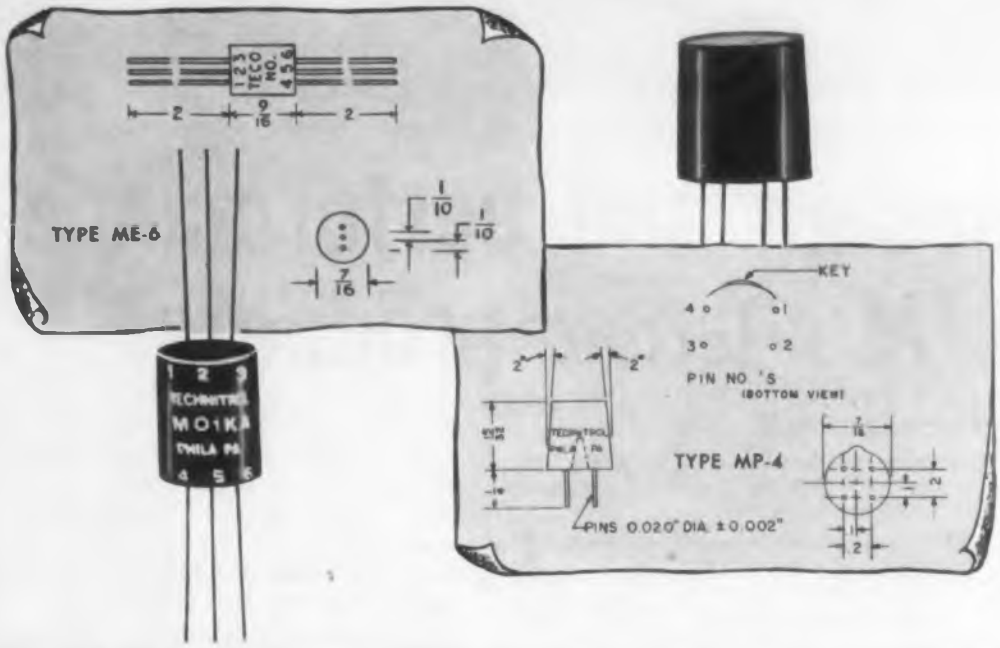


miniature

encapsulated

PULSE TRANSFORMERS

by TECHNITROL



Wound on ferrite cores, the Type M series is available in a variety of windings to cover pulse widths from 2 microseconds down to .05 microsecond, wound inverting or non-inverting.

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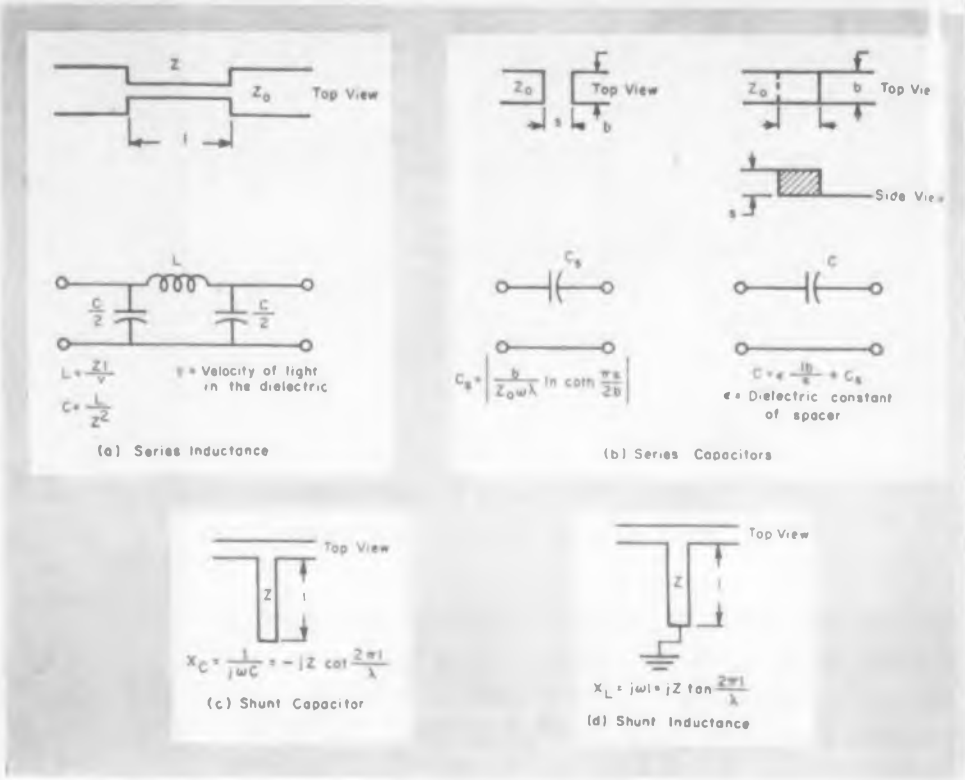


Fig. 3. Center conductor configurations of strip line circuit elements.

variety of circuits, including filters, equalizers, matching networks, etc. Shunt elements can be represented by branching lines. Therefore such elements can be constructed by placing a length of center conductor at right angles to the main line, and extending the dielectric layers and ground planes over this branch of the center conductor. Series elements can be obtained either by the use of a length of line of different characteristic impedance in series with the center conductor or by discontinuities in series with the center conductor. Ground plane spacing of a strip line device is usually kept constant, consequently impedance is changed by changing the width of the center conductor. Most lumped structures can be constructed simply by designing a strip line section having the appropriate center conductor geometry. Design of strip line components is essentially a two dimensional problem.

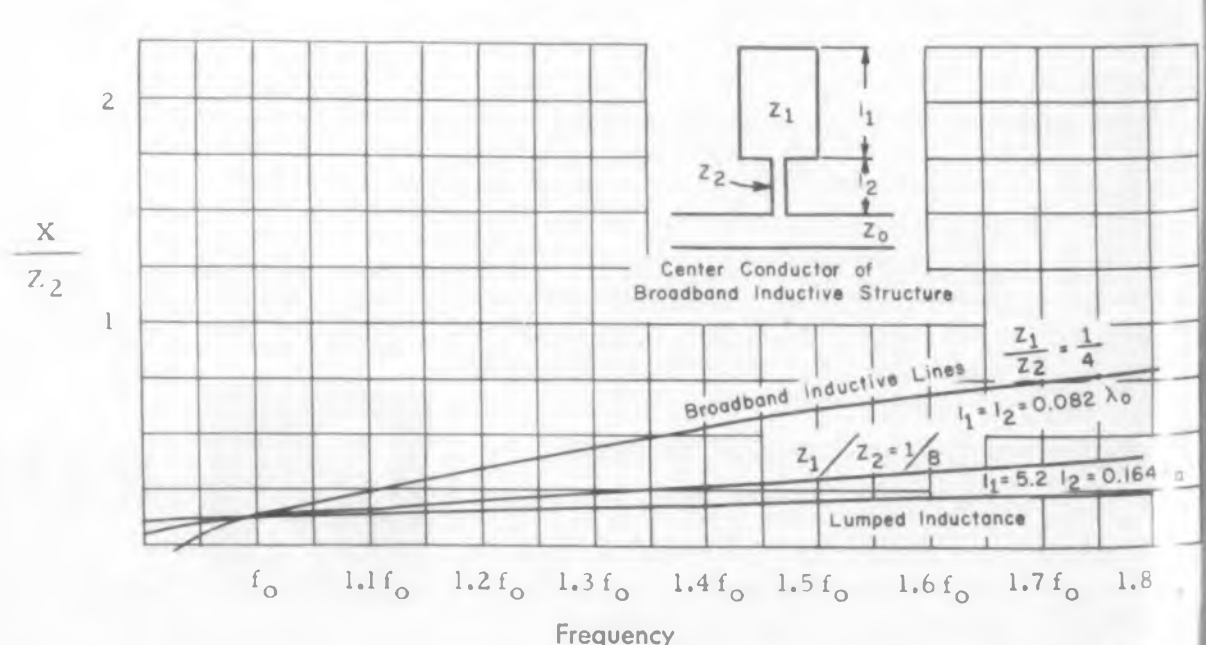


Fig. 4. Impedance of broad band inductive structure.

Circuit Elements

The more commonly used strip line circuit elements are illustrated in Fig. 3. A short length of line of high characteristic impedance is essentially a series inductance shunted by two small capacitors to form a "pi" structure. The equivalent shunt capacitors in this circuit are small enough to be neglected in the design of the series inductance and they can be taken into account as correction terms in the design of subsequent elements in most circuit designs. Series capacitors can be obtained by the use of a small gap in the center conductor, provided that the desired value of capacitance is small. When larger values of capacitance are required, the gap dimensions become impractically small. Larger values of capacitance can be obtained by the use of parallel plate structures formed by overlapping two short lengths of center conductor with a dielectric spacer, such as 0.001 in. thick Teflon tape, between them. An open circuited branch line less than a quarter wavelength long acts as a shunt capacitance. Shunt inductance can be realized by the use of short circuited branch lines less than a quarter wavelength long or by open circuited branch lines whose lengths lie between a quarter and a half-wavelength. With the exception of the overlap capacitors and the terminations required for the short circuited inductive lines, all these strip line elements can be designed by proper shaping of the center conductor. Entire assemblies can be obtained by photo-etching the appropriate center conductor configuration from a thin sheet of copper foil. This permits the exact reproduction of complex assemblies in large quantities at low cost.

In order to simplify fabrication procedures, it is desirable to eliminate the short-circuited termination of the shunt inductive element. For operation over a narrow band on open circuited line between a quarter and a half wavelength long will be a good approximation to shunt inductance. When wider band operation is required, it is sometimes possible to use a special structure which exhibits inductive behavior over a wide frequency band. The structure consists of a short length of high characteristic impedance line terminated in a short length of open circuited low characteristic impedance line. As can be seen from Fig. 4, the proper choice of line lengths and impedance leads to a fairly good broadband inductance.

Resonant elements can be realized in strip transmission line by the use of quarter and half wavelengths sections of open and short circuited sections of line. Great care must be exercised in the design of such elements since they approximate the performance of lumped L-C resonant circuits only over very narrow frequency bands.

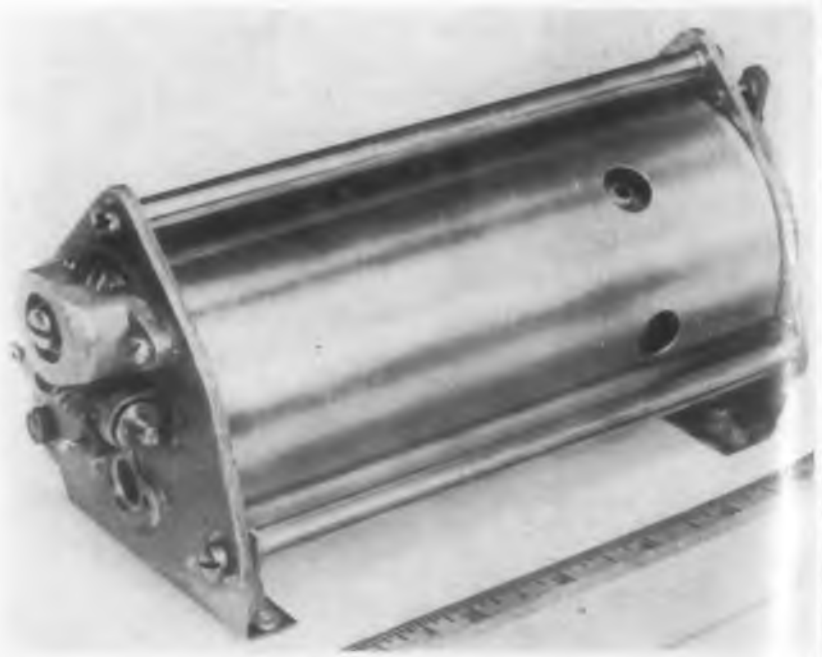
This paper describes work done under the sponsorship of the Rome Air Development Center, Griffiss Air Force Base, Rome, New York on Contract AF-30 (602)-1430. The paper was originally presented at the "1956 Electronic Components Symposium" in Washington, D. C. on May 2, 1956 and is published in the proceedings of that Symposium.

"S" band tunable stalo with AFC control.

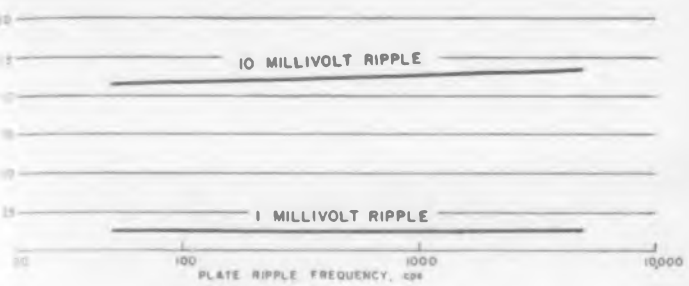
Tunable S

THESE stable local oscillators (stalos) are tunable over a frequency range of at least 10 per cent of center frequency. They also have extremely good short term stability and appreciable power output.

Developed by the Pitometer Log Corp., 237 Lafayette St., New York 12, N.Y., tunable "stalos" are available at present for both L-band and S-band operation. Both types are illustrated. The S-band stalo employs an added feature of an automatic frequency control plunger, to assure long-term stability. This feature can be supplied with the L-band units as well. The L-band stalo shown is tunable from 1200 to 1350 mc, but other frequencies can be supplied. Its short-term stability, as measured on an LFE Stalo Stability Tester, is approximately one part in about 250 million. When the stalo is isolated from vibration, and has reached thermal equilibrium, the peak deviation is 5 cps or less in the disturbance frequency range from 20 to 5000 cps.



Tunable "L" band stable local oscillator (stalo).



Frequency deviation vs plate ripple frequency for tunable S-band stalo

Stalos

Although it is suggested that the units be isolated from vibration effects, the heavy cast construction of the cavities, and the elimination of unnecessary components and appropriate selection of materials, minimizes vibration effects in service. The body casting is brass, silver-plated, and has a gold flash to prevent tarnishing. Moving members are supported on Teflon bearings. Other insulation materials are nylon and Rexolite.

Long-range stability of the S-band unit, without automatic frequency control, is such that 1 mc drift is obtained at 2700 mc when temperature is varied from 70 to 170 F. Less drift could be designed in if necessary, since no special attempt was made to minimize this characteristic. Both stalos shown can be operated over the temperature range from —55 to +85 C. The physical sizes of the units shown are approximately 9 x 3-1/2 in. for the L-band stalo and 8 x 3 in. for the S-band unit.

Voltages required for operation consist of a filament supply of 6.3 v ac or dc depending upon local oscillator tube employed, and 150 to 250 v dc regulated plate supply with ripple voltage not greater than 1 mv rms to obtain the short-term characteristics described. When dc filament voltage is required, ripple voltage should not exceed 5 mv. Output power is at least 300 mw on S band and 500 mw on L band.

Compared to crystal-chain multipliers, the stalos are much less complicated, tunable over a wide range, and have considerable power output without the use of power amplifiers.

Applications include test equipment for examining quantitative performance of doppler radars, where the phase of one pulse must be compared to that of the next. They can also be used in the radar sets themselves for improved sub-clutter visibility performance.

For further information on stable oscillators turn to Reader's Service Card and circle 213.

Molded Printed Circuits

DESCRIBED here is a clever but simple molded printed-circuit panel design, for use in a new relatively inexpensive automatic component assembly machine. It has many advantages over conventional paper laminate, NEMA XXXP, and few disadvantages apparent at first glance. Not only are electrical and mechanical characteristics of the molded panels better than for etched paper-laminate boards, but their eventual cost for molding and component assembly should be only a fraction of that for "conventional" printed-circuit assemblies. The accompanying comparison table details the differences to be found in molded versus laminate printed circuitry.

This molding technique and the automatic component assembly method were developed by Die-Form Circuits, Inc., 6045 W. Ogden Ave., Chicago 50, Illinois.

Characteristics Of The Material

The resin used in the standard molded panel to replace XXXP paper laminate is electrical grade phenol resin. As supplied by the Bakelite Company, the minimum material characteristics are: Power factor at 1.0 mc, 0.025; dielectric constant at 1.0 mc, 4.4; water absorption, 0.3 per cent; tensile strength, 7500 psi; flexural strength, 10,000 psi; compressive strength, 32,000 psi; dielectric strength, 380 v per thousandth; izod impact, 0.28. Surface characteristics may be further improved by a film of cured epoxy over the entire surface.

Great flexibility is provided in selection of material, because any material that can be transfer-molded can be used. For superior electrical properties, mica-filled phenolic or melamine plastic resin can be employed.

Molding

A standard transfer-molding press is used for molding the panels. Dies are simply made from a scaled photographic negative of the engineer's printed-circuit layout drawing. Molded-in channels for printed-circuit wiring on *both sides* of the panel is no more expensive than for wiring on one side only. Jumper wires can be molded in, avoiding an added operation. Wire channels are depressed 0.015 in. below the face of the panel. All holes for feed-through wiring or component terminations are molded in, avoiding the use of punch presses for piercing in a subsequent operation. These holes have an "hour-glass" shape to facilitate uniform copper deposition throughout the holes during the circuit plating operation. The channel grooving adds strength to the printed wiring, and its depression not only facilitates subsequent operations on the panel but acts as a safe-guard against short circuits in service.

Printed-Circuit Processing

After the panels are molded, it is a simple process to "install" the conductors. This processing is done by Die-Form Circuits, Inc. and is essentially "com-

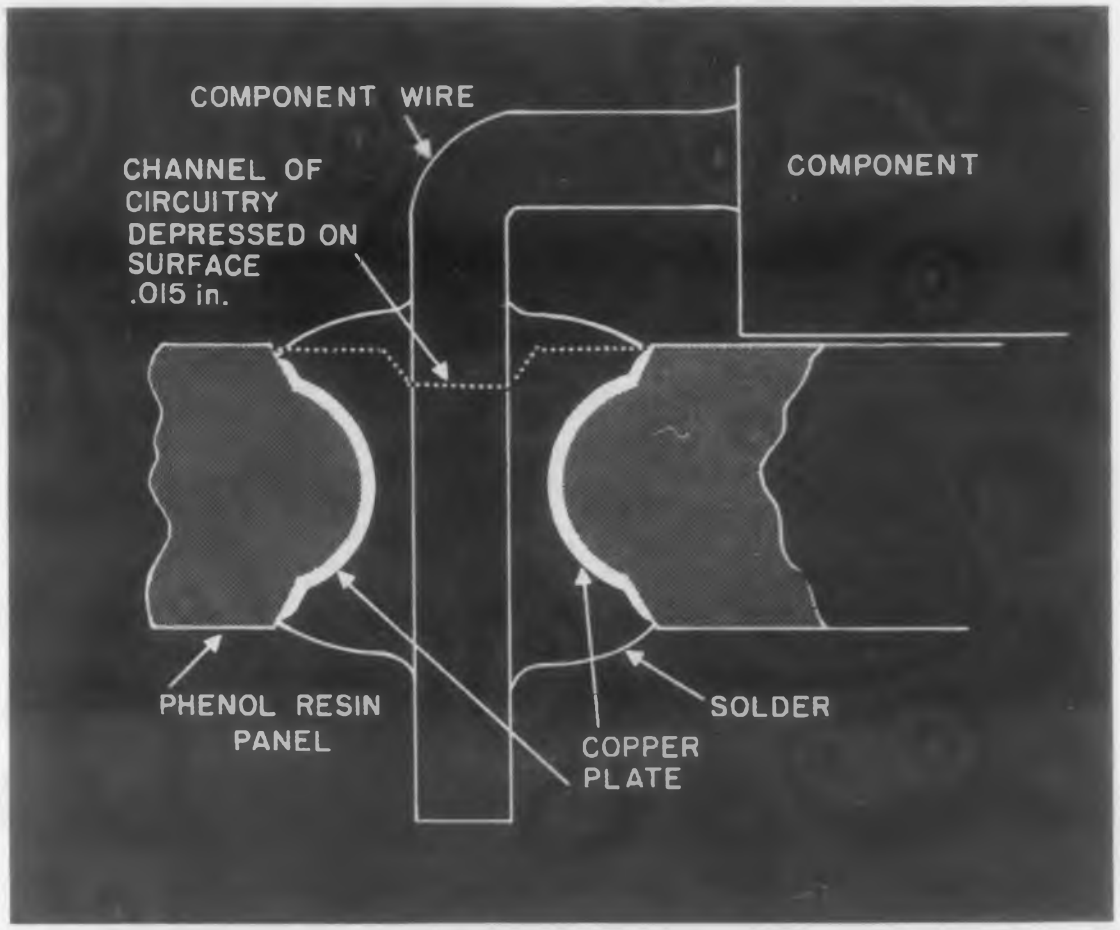


Fig. 2. Enlarged cross-section of molded panel showing how components are inserted and anchored by solder. The hour-glass shaped holes result in uniform copper deposition and forms an "eyelet" integral with the channel circuitry.

Fig. 1. Typical molded-phenolic printed-circuit panel. The circuitry, which is electro-deposited, is recessed below the surface of the board. This design cuts cost of manufacture and reduces the possibility of shorts from wires and components on the surface.

pany confidential." However, it can be assumed to be done as follows:

A wax mask is roller-coated onto the surface of the panel.

Adhesive (although believed not to be required) is sprayed on.

A conductive film (for plating) is sprayed on.

The wax is cleaned off the panel surface.

Copper is plated to about 25 millionths of an inch of thickness. The holes are uniformly plated along with the wiring channels. Both sides of the panel are plated at the same time.

Solder (60-40) is plated on top of the copper to prevent oxidation of the copper circuitry.

Rosin flux is sprayed on and baked.

A typical molded printed-circuit panel, ready for component assembly, is shown in Fig. 1.

Panel Dimensions

Present indications point to a panel size of about 10 x 6-1/2 in. maximum. Smaller panels than this will generally be molded in multiple and later separated on scored lines. Panel thickness can be selected, although 0.093 in. is standard. With depressions of the circuitry 0.015 in. on each side, this allows 1/16 in. thickness between opposite side circuitry.

Cost

Eventual costs are as yet hard to predict, as there has been no experience to date with volume production of molded panels. The first real production will begin in April. However, the present initial "processing charge," which includes molding dies and set-up for molding, is $1000. This is less than 10 per cent of the cost of piercing dies for typical laminated panels. Also, there is no charge for tool maintenance or replacement on long runs. Prices being quoted on finished molded printed-circuit boards at present are about 30 per cent lower than

Etched Panels vs Molded Panels*
Comparison Table

Etched	Molded
Foil laminate sheet—approx. $1.75 per lb.	Molding material—$0.21 per lb.
Panel waste consists of hole slugs and sheet cutting.	Only waste is a 2-gram gate.
Most of copper is etched away and unrecoverable.	Copper is deposited only where desired.
Cut edges moisture absorbent due to exposure of laminations and wood fibers.	All surfaces are of mold texture; no bared fibers.
Moisture absorbency—1%.	Moisture absorbency—0.3%.
Likelihood of retained acids and acid salts in processing.	Relatively impregnable surface.
Subject to retention of volatiles—raw ketone and unpolymerized or thermoplastic material.	Complete cure.
Softens in soldering operation often releasing volatiles producing vapor pressure, lifting circuitry, and blistering.	Cured to complete stability. Does not soften.
Subject to warping.	Stable.
Spontaneous aging continues indefinitely, releasing water and possibly corrosives.	Completely cured in the die.
Adhesion of copper is limited by above-mentioned conditions.	Adhesion of copper approaches molecular attraction.
Usually requires heating for piercing, resulting in shrinkage.	Holes are molded in; no dimensional disparity results.
Requires expensive blanking and piercing dies costing from $5000 to $12,000.	No piercing dies required. There is an initial processing charge which at present is $1000.
Dies require a 6 to 12 week fabrication period.	Panels are in production 2 weeks after drawings are completed.
Dies load up causing operating difficulties.	No dies involved.
High die maintenance cost.	No charge for maintenance or mold replacement.
Requres punch presses.	No presses required.
Die revision for circuit change is costly.	Mold replacement more rapid and about 10 per cent as costly.
Use is limited to sheet products. Only resins applicable to sheet processing can be employed.	Any resin which can be transferred molded can be used.
If epoxy overcoat is used, it must be applied by a printing system to avoid covering points to be soldered. Epoxy requires higher curing temperatures to develop full characteristics than laminate board will stand without damage.	Epoxy, if desired, is merely roller coated on surface. Cure is complete since high curing temperature does not deteriorate the stable molded panel.
Circuit on surface is subject to damage.	Circuit is imbedded 0.015 in. below surface and is thus protected against damage.
The exposed copper circuit oxidizes requiring considerable liquid flux to effect soldering. Since this flux is sticky, subject to softening, and hydroscopic, it must be washed off with a solvent after soldering and properly dried.	Solder is electro-deposited after the copper circuit, thus preventing oxidation. This solder readily combines in the soldering operation. A deposit of baked flux is applied to soldering points. This supplies the fluxing action to effect soldering of component terminals and becomes completely vaporized, leaving no residue to be washed off.
Operating temperature of the panel is limited to 221 F—Underwriters rating.	Operating temperature can go to 302 F without damage to panel.
Power factor at 1.0 mc: 0.027.	Power factor at 1.0 mc: 0.025.
Dielectric Constant at 1.0 mc: 4.5.	Dielectric Constant at 1.0 mc: 4.4.
Component leads must be bent against circuit edges or must be provided with clipping action to permit soldering. Holes must be no greater than 0.010 in. larger than the terminal. This causes indexing difficulties in automatic insertion and makes manual insertion difficult. Movement of parts after soldering will force circuitry off panel. Manual placement of parts must be accomplished after removal from assembly machine and then later soldered by dipping or by additional soldering machine.	Holes are eyeletted with copper deposition, and thus may be relatively much larger since hole will be filled with hour-glass shaped solder nugget. This lends great efficiency to both methods of insertion, providing indestructible mounting attachment. No component terminals need be crimped. This permits manual insertion on the assembly machine where all other operations are performed, including automatic small-component insertion and soldering. Thus, a unit is completed with no interoperation banking or handling.

(*Continued on next page*)

Comparison Table Etched

Etched
Single-side circuitry, inherent with this system, permits no cross-overs except by use of jumper wires. Such jumper wires require an inserter and station space on the machine.
Circuit layout is difficult, resulting in much paralleling of conductors which often cause feedback and electrical instability.
Circuit is restricted to area of one side of panel. Parts orientation is restricted and causes electrical inefficiency.
No parts, shafts, or components can be allowed to project on the soldering side of the panel since the entire lower surface will be immersed in molten solder.
Only equipment available to insert 100 parts would require 100 inserters averaging approx. $3000 each. These would require 150 ft of floor space in length (1000 sq ft approx.), costing $1000 per ft; also, a soldering unit of $45,000. A grand total of $495,000 results, requiring about 2000 sq ft of manufacturing space.

the cost of etched printed circuits. Evidence points toward considerably lower cost eventually, since the process is inherently less complicated than production of etched panels.

Assembly Of Components

To gain full advantage of the features of molded printed circuitry, a special automatic component assembly machine has been developed. It is far simpler than the equipment currently used for assembling on etched boards, yet is more automatic, takes up less floor space, and eliminates separate operations for hand assembly of irregular or bulky components.

No punch presses are required, since component lead holes and terminal holes are molded in. The assembly equipment, especially designed for molded-panel component assembly, is relatively inexpensive compared to that currently being used for assembling components on etched panels and occupies a space only 9 ft in diameter—an area less than 10 per cent as great as for the etched-panel assembly.

The large components, other than resistors, small capacitors, and the like, can readily be installed in the panels by operators located around the assembly machine. Soldering in place is accomplished automatically by a selective soldering technique.

Panels vs. molded panels*

	Molded
	No jumper wires are used. Circuitry is printed on both sides of board, providing cross-overs by the simple expedient of leading the circuit through holes to the other side.
	Layout easily accomplished with great flexibility of conductor location.
	Area of two sides of panel for circuitry permits proper orientation, and provides shorter and more direct radio-frequency conductors.
	The soldering system proposed provides for area control and permits socket parts and shafts to project from the soldered side. This allows great design flexibility.
	Basic "Equip-a-matic" machine, with multiple inserters, and including automatic loading, soldering, and ejection, costs $60,000. It occupies a space of about 100 sq ft.

* Comparisons based on use of electrical grade phenol resin for the molded panel, the "Die-Form" molding technique, and the "Equip-a-matic" automatic assembly process.

Limitations

To take full advantage of printed circuitry, a company must make a rather substantial investment in equipment for component assembly. Investments in excess of $100,000 are not uncommon. As previously pointed out, the advantages of molded circuitry are obtained to a large extent only when automatic assembly equipment specially designed for the molded panels is employed. Some firms may find it economically impractical to switch over and take the loss of obsolescence of existing equipment.

At present, only two companies are tooling up to produce the molded panels—Die-Form Circuits, Inc., Chicago, and Michigan Die-Form Circuits, Inc., Ann Arbor, Mich. A patent is pending on the process; however, it seems quite likely that a number of companies will be licensed to make the panels. Plans for the Chicago plant call for production of up to 20,000 panels per shift.

Since only the Equip-a-matic Engineering Corp., an affiliate of Die-Form Circuits, Inc., can supply the component assembly equipment at present, orders may experience some delay.

Aside from the above limitations, which in the long run appear to be minor, everything seems to be in favor of this new concept of printed wiring units.

Additional information may be obtained by filling out the Reader's Service Card and circling **221.**

Electronics Engineers

Plant of Westchester manufacturing subsidiary, Pleasantville Instrument Corporation; additions are under construction.

Latest GPL engineering building, for which ground was broken recently.

Plant of Bloomfield, N. J., manufacturing subsidiary, Simplex Equipment Corporation; added in 1957.

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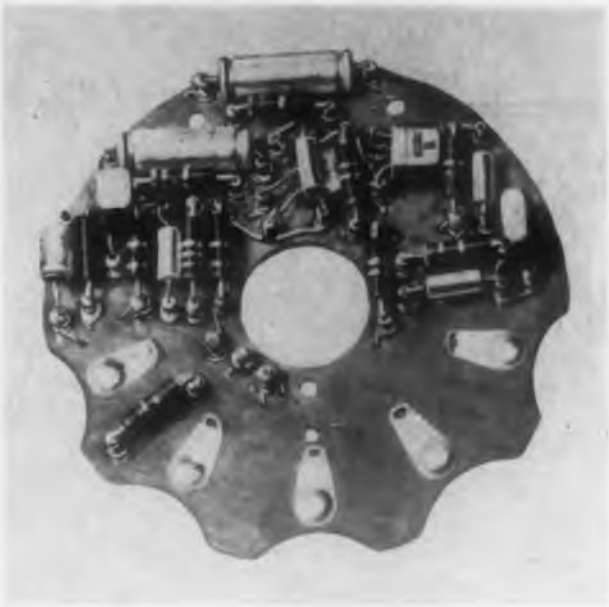

Fig. 2. Printed circuit construction of amplifier terminal board adds to compactness of unit.

UV-IR Photometer

Design Forum

EXPLOITATION of the small size and low power requirements of transistors resulted in the manufacture of this precision portable UV-IR photometer. To obtain satisfactory readings under a wide range of ambient lighting conditions required a relatively high gain amplifier to amplify the response of a lead sulfide detector. A power gain of 84 db was provided by a straightforward transistor amplifier circuit.

Four transistors are used in the amplifier. The input circuit, consisting of the lead sulfide detector, a balance resistor and a pnp junction transistor, provides temperature compensation and low—9db—noise. An input impedance of 150 K prevents loading the detector. Successive capacitive-coupled npn transistor amplifier stages are terminated in a 1 K output impedance

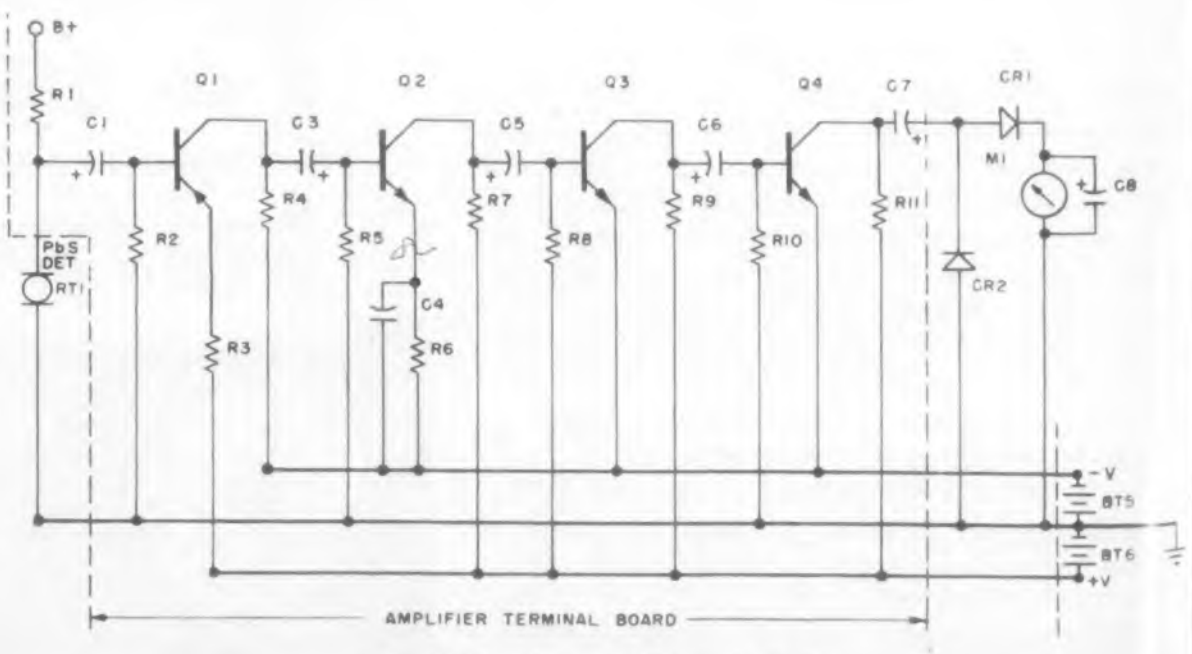

Fig. 1. Transistor amplifier schematic

to drive the meter, and at the output there are two germanium diode rectifiers in a voltage doubler circuit. The batteries for the amplifier and detector bias are lightly loaded and will last for the shelf life, a year or so. The terminal board shown in Fig. 2 was constructed using a printed circuit.

An ac amplifier was used to provide high gain and drift-free operation, and in order to interrupt the optical signal to the detector a dc motor, drawing less than 10 ma from a 3 v battery is used. A chopper disc is attached to the shaft of this motor, and inserted behind the first objective lense. Small mercury cells will power the motor for several hundred hours.

An interesting optical arrangement to remove the necessity for extreme amplifier linearity was used. A neutral density circular wedge with a linear variation in density from 100 per cent light transmission to 0.01 per cent is positioned in the optical path. This disc is rotated through increasing density until the meter needle reaches a "set" position. As a result the signal level for reading is maintained at a constant level regardless of the intensity of incoming radiation. The neutral density wedge is accurately calibrated, and as it is rotated, provides exposure guide information.

The photometer, manufactured by Servo Corp. of America, New Hyde Park, N.Y., has a flat spectral response to electromagnetic radiation from 2.5 to 0.35 microns—well below the visible into the near-infrared and up into the ultra-violet. By combining optical filters it is possible to approximate almost any spectral distribution. Two field-of-view angles of 50 and 7 deg are supplied, to enable the photographer to duplicate the viewing angle of the average camera and to read the light value of a small part of the scene. A non-imaging optical system solves the problem of providing a variable field of view and keeping the detector spot size constant.

For additional information on this portable photometer, turn to the Reader's Service Card and circle 38.

Editor's Note: The significant transistor articles covered in this report were delivered at the AIEE Winter General Meeting, 1957. "A New Family of Transistor Switching Circuits" is AIEE Transactions Paper No. 57-105 by Morris Rubinoff, University of Pennsylvania, Philadelphia, Pa. "Transistor NOR Circuit Design" is AIEE Transactions Paper No. 57-196 by William D. Rowe and George H. Royer, Westinghouse Electric Corp., East Pittsburgh, Pa. Both of these are abstracted here by Sol D. Prensky, Fairleigh Dickinson Univ., Teaneck, N. J.

A New Family of Transistor Switching Circuits

A NEW circuit prototype which uses direct-coupled pnp and npn transistors and incorporates "dual-range" circuits (characterized by two pairs of output levels), results in a number of outstanding advantages over previous direct-coupled systems.

The new family of dual-range transistor switching circuits that is introduced in an outgrowth of a family of direct-coupled transistor circuits previously developed at Philco Corp. by the author, and referred to as DCTL circuits. Both the new dual-range system and the older DCTL system use the same number of transistors and both require a smaller number of additional components than is required by conventional vacuum-tube designs. Although the dual range family employs a larger number of components than the previous DCTL system, the new system offers the following important advantages over other transistor switching circuits:

1. Lower stand-by power dissipation, resulting from the fact that the OFF transistors are fully cut off, except for the irreducible I_{co} leakage;

2. Higher switching speed capability, achieved by capacitor shunts across the coupling resistors;

3. The full common-emitter current gain is available to the designer;

4. The base current of every ON transistor is controllable to a narrow tolerance;

5. Sneak paths, such as unwanted base-to-collector currents, cannot occur.

As an example of the simplest dual-range circuit, Fig. 1 shows a basic flip-flop as an anti-symmetrical "both-on or both-off" circuit, using one pnp and one npn transistor.

In the OFF state, each transistor is held OFF by the bias applied to its base through load resistor (R_L) and transfer resistor (R_t). Four values of voltage are applied in the following decreasing order, V_{P+}, V_{N+}, V_{P-}, and V_{N-}. Since any one of these points can, of course, be chosen as system ground, the required voltage can be obtained by three physical supplies. (Three six-volt sources are used in the de-

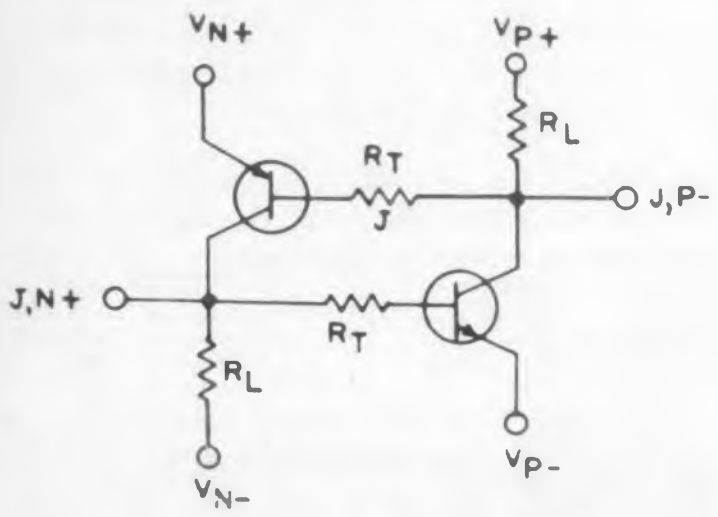

Fig. 1: Basic dual-range flip-flop, with on state 'J', using one pnp and one npn transistor.

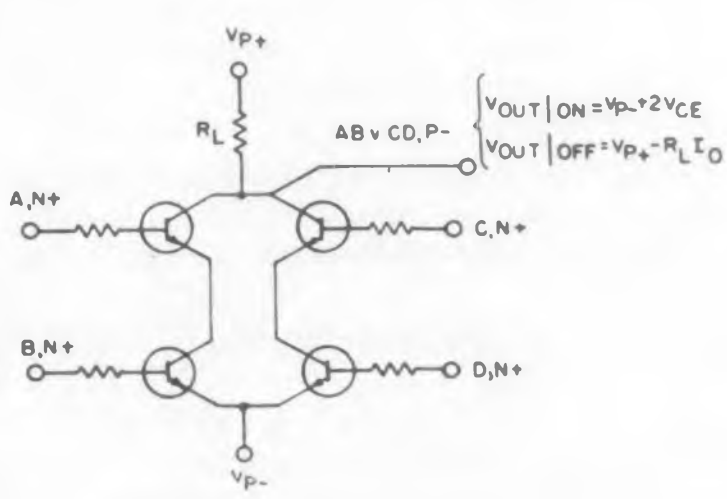

Fig. 2: Basic dual range P-type gate of height 2. (I_o = total leakage current).

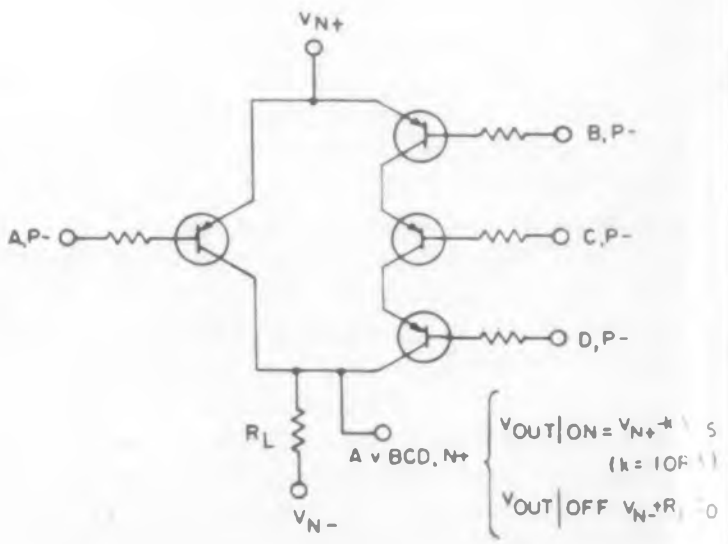

Fig. 3: Basic dual-range N-type gate of mixed height. (I_o = total leakage current).

sign example; and, with N+ chosen as system ground, the four voltages to ground are correspondingly $V_{P+} = +6$ v; $V_{N+} = 0$; $V_{P-} = -6$ v and $V_{N-} = -12$ v.)

The flip-flop arrangement of Fig. 1 is shown in the ON state (J). Two pairs of output voltages are provided; one pair at each collector. For example, the npn collector is labeled (J, P—) to indicate that when the flip-flop is set (J = 1), this collector is at the P— level, i.e. at a voltage slightly more positive than V_{P-}; (the corresponding pnp collector is similarly labeled J, N+).

While the flip-flop is conducting, the base current of each transistor is almost entirely determined by the power-supply voltages and its transfer resistor (R_T), across which almost the entire voltage drop (V_{N-} to V_{P-}) appears. This is true for all dual-range circuits, and results in a closely controlled base drive.

Dual range gates, both of the P-type and N-type, are available to the designer for combinational switching, as illustrated in Fig. 2 (AND-OR function), where a two-high series parallel P-type gate is shown.

Each of the four transistors in Fig. 2 is cut off in the absence of its input signal, i.e., when the signal applied to its base is at the N— level. Since V_{N-} is more negative than V_{P-}, the transistor is completely cut off, except for the small collector leakage I_{co}. Supposing now that A is present (and hence at N+ level), but B is absent (or at N— level), then the base of the A transistor rises only to the N+ level, which is still more negative than V_{P-}, so that unwanted base-to-collector current cannot flow.

More complicated combinational circuits can be obtained by alternately cascading P-type and N-type circuits. For example, the output of Fig. 2 might be connected to one of the inputs of Fig. 3, say input (A, P—). As a result, saturation I_c can be made available, and full advantage can be taken of grounded-emitter current gain.

The switching speed of circuits of Figs. 2 and 3 can be increased by shunting each transfer resistor with a capacitor large enough to generate a transient voltage overshoot at the base during change of state. This is particularly effective in reducing hole (or electron) storage time, by sweeping the holes out of base region through reverse base voltage.

Other schematics in the paper (seven in all), show set, reset and hold circuits, negation and differentiator circuits. A tabulated sample of a typical dual-range design is included, employing a GE 2N43 pnp type and a GE 2N78 npn type transistor as a basis. Design values are given for a five-high, five-wide network, driving five outputs. Among other references, the author points out that the advantage of minimum standby current so important in such systems as telephone offices, is the subject of another paper being prepared by H. E. Tompkins.

Transistor NOR

THE CIRCUIT design of a transistor NOR circuit which produces a single logic element, capable of combining well in logic configurations, with a minimum of concern for matching and element loading, is presented in this article.

An NOR element has a signal output only if there are no input signals, and consequently has no output if any signal input is present. The design of such a single logic element requires a circuit having a considerable amount of flexibility to meet many possible variations, such as those encountered in different input and output loadings, operating temperatures and power supply variations.

A transistor circuit with an arbitrary number of M inputs and loaded with N outputs is shown in Fig. 1. R_1 is the current limiting resistor for each input; V_{cc} is the collector supply voltage and the R_T-V_{BB} combination supplies a bias to reduce the transistor leakage current to a minimum when the transistor is cutoff. The transistor operates in the switching mode, becoming saturated and offering a low conducting impedance when ON, while allowing only a small leakage current to flow when blocking, or OFF. The pnp transistor shown yields negative voltage signals throughout the system. Positive voltage signals can be obtained by the use of an npn transistor; however both pnp and npn types of NOR circuits as shown cannot be readily intermixed.

To enable the designer to choose effective operating parameters and also allow for the use of a particular manufacturer's type of transistor, a testing program is suggested, giving the details of tests for (1) back collector current I_{CBO}; (2) current gain, base-to-collector (dc Beta); (3) forward collector saturation drop (V_{CE}); (4) noise figure (NF), and (5) the base-input characteristics (I_B vs. V_{BE}). Following this, circuit design equations are developed, leading

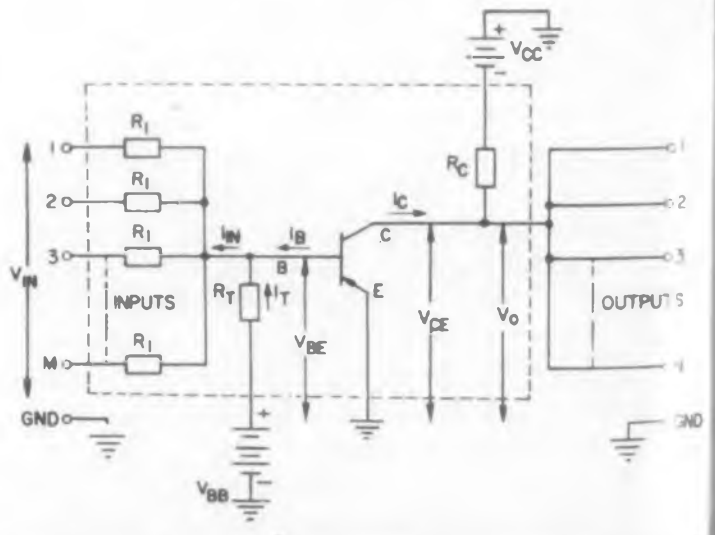

Fig. 1: Transistor NOR circuit with M arbitrary inputs and N outputs.

Circuit Design

to an expression that enables the designer to determine the allowable number of outputs (N) for a given number of M inputs, without sacrificing reliability of operation.

The equation for this number of outputs N is plotted against design collector current (I_C maximum), to give the graph of Fig. 2. After the first group of detailed calculations are carried out, the following typical values are obtained:

$$I_T = 0.11 \text{ ma}, R_T = 180 \text{ K}$$
$$V_{CC} = -20 \text{ v and } V_{BB} = +20 \text{ v}$$

Then, choosing M = 9 as an acceptable number of inputs, and employing a safety-factor S = 2 for minimum base current, use is made of the family of curves in Fig. 2, which show N vs. I_C for M = 9 and R_1, as a parameter. As high a value of N is selected, consistent with keeping collector and base dissipation low. Since any value of N above 7 seems to show only moderate increase in N for substantial increase in I_C, this number of outputs is selected, showing a value of I_C of 5 ma. to be sufficient. Here R_1 = 15K gives N = 7.6 and there is a broad enough maximum on the R_1 = 15K curve to allow operation at N = 7 between I_C values of 4.2 to 10.6 ma. At the 5 ma. figure R_C becomes 20 v/5 ma. or 4K (or 3900 ohms).

Equations are next given for power dissipation and cross-talk loading calculations. The detailed example of the calculations given in appendix 1 of the paper shows how the design criteria are applied to determine an optimum NOR circuit for an RCA 2N109 transistor used as an example. As designed, the circuit operates well up to 25 to 40 kc. The authors conclude with data showing that the design has been applied to a sufficiently large sample (1500 NOR elements) to show its reliable operation in actual service.

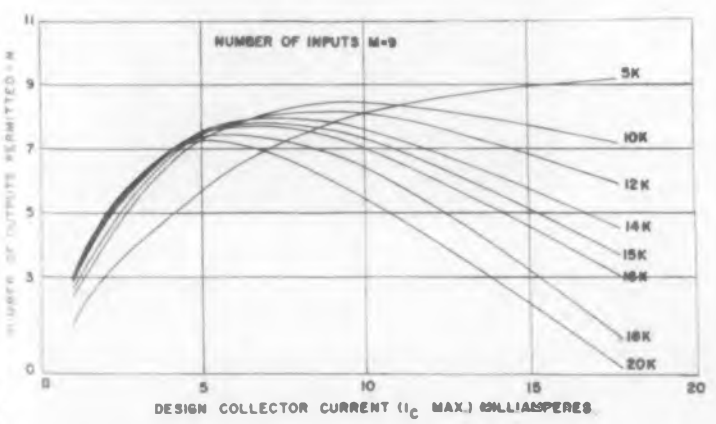

Fig. 2: Graph of number of outputs N vs. collector current for 2N109 sample transistor.

New Products

Sub-Miniature Dry Cell

95 Volt

Designed for high voltage-to-volume requirements and long storage or standby service, this cylindrical, axial-leaded 95 v battery is 31/32 in. long, .335 in. in diam and weighs .15 oz. It has a projected shelf life of 20 years. The battery is designed to withstand temperatures from −100 to +165 F during storage or operation. When properly mounted, it can withstand extreme shock and vibration.

Available charge of this battery is 1 coulomb, the flash current is 8 μa, and the voltage-temperature coefficient is 0.08 v per deg F.

Specialty Electronic Components, General Electric Co., Dept. ED, W. Genesee St., Auburn, N.Y.

CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

Delay Line

300 Microseconds

With a total delay of 300 ±1 per cent μsec, taps available at every one μsec or any multiple thereof, the type 4D92 delay line has a maximum attenuation of 4 db and a delay-to-rise time ratio of 75 to 1 over its entire length. Maximum rise time is 4.0 μsec. Impedance is given as 1000 ±5 per cent ohms.

The 4D92 unit is packaged in an open-type housing measuring 16-5/8 x 2-11/32 x 2-15/16 in.

Underwood Corp., Electronic Computer Div., Dept. ED, 35-10 36th Ave., Long Island City 6, N.Y.

CIRCLE 44 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse System

Magnetron Driver

This encapsulated pulse system containing a resonant charging choke, pulse forming network, and pulse transformer in a package 2 x 2 x 2 in. is designed to drive a special magnetron.

The unit withstands extremes of mechanical shock and vibration as well as thermal shock and is suitable for high altitude use in a radar transmitter.

AMP Inc., Chemical & Dielectric Div., Dept. ED, Harrisburg, Pa.

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Improved Noise Blanker

Reduces Precipitation Static

This noise blanker uses basic techniques developed by the Communications and Navigation Laboratory, Wright Air Development Center and incorporates them in a commercial instrument. The Model 10018 reduces or eliminates "P-static," resulting from electrostatic discharges against snow, rain, ice or dust particles. These discharges shock-excite the "Hi-Q" input circuits of a receiver with very high amplitude, short duration pulses; and in severe cases produce a "St. Elmo's Fire" corona discharge on the antenna leadin.

Hoover Electronics Co., Dept. ED, 3640 Woodland Ave., Baltimore 15, Md.

CIRCLE 46 ON READER-SERVICE CARD FOR MORE INFORMATION

Pressure-Sensitive Switches

Meet MIL-E-5272A

Whenever the difference between two pressures is equal to or greater than a predetermined value a differential pressure switch recently developed can open or close electrical circuits. Designated Model 501-A, its low and high operating pressures are 250 psig and 500 psig respectively. A diaphragm-type capsule senses the pressure difference and operates the switch. This capsule is built to withstand high overpressure without sacrifice of sensitivity.

Companion units in this new line of switches include an altitude switch, Model 101-A, and a gage pressure switch, Model 301-A.

Gulton Industries, Inc., Dept ED, Metuchen, N. J.

CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Resistors

Wire-Wound

These resistors are available with characteristics G, V, or Y and in three basic mounting types: stack mounting, tab terminal, and axial lead. Maximum dissipation ratings range from 2.5 to 21 w. The resistors conform to MIL-R-26C.

Ward Leonard Elec. Co., Dept. ED, 115 Mac-Questen Pwy. So., Mt. Vernon, N.Y.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

Band Pass Network

Good Adjacent Rejection

The series 2090 Unifilter is a band pass interstage network with good frequency attenuation characteristics and low insertion loss. Units are available with band widths ranging from 6 kc to 35 kc at a center frequency of 455 kc. Typical adjacent channel rejection is 85 db at plus or minus 40 kc. The Unifilter series includes types suitable for use in triode or penthode mixer plate circuits. High stage gain is achieved through the combination of low pass-band transmission loss and high input and output impedance. Field tests indicate no observable ringing is introduced by the incorporation of the network in standard receivers. Other available center frequencies range from 50 kc to 40 mc.

Ortho Filter Corp. Dept. ED, 196 Albion Ave., Paterson 2, N.J.

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

Sub-Miniature Relay

Hermetically Sealed

Weighing 3/4 oz and the size of a three cent stamp, this relay is designed with a hermetically sealed coil assembly, which is independent of contact assembly.

It has double pole double throw bifurcated break-before-make, or make-before-break contacts, with a contact rating of 3 ohms resistance at 115 v ac or 28 v dc and a coil resistance to 10,000 ohms. It is vibration rated at 20g at 5 to 2,000 cps, shock at 50g. It has a minimum life of 500,000 operations. The entire relay is hermetically sealed, and standard units are temperature rated to 125 C.

Ace Relay Assoc., Dept. ED, 103 Dover St., Somerville, Mass.

CIRCLE 50 ON READER-SERVICE CARD FOR MORE INFORMATION

Photo-Multiplier Power Supply

For 14-Stage Tubes

The high current capability of this power supply unit, Model 405, permits simultaneous operation of several multiplier tubes. Its output is from 600 to 3110 v dc, at currents from 0 to 15 ma. Regulation for a line voltage change of 20 per cent is 0.01 per cent maximum; for a load change of 10 ma regulation is 0.005 per cent. Ripple is less than 5 mv rms at any output voltage. Resolution is 10 mv at any output voltage, and calibration accuracy 0.5 per cent. Connectors are available both at front panel and rear skirt. Output polarity can be reversed by a front panel switch. A 1.02-v sample of the output is available at the front panel for potentiometric monitoring. The unit is adaptable to standard 19-in. rack mounting.

John Fluke Mfg. Co., Inc., Dept. ED, 1111 W. Nickerson St., Seattle, Wash.

CIRCLE 54 ON READER-SERVICE CARD FOR MORE INFORMATION

Noise Meter Accessories

Switching Unit and Antenna

In operation, the switching unit is connected between the pickup device and the NF-105 meter input. A built-in coaxial switch effects a changeover from antenna signal to calibrating signal. The switching unit is designed to function efficiently over a range of 150 kc to 1000 mc. Low VSWR and high crosstalk ratio are maintained over this range.

The antenna consists of three separate assemblies, whose ranges correspond to three tuning ranges of the NF-105. One unit is provided for 20 to 200 mc, one for 200 to 400 mc, and one for 400 to 1000 mc. In each case the broad band balun matches, without power loss, the balanced voltage of the dipole to the unbalanced input of the noise and field intensity meter. A clamping block mounting affords simple and rapid orientation of the antenna.

Empire Devices Products Corp., Dept. ED, 38-15 Bell Blvd., Bayside, N.Y.

CIRCLE 55 ON READER-SERVICE CARD FOR MORE INFORMATION

Using Thermistors

Edited by
FENWAL ELECTRONICS

Thermistors, with their almost incredible sensitivity to temperature change, now get a news column all their own.

The cases in point for the first column: temperature measurement and temperature control.

Three basic circuits for temperature measurement with thermistors:

FIG. 1

FIG. 2

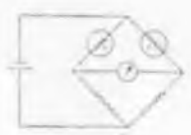


FIG. 3

The first is a battery, a thermistor, and a micro-ammeter. The second, more sensitive, has a thermistor as one leg of a bridge circuit. The third incorporates two thermistors in a bridge, making possible even more precise temperature differential measurements.

Two basic circuits for temperature control with thermistors:

FIG. 4

FIG. 5

The first has a thermistor in series with a relay, a battery, and a variable resistor. By adjusting the resistor, it is possible to make the relay operate at any desired temperature of the thermistor.

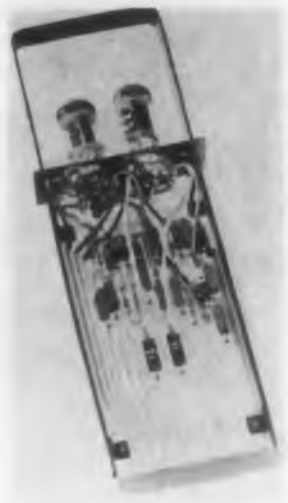
The second is more sensitive, and has a thermistor as one leg of a bridge circuit, a variable resistor in another leg, and a polarized relay across the output. Even more sensitive control can be had by applying AC to the bridge and placing a high-gain amplifier between the bridge and the relay.

Designers: if you are not already familiar with the tremendous possibilities of thermistors, write for details to FENWAL ELECTRONICS, INC., 33 Mellen St., Framingham, Massachusetts.

Fenwal Electronics

Makers of Precision Thermistors

CIRCLE 57 ON READER-SERVICE CARD



Computer Plug-In Units

Complete in Itself

A line of computer circuits is available in a new series of plug-in units, including flip-flops, shift register elements, d-c Not circuits, delay units, pulse mixer amplifiers, quadruple cathode followers, one-digit adders and subtractors (matrices), one shots, neon drivers, and diode logic units incorporating And and Or circuits. Each of these plug-ins is complete in itself. Mounting frames, each accommodating 15 plug-ins (30 tubes) can be stacked as desired.

Tube dissipation has been derated 75 per cent and cathode current derated 50 per cent. Each unit is constructed with a heat barrier between tubes and the other components. They embody gold-plated etched circuits on epoxyglass. An in-circuit test fixture is available to make plug-ins accessible while in operation for testing or other purposes.

Dimensions of the mounting frames are 3-1/2 in. x 19 in. so that the frames are adaptable to standard 19-in. rack mounting.

Engineered Electronics Co., Dept. ED, 506 East First St., Santa Ana, Calif.

CIRCLE 58 ON READER-SERVICE CARD FOR MORE INFORMATION

Gold Bonded Germanium Diode

Has High Conductance

The DR385 gold bonded germanium diode has a high forward conductance, and at 10 ma the voltage drop is controlled between .34 and .37 v. It is offered in a hermetically sealed, glass encased subminiature package.

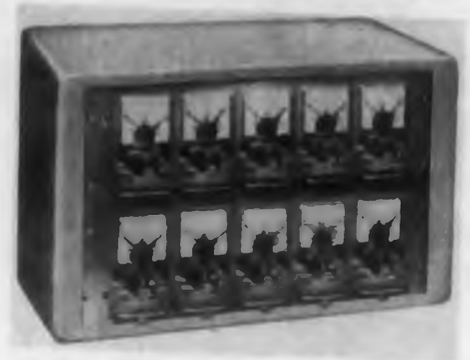
The reverse characteristics of the DR385 at 10 v is one megohm, with a peak inverse voltage of 60 v. It exhibits fast transient response. Similar diodes can be offered fully tested to individual recovery conditions.

Radio Receptor Co., Inc., Germanium & Silicon Products Div., Dept. ED, 240 Wythe Ave., Brooklyn 11, N.Y.

CIRCLE 59 ON READER-SERVICE CARD FOR MORE INFORMATION

Remote Area Monitor

Meets AEC Requirements



This multi-channel monitor and sensing unit installation affords a means of keeping continuous check on radiation levels. The system comprises five elements: basic control unit, plug-in stations, remote sensing unit, calibration source and beta window with discriminator.

Ranges are any three adjacent decades from 0.01 to 1,000,000 mr/hr as standard. Changes as small as 0.002 mr/hr can be detected. Gamma energy response is independent within ±10 per cent from 80 kev to 1.3 mev. Accuracy, when the built-in calibration check source is used, is better than 5 per cent of dose rate; and ±15 per cent of the radiation at all points within range of the detector. Line voltage fluctuations between 100 and 130 v cause less than 5 per cent change in accuracy.

Power required is 115 v, 60 cps. The control unit with 10 plug-in stations measures 19 x 12-1/4 x 12-1/4 in.; the sensing element measures 3-1/4 x 6-1/8 x 6 in.

Victoreen Instruments Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

Remote-Point Indicator

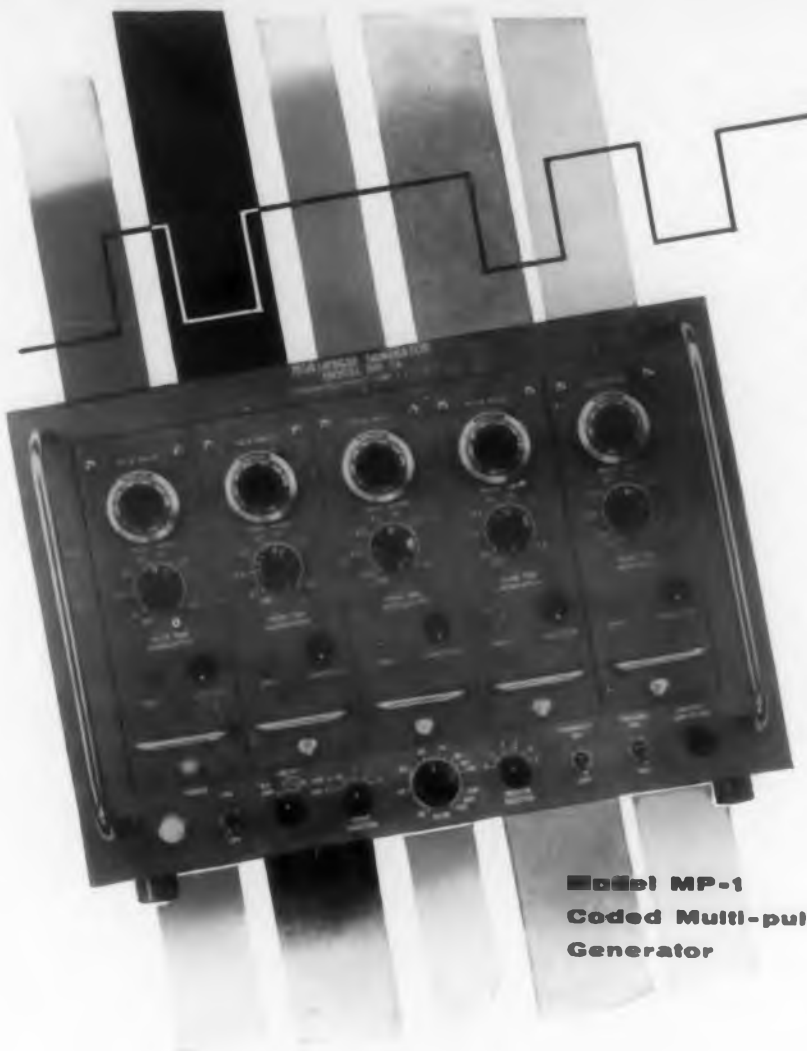
Scans Up To 48 Instruments

A drum-type remote-point indicator that can report at a central station the readings of as many as 48 thermometers, pyrometers or other instruments, is now available. It has a revolving drum-scale with a calibrated length of over 26 in. Full-scale travel takes place in 4-1/2 sec. Remote locations are selected by means of numbered pushbutton switches on the front of the case. Offered primarily for use with its own manufacturer's resistance thermometers and pyrometers, it can be supplied for measurement of other remote variables.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 66 ON READER-SERVICE CARD



Model MP-1
Coded Multi-pulse
Generator

5 PULSE CODED MULTI-PULSE GENERATOR

Generates 5 separate pulses each with independently variable width and delay for missiles, beacons, and other systems

A self-contained unit. Provides any code—one to five pulses—with completely independent adjustment for each pulse.

Any or all pulses can be time modulated. And, the Model MP-1 can be used to synchronize other equipment because of its trigger output.

The instrument is provided with internal calibration circuits — 1 microsecond markers to check code settings.

In addition, it supplies a square wave pulse, at a separate output jack, operating at 40 to 4,000 pps. This is extremely useful for modulation and general testing.

Write to Polarad for a detailed data sheet on the Model MP-1.

FEATURES:

- **Provision for external pulse time modulation.**
- **Trigger selection at any of the code pulses.**
- **High level, low impedance output.**
- **Short rise and fall time of pulses.**
- **Square wave output.**
- **Internal calibration time marker.**
- **Accurately calibrated delay dial.**

SPECIFICATIONS:

Internal Pulse Characteristics:
No. of Channels 1 to 5 independently on or off
Repetition Rate ..... 40 to 4,000 pps
Pulse Width ..... 0.2 to 2.0 microseconds
Pulse Delay ..... 0 to 30 microseconds
2 to 300 microseconds
Minimum Pulse Separation 0.1 microsecond
Initial Channel Delay 2 microseconds from sync. pulse

Output Pulse Characteristics:
Rise Time ..... 0.1 microsecond
Delay Time ..... 0.1 microsecond
Overshoot ..... less than 10%
Amplitude .... 20 v. minimum into 100 ohms

Trigger Pulse Output:
(a) At zero time or simultaneous with any one of the output pulses.
(b) 10 volts positive and negative into 75-ohms.

External Sync Pulse:
Positive or negative pulse or sine wave

Pulse Time Modulation:
Frequency .... 40-400 cps any or all channels
Required Ext. Mod. ..... 1 volt rms min.
Maximum deviation ..... ±0.5 microsecond

Reliable maintenance service throughout the country is an important part of the Polarad instrument.

For private demonstration without obligation ask for the

to stop at your plant

POLARAD ELECTRONICS CORPORATION
PROVEN RELIABILITY
43-20 34th Street • Long Island City 1, New York

REPRESENTATIVES: Albany, Albuquerque, Atlanta, Baltimore, Boston, Chicago, Cleveland, Dayton, Denver, Englewood, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, Rochester, St. Louis, San Francisco, Schenectady, Stamford, Syracuse, Washington, D. C., Winston-Salem, Canada: Arnprior, Ontario.
Resident Representatives in Principal Foreign Cities

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

Remote Area Monitor
Meets AEC Requirements

This multi-channel monitor and sensing unit installation affords a means of keeping continuous check on radiation levels. The system comprises five elements: basic control unit, plug-in stations, remote sensing unit, calibration source and beta window with discriminator.

Ranges are any three adjacent decades from 0.01 to 1,000,000 mr/hr as standard. Changes as small as 0.002 mr/hr can be detected. Gamma energy response is independent within ±10 per cent from 80 kev to 1.3 mev. Accuracy, when the built-in calibration check source is used, is better than 5 per cent of dose rate; and ±15 per cent of the radiation at all points within range of the detector. Line voltage fluctuations between 100 and 130 v cause less than 5 per cent change in accuracy.

Power required is 115 v, 60 cps. The control unit with 10 plug-in stations measures 19 x 12-1/4 x 12-1/4 in.; the sensing element measures 3-1/4 x 6-1/8 x 6 in.

Victoreen Instruments Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

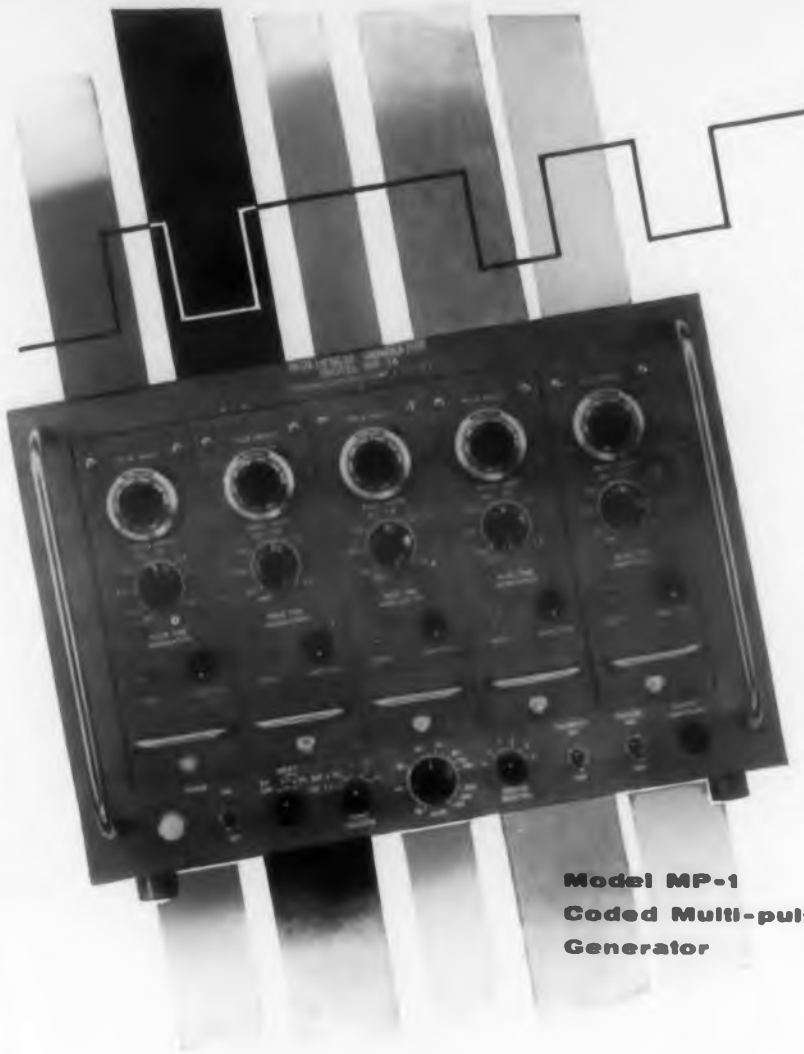
Remote-Point Indicator
Scans Up To 48 Instruments

A drum-type remote-point indicator that can report at a central station the readings of as many as 48 thermometers, pyrometers or other instruments, is now available. It has a revolving drum-scale with a calibrated length of over 26 in. Full-scale travel takes place in 4-1/2 sec. Remote locations are selected by means of numbered pushbutton switches on the front of the case. Offered primarily for use with its own manufacturer's resistance thermometers and pyrometers, it can be supplied for measurement of other remote variables.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 66 ON READER-SERVICE CARD FOR MORE INFORMATION



Model MP-1
Coded Multi-pulse
Generator

5 PULSE CODED MULTI-PULSE GENERATOR

Generates 5 separate pulses each with independently variable width and delay for missiles, beacons, and other systems

A self-contained unit. Provides any code—one to five pulses—with completely independent adjustment for each pulse.

Any or all pulses can be time modulated. And, the Model MP-1 can be used to synchronize other equipment because of its trigger output.

The instrument is provided with internal calibration circuits — 1 microsecond markers to check code settings.

In addition, it supplies a square wave pulse, at a separate output jack, operating at 40 to 4,000 pps. This is extremely useful for modulation and general testing.

Write to Polarad for a detailed data sheet on the Model MP-1.

FEATURES:

- **Provision for external pulse time modulation.**
- **Trigger selection at any of the code pulses.**
- **High level, low impedance output.**
- **Short rise and fall time of pulses.**
- **Square wave output.**
- **Internal calibration time marker.**
- **Accurately calibrated delay dial.**

SPECIFICATIONS:

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2 to 300 microseconds
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Initial Channel Delay
2 microseconds from sync. pulse

Output Pulse Characteristics:
Rise Time .....0.1 microsecond
Delay Time .....0.1 microsecond
Overshoot .....less than 10%
Amplitude....20 v. minimum into 100 ohms

Trigger Pulse Output:
(a) At zero time or simultaneous with any one of the output pulses.
(b) 10 volts positive and negative into 75-ohms.

External Sync Pulse:
Positive or negative pulse or sine wave

Pulse Time Modulation:
Frequency....40-400 cps any or all channels
Required Ext. Mod......1 volt rms min.
Maximum deviation .....±0.5 microsecond

Reliable maintenance service throughout the country is an important part of the Polarad instrument.

For private demonstration without obligation ask for the

to stop at your plant

POLARAD ELECTRONICS CORPORATION
PROVEN RELIABILITY
43-20 34th Street • Long Island City 1, New York

REPRESENTATIVES: Albany, Albuquerque, Atlanta, Baltimore, Boston, Chicago, Cleveland, Dayton, Denver, Englewood, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, Rochester, St. Louis, San Francisco, Schenectady, Stamford, Syracuse, Washington, D. C., Winston-Salem, Canada: Arnprior, Ontario.
Resident Representatives in Principal Foreign Cities

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

General Electric announces

GENERAL ELECTRIC VITREOUS-ENAMELED RESISTORS are available in both fixed and adjustable types. Most requirements can be met with immediate shipment from stock. Additional units with a wide variety of mounting arrangements are available for special applications.

GENERAL ELECTRIC

a new line of...

vitreous enameled resistors

General Electric presents a new line of enameled resistors designed for dependable, long-lasting service. These new resistors—rated from 5 to 218 watts—are ideal for both industrial and electronic applications.

RELIABLE PERFORMANCE THROUGH PRECISION MANUFACTURING

Maximum equipment-performance and long resistor life are assured with G.E.'s new line of resistors because:

- Low-temperature-coefficient wire means stable operation.
- Elimination of "hot-spots" reduces resistor burnouts.
- Special enamel coating is moisture and acid resistant.
- Wire junctions are silver brazed for positive connection.

NEW CATALOG SIMPLIFIES SELECTION AND ORDERING

To aid you in selecting the right resistors for your specific applications, General Electric's new easy-to-use resistor catalog puts complete information on performance, ratings, dimensions, mounting arrangements, and ordering instructions right at your fingertips.

For complete information on General Electric's new enameled resistors, contact your nearest General Electric Apparatus Sales Office. For your copy of the new G-E resistor catalog, GEA-6592, write Section 784-5, General Electric Company, Schenectady, N.Y.

Industry Control Department, Roanoke, Virginia

Progress Is Our Most Important Product

GENERAL ELECTRIC

NOW! CONTROLLABLE PERSISTENCE FOR TV AND RADAR

TONOTRON

Direct-display, cathode-ray storage tube by Hughes with magnetic deflection and electrostatic focusing

FOR NARROW BAND, SLOW SCAN CLOSED CIRCUIT TV

Controllable long persistence makes the Tonotron ideally suited for picture transmission over conventional radio channels or telephone lines. Coaxial cables or microwave transmitters and receivers are unnecessary. Pictures up to 80 lines per inch resolution cover the full half-tone scale with controllable persistence—instantaneous or gradual erasure. Light output of 1000 foot-lamberts at 10 kv assures extremely high brightness at the viewing screen for use in high ambient-light levels.

DIMENSIONS
Over-all length: 11 1/2" nominal
Bulb diameter: 5 1/4" ± 1/8"
Neck diameter: 1" ± 1/16"

FOR RADAR PPI DISPLAY

Because of the Tonotron's compact size, it can be used in many existing radar indicator housings. Brightness of 1000 foot-lamberts at 10 kv makes a viewing hood unnecessary, even in full daylight. Persistence can be adjusted to retain nearly maximum brightness throughout the major portion of a 360° sweep. Ability to cover the complete grey spectrum provides maximum contrast for easy identification of cloud formations, mountains, harbors and waterways, airports, ground clutter and targets.

ELECTRON TUBES

For additional information, write to HUGHES PRODUCTS • ELECTRON TUBES
International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

CIRCLE 220 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetically Locked Switch

Resists Shock and Error

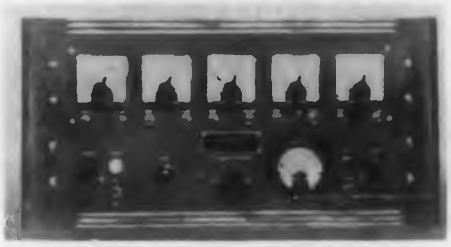
After this electromagnetic switch has been operated it cannot be released inadvertently or through error. With the electromagnet unenergized, the lever is locked in the down (off) position, and the switch cannot be operated at all. When the magnet is energized the lever may be moved manually to the on (up) position, and there it stays. When the magnet is de-energized, the switch returns to off position by spring action, and cannot be moved again until the magnet has again been energized. Switch contact pressures are high. Aluminum parts are black-anodized; ferrous parts cadmium plated with chromate exterior finish, and hinge pins and rollers stainless steel. Standard operating voltage is 24 v, but units can be supplied to order for any dc voltage up to 130 v. The switch meets military requirements. Weight is 2-3/4 oz; dimensions are 2-5/8 in. long, 2 in. high and 1-3/16 in. wide.

Jaidinger Mfg. Co., Dept. ED, 1921 W. Hubbard Street, Chicago 22, Ill.

CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION

Radiation Monitor

For Personnel Safety



This basic unit, designated UAC 450, is a five-channel master console type remote monitor, can be used to monitor alpha, beta, gamma or neutron radiation at distances up to several thousand feet and in five different locations. Each channel is independent of the others. Each embodies a contact-type meter-relay which can be connected to any form of desired alarm circuit and needs no watching. Each meter has an average full-scale range of 2000 counts per minute but can be screwdriver adjusted to any range between 1500 and 2500 cpm. Power needed is 115 v, 60 cps ac. Internal regulation is 0.05 per cent. Units measure 19 x 8-1/2 x 14 in. Each unit weighs about 40 lb.

Universal Atomics Corp., Dept. ED, 50 Bond St., Westbury, L. I., N.Y.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

military test equipment

TS-505 B/U
MULTIMETER

AC volts 0-150
DC volts 0-1000
DC res. 0-1000 megs
RF up to 500 mc

AN/USM-26
FREQUENCY COUNTER
10 cps to 220 mc

AN/UPM-33
SPECTRUM ANALYZER
8470 to 9630 mc

northeastern engineering

Manchester New Hampshire

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Synchronous Closing Switch

To Measure Inrush Currents

This switch will close a circuit at any selected point on the ac voltage wave. It is used with a measuring device such as an oscillograph to close a circuit at a point on the wave where maximum inrush current will occur. A lockable dial graduated for 360 deg permits setting the closing instant at any angle in either the positive or negative voltage half cycle. Either three phase or single phase input may be specified. The internal electronically controlled power circuit closing contactor can close currents up to 5000 amp.

In operation the circuit opening contactor is first closed by means of a pushbutton on the panel. A second pushbutton triggers the synchronous closing contactor which establishes the power circuit at the angle selected irrespective of when the button is pushed.

The switch has a regulated power supply, built-in time relays to assure tube warm up, and automatic circuit opening. Pilot lights indicate clearly the position of both opening and closing contactors. Precision electronic timers are available to make the equipment recycle automatically to aid in life testing of components.

Rowan Controller Co., Dept. ED, 2313 Homewood Ave., Baltimore 18, Md.

CIRCLE 74 ON READER-SERVICE CARD FOR MORE INFORMATION

Nylon Extension Shafts

Made to Specification

Nylon extension shafts are made to specification in various diameters, wall thicknesses, lengths and ends. One end is flattened for better grip, and the other may be supplied with or without threaded inside diameter. No molds are needed. The shafts are flexible, with little backlash, heat-resistant up to 350 F, and with good insulating properties. They are useful for adjusting ferrite cores in tuning coils and for setting other variable controls.

Anchor Plastics Co., Inc., Dept. ED, 36-36 Thirty-sixth St., Long Island City 4, N. Y.

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

Halogen Geiger Tubes

High Efficiency

These halogen quenched, all-glass geiger tubes have infinite life and 20 per cent higher gas counting efficiency than any other halogen counters. Neither light nor extreme temperatures affect the characteristics of these non-photosensitive tubes. The tubes come in six basic models: civil defense counter; thin wall for survey meters; thin wall jacketed; general purpose thin wall; long thin wall, and mica window counter.

Radiation Counter Labs. Inc., Dept. ED, Nucleonic Park, Skokie, Ill.

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

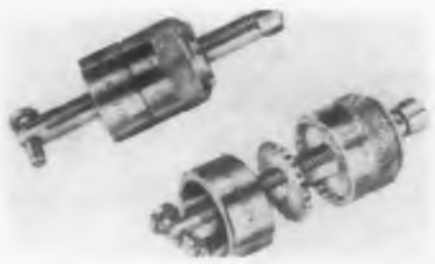
Miniature Relay

Snap Action Contacts

Designated Class 22SA, this relay can be furnished with one snap action switch for spdt contacts or with two switches for dpdt use. Contract rating is 10 amps at 115 v ac, non-inductive. It can also be supplied for 440 v 60 cps ac and for 230 v dc. It is available with plug-in mounting. Approximate dimensions are 2-3/8 in. long, 1-7/8 in. high and 1-1/16 in. wide.

Magnecraft Elec. Co., Dept. ED, 3350 W. Grand Ave., Chicago 51, Ill.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION



Hold-Down Clamp

Self-Locking

The hold-down clamp is designed with a spring loaded rotating member which contains an internal spline that locks with a floating spline on the shaft. The installation of this new clamp is the same as the conventional type. The clamp is placed in position and the rotating member tightened, which automatically locks it to the shaft through the floating spline.

To release the clamp, the rotating member is pulled back against the spring and rotated until it is disengaged from the locking spline. It may then be turned freely to clear the clamp for removal.

Whitney Blake Co., Electronic Div., Dept. ED, New Haven 14, Conn.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Sweep Frequency Generator

For Production Testing

This signal generator provides instantaneous and continuous amplitude-versus-frequency displays of high accuracy when used with a large screen oscilloscope.

The Model 200K has an output frequency range from 20 cps to 200 kc and a frequency deviation range from 0 cps to 200 kc; sweep linearity is +2 per cent for full deviation. Variable marker circuit places a marker pulse on the oscilloscope display at any frequency within the range of the instrument. Marker width can be adjusted to less than .1 per cent of the frequency being measured. The pip can also be set within 1 per cent of the desired position on a laboratory type oscilloscope display, and within .1 per cent by use of a frequency counter. Marker width can be adjusted to less than .1 per under test and are unaffected by deviation rate. Additional marker circuits are available in a separate package to provide a number of frequency calibration points. The Model 200K may also be used as an FM signal generator capable of 100 per cent FM up to a carrier frequency of 100 kc.

Federal Telegraph Corp., Instrument Div., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

Torque Motors

For Servos

A series of three torque motors designed for aircraft and missile servosystems, these units operate under adverse temperatures and vibration conditions without zero shift because they are brazed and welded together. The Model 28 produces a force of 13-1/2 lb, with a ±0.015 in. stroke. Model 24, a medium-sized motor, has a force output of 8 lb and a ±0.008 in. stroke, and the Model 23, produces 5 lb of force with a ±0.007 in. stroke.

Raymond Atchley, Inc., Dept. ED, 2340 Sawtelle Blvd., Los Angeles 64, Calif.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

Machine Tool Relays

10-15 Amp, 600 V AC

Four new relays, specifically intended for machine tool control, have been put on the market. Built to serve one purpose only, they embody specific features that fit them for their work. They can be supplied with either 2, 3, 4, 6 or 8 poles, as desired. Magnet and coil are accessible, magnet pole faces can be exposed, there are no loose springs or other loose parts. The relays are friction-free and dust-resistant and have positive, fail-safe action; the design assures alignment of contact prongs; all current-carrying parts are silver-plated.

The four relays are size 00 10 a, 600 v ac, fixed multiple pole and interchangeable multiple pole; and size 0 (15 a, 600 v, ac), also in FP and IMP types. The IMP units are readily changed from normally-open to normally-closed contacts.

Arrow-Hart Hegeman Electric Co., Dept. ED, 103 Hawthorn Street, Hartford 6, Conn.

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

Chilling Machine

For Insulation Stability Testing

The unit, Model U-70-6 includes an air circulator in the door, observation window and lights, and fittings for holding a manually rotated mandrel shaft which supports weighted lengths of wire. The chilling unit has temperature adjustment from —10 to —80 F, and a thermal capacity of 200 BTU/hr at —70 F operating under normal ambient conditions. Constructed of 14 gauge galvanized steel, the chamber area is 12 x 12 x 72 in. It is insulated by four inches of Santocel "A". The unit operates on 230 v, 60 cycles, single phase.

Cincinnati Sub-Zero Products, Dept. ED, Reading Rd., at Paddock, Cincinnati 29, Ohio.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

1 in 3

Panel Chanel® does any wiring job with one-third the work

PANEL CHANEL is the new way to wire panels. It eliminates costly, time-consuming bundling and lacing methods . . . actually makes any wiring job easier. It has helped boost production and simplify user maintenance for many leading electrical and electronic equipment manufacturers. PANEL CHANEL requires no special tools or hardware. Made of a strong, lightweight material, it will not warp under high temperatures normally encountered in control panel service. PANEL CHANEL is available in a wide variety of standard sizes and styles . . . can be produced in special designs to reduce work on your wiring jobs.

HOW-TO-DO-IT Booklet . . . gives full details on this new wiring method. It is profusely illustrated, graphic and complete. Send for your copy of Bulletin S-301.

Panel Chanel®

STAHLIN BROTHERS, Inc., 103 Maple Street, Belding, Michigan

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Sockets

High Power, High Frequency

This tube socket is designed for use with tubes such as the 3X2500-A and F3 and the 3X-3000A1 and F1, and similar tubes with an anode of 4-1/8 in. OD. It incorporates a ring-type design which provides 100 per cent contact all around the anode. It can be supplied to accommodate a one, two, or three tube design. The socket has a ring clamp for mounting a silicone rubber air duct to the tube. This duct is used to direct the flow of air from a blower onto the tube for cooling purposes.

Radio Frequency Co., Dept. ED, 44-46 Park St., Medfield, Mass.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

Liquid Metal Level Indicator

Without Internal Probe

With the probe external to the container, a new liquid metal level indicator, operating electronically, is sensitive to changes in level as small as 1 mm. Measurement is made through the wall of the container. The electronic principle is that of a balanced inductance bridge, and an oscillating signal that can be shifted in frequency to adapt it to the thickness of the container wall. The external probe, made of heat-resistant material, can be shaped as needed. At present the indicator can be used only with containers having non-magnetic walls but future modifications will permit its use with magnetic containers.

Nuclear Development Corp., Dept. ED, 5 New Street, White Plains, N. Y.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

DUAL PURPOSE

TRANSISTORIZED ELECTROMETER

combined preamplifier and dc vtvm has 10^{14} ohms input, 1 mv sensitivity

HIGH input impedance is only part of the story with the new Keithley Model 220. As a sensitive dc vtvm, it's especially convenient when measuring voltages of transistors, dc amplifiers and computers, as well as many electrochemical and biological tests. In its alternate role as a dc preamplifier, the 220 has gains of 0.05 to 167 with suitable outputs. Uses include recording the variations in piezo-electric and pH voltages; currents in photocells, vacuum tube grids and ion chambers; and other long-term monitoring functions.

LINE-OPERATED, the 220 has 8 voltage ranges from 30 millivolts to 100 volts full scale. With added accessories, the instrument measures voltages from 1 mv to 20 kv, currents from 10^{-3} to 5×10^{-14} ampere, resistances from 10^{4} to 10^{16} ohms.

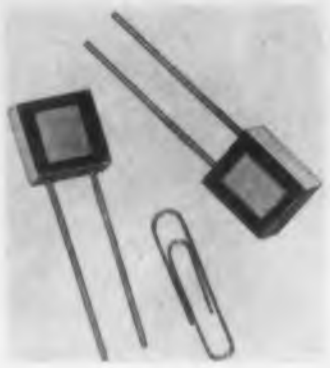
USEFUL FEATURES include a 5-volt unbalanced output for amplifiers and oscilloscopes, and a one-milliampere output for sensitive recorders; a polarity reversing switch; and zero drift below 3 mv/hr.

DETAILS about the Model 220 are given in Keithley Engineering Notes, Vol. 5 No. 2. A request on your company letterhead will bring a copy promptly.

KEITHLEY INSTRUMENTS, INC.

12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 95 ON READER-SERVICE CARD



Photocell

Power Control

Continuous power dissipation of 1/2 w, with short interval higher peaks is said to be practical for this photocell. Voltage rating is 120 v ac or dc. Total encapsulation in resin makes it moisture-proof and shockresistant. Photosensitivity is substantially independent of temperature from 0 to 175 F, and decreases slightly as it approaches 212 F. At these levels, operation is stable, dependable and repeatable. The Powermaster operates as a non-polar variable resistor, and the lowest sensitivity unit will pass 10 ma at 22.5 v at 50 ft candles. Higher sensitivities are available. Dark resistance is over 1 megohm. Maximum sensitivity is to blue-green light at 5100 A, although cadmium sulfide as used here gives a useful response to violet and red-orange light. It measures 5/8 x 9/16 x 1/4 in. and is equipped with 1-1/2 in. leads.

Hupp Electronics Co., Dept. ED, 743 Circle Ave., Forest Park, Ill.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Audio Filter Kit

High Q Toroids

Announced is the new Filtorpac, an audio filter designers kit. This kit offers the used detailed filter data and know-how as well as a set of 18 high "Q" torodial inductors which can be quickly assembled into all combinations of high, low, and band pass or rejection filters. Filtorpac consists of complete design information and measurement technique suggestions, including graphs, formulas, and typical examples as well as the set of multivalued toroidally wound permalloy dust core inductors. The inductors are plastic encased for ruggedness and provided with single screw mounting and turret terminals for maximum convenience in rapid assembly and disassembly of test setups.

Torocoil Co., Dept. ED, 2615 Bristol Rd., Columbus 21, Ohio.

CIRCLE 98 ON READER-SERVICE CARD FOR MORE INFORMATION

Pressure Measuring System

Plug-In Unit for Scope

This plug-in unit developed for the 530-540 Series Tektronix oscilloscopes has vernier tuning, precision attenuation and vertical positioning controls. A separate low impedance output connection is provided to operate auxiliary readout instruments.

The DG-500 Dynagage may be used with a set of pressure transducers, microphones, flow meters, displacement and proximity transducers. The transducers cover the pressure range from 0.1 psig full scale to 75,000 psig with frequency response from 0 to 15 kc. Special water cooled units can be used at temperatures up to 6000 F.

Photocon Research Products, Dept. ED, 421 N. Altadena Dr., Pasadena, Calif.

CIRCLE 108 ON READER-SERVICE CARD FOR MORE INFORMATION

Temperature Indicator

Potentiometer-Type

This portable, potentiometer-type temperature indicator measures only 4 in. x 5 in. x 6 in., but has a scale 23-1/2 in. long. It has a standard, double-scale range from 0 to 1800 F for iron-constantan and 0 to 2400 for Chromel-Alumel. Major scale gradations are 100 F for both calibrations; minor gradations are 5 F for iron-constantan and 10 F for Chromel Alumel. Other scales can be supplied to order. Accuracy is 1/4 of 1 per cent of scale range.

The MiniMite can be used either to measure temperature directly through connection to a thermocouple; or as a standard against which to check other millivoltmeters or potentiometer-type instruments. The scale is calibrated in degrees F. Operating voltage is supplied by an easily-replaced mercury-cell battery.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N.J.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

Infra-Red Photocell

Operates At Low Temperatures

The 63TV is a cooled lead telluride photoconductive cell. It has a high infrared sensitivity at liquid air temperature.

Mullard Ltd., Dept. ED, Torrington Place, London, W.C. 1, England.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Fiberglass and Teflon

Tapes, Sheets or Fabricated

Trade named Korda-Flex, this fiberglass and Teflon product is resistant to temperature extremes, chemicals and solvents. It has good insulation characteristics, a high degree of dimensional stability, and is of substantial mechanical strength. Korda-Flex is available in tapes, sheets and rolls, to 38 in. wide, in thicknesses of 0.003, 0.005, 0.010 and 0.015 in. The fabricated forms include belts, pads or other shapes, die cut, heat welded, or stitched with Teflon thread.

Chicago Gasket Co., Dept. ED, 1271 West North Ave., Chicago 22, Ill.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

Oscillograph Tubes

This new series of 1-1/4 in. oscillograph tubes is intended for use in light, portable equipment, or in continuous monitoring service for larger installations. The IEP1 has a medium-persistence phosphor, the IEP2 has a long-persistence characteristic, and the IEP11 display is of short persistence. All have separate base-pin terminals for each deflecting electron to permit use of balanced deflection, all utilize electrostatic focus and deflection; all have a flat face, a minimum useful screen diameter of 1-16 in. a maximum overall length of 4-1/16 in., and weigh 2 oz.

Radio Corp. of Amer., Tube Div., Dept. ED, Harrison, N. J.

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Alignment Tools

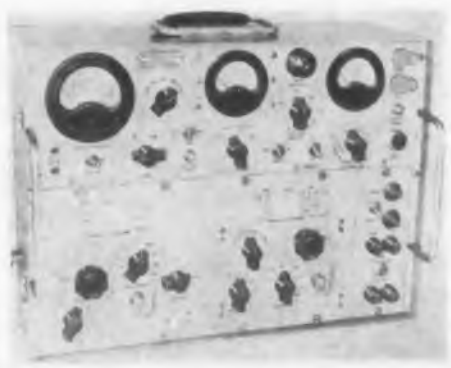
Counts Turns

The tools automatically count and indicate the number of turns made to facilitate resetting of slugs, trimmers and screws to their original position. These tools are made of plastic with a clear Lucite, calibrated sleeve that records each full and quarter rotation in either direction.

Tel-A-Turn tool #2586 is a I.F. aligner with one end fitting a #4 stud, the other a #6. Tool #2587 is an alignment screwdriver with a standard metal tip at one end and an extra narrow metal blade at the other for small can openings. Tel-A-Turn #2588 is a double-ended Hex aligner that turns top and bottom slugs. One side is for .100 in Hex slugs and the other for .125 in. slugs.

Walsco Electronics Mfg. Co., Dept. ED, 3225 Exposition Pl., Los Angeles 18, Calif.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION



Transceiver Test Set For Field Use

Equivalent to Armed Forces Model AN/TRM-1, the RT-500 is a laboratory-quality, portable instrument, designed to furnish performance measurements on transmitting and receiving equipment in the 190 kc to 400 mc range. It consists of a transmitter performance monitor, two rf signal generators covering 190 kc to 400 mc, and a multi-range 20,000 ohm/v dc or 5000 ohm/v ac meter.

Trad Electronic Corp., Dept. ED, Asbury Park, N.J.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION

SUBMINIATURE HUGHES SILICON POWER RECTIFIERS PICTURED WITH SOME OF THE STANDARD VACUUM TUBES THEY REPLACE.

For electronic power supply applications . . .

NEW HUGHES SILICON POWER RECTIFIERS

Hughes now offers silicon power rectifiers (as shown at the I.R.E. convention), designed for use in miniaturized circuitry and particularly effective in electronic power supplies. All types in this new series convert AC to DC with exceptional efficiency. And their power handling capabilities are exceptional, enabling them to deliver considerable power to loads at high voltages. Within PIV ratings in a full-wave rectifier, they can handle as much current per section as standard vacuum-tube rectifier types. In fact, these tiny rectifiers can replace *any* of the standard types when suitable series or parallel combinations are used.

FEATURES. The new Hughes rectifiers are characterized by low forward drop, together with low back leakage. They feature: maximum AC input voltages up to 275 volts RMS; maximum reverse DC working voltages up to 375 volts; maximum average rectified forward current up to 200mA; maximum power dissipation up to 200mW at 25°C. The operating temperature range for all types is from 75°C to 150°C.

PHYSICAL CHARACTISTICS. All types of silicon power rectifiers are packaged in the famous one-piece glass body, developed at Hughes. This construction provides complete protection against contamination and moisture penetration, results in stable operation under severe operating conditions. Maximum dimensions: body diameter, 0.015 inch; body length, 0.265 inch.

For details, please write:

SEMICONDUCTOR DIVISION · HUGHES PRODUCTS
International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

Regulated Silicon Rectifiers

Up to 1000 Amperes

Automatically regulated silicon power rectifiers in a standard line up to 1000 amp continuous capacity is proving useful as the dc source for ground support equipment used in missile testing. Hermetically sealed silicon diodes give reliable performance. Operating temperature range is −55 C to +65 C. Available models have d-c voltage ranges from 6 to 40 v, d-c regulation of ±0.5 per cent, response time of 0.1 second and ripple content of 1 per cent rms. All models meet the requirements of applicable military specs.

Christie Elec. Corp., Dept. ED, 3410 W. 67 St., Los Angeles 43, Calif.

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

Constant Delay Lines

Fast Rise Time

Made to specifications, these constant delay lines are characterized by fast rise time and by highly accurate constant delays. They are used in color TV sets, computers, automatic firing control and related electronic equipment. Each consists of a winding of fine enamel or teflon-coated copper wire on an extruded styrene tube. Material purity and dimensional tolerances of the tube (which is made by Anchor Plastics Co. of Long Island City, N.Y.) assure maximum uniformity. The complete assembly is epoxy-sealed into a waxed fibre tube. These delay lines are available in a variety of models having delays from 0.02 to 2.0 microseconds, with bandwidths up to 6.0 mc. The sample shown in the photograph is a 1000 ohm, 1.3 microsecond delay line, completely assembled at left, partly disassembled at right.

Bel Fuse, Inc., Dept. ED, 311 Mountain Rd., Union City, N.J.

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

Pressure-Actuated Switch

Handles 6-8 V 250 MA DC

Capable of switching 6 to 8 v d-c resistive circuits carrying up to 250 ma, a bellows-type pressure-sensitive switch operates in response to pressure changes in a closed vessel. The switch is mounted through the wall of the vessel. Available pressure ranges are 50 to 500 psi. The unit withstands burst pressures up to 1000 psi, and continues to operate satisfactorily after having been subjected to physical and environmental shocks encountered in missile and aircraft applications. Designated GPI-2000, these switches meet the requirements of MIL-T-5422C and can be made to meet more severe specifications. They can be tailored specifically to customer needs.

Aircraft Controls Co. Div. of Gorn Electric Co., Inc., Dept. ED, Stamford, Conn.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

Coaxial Directional Couplers

225-4000 Mc

Four models of 10 db coaxial directional couplers, covering a range of 225 to 4000 mc, are machined from solid blocks of aluminum. They provide flat coupling over a full octave frequency range with low vswr. Included with the unit is a built-in secondary arm termination. All four models, 3000-10, 3001-10 and 3002-10 and 3003-10, are 7/8 x 2-1/8 in. The coupling values are within 1 db of nominal value over the specified range. Calibration charts are provided to ±0.2 db accuracy. Coupling increases below the specified range at approximately 6 per octave. All models have a maximum primary line vswr of 1.15 and a power rating peak of 10 kw. Models 3000-10, 3001-10 and 3002-10 have a forward power rating of 200 w average and a reverse of 2 w average. Model 3003-10 has a forward power rating of 2000 w average and a reverse of 20 w average.

Narda Corp., Dept. ED, 160 Herricks Rd., Mineola, N.Y.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Transistor Manual

"Transistor Manual" is a booklet of basic information on transistors and their operation in circuits. Its 61 pages offer information on basic semiconductor theory, on construction techniques used to make the various types of transistors now on the market, and on basic principles of transistor circuit design. Specifications, with outline drawings, are given for all transistors registered with RETMA. The booklet contains complete explanations of transistor parameter symbols now in common use. Nineteen circuit diagrams ranging in complexity from a one transistor simple audio-amplifier to a six transistor superheterodyne broadcast receiver are shown with complete parts lists. A cross-reference chart for replacement of transistors in current transistorized radios of all manufacturers is also presented. The booklet costs $0.50. General Electric Co., Semiconductor Products Dept., Syracuse, N.Y.

Synthetic Paraffin - 135

A four-page brochure describing synthetic paraffin has been released. The illustrated brochure explains the high melting point, chemical characteristics, petroleum wax modifier, and plastic and rubber processing.

The unique properties make it a modifier in varying percentages for petroleum waxes usable in polish formulations, and rubber plastic processing. It includes typical tests showing the qualities of paraffin which can be used as a low-cost chemical raw material or for processing. Moore and Munger, 33 Rector St., New York 6, N.Y.

Automatic Controls 136

A 1957 Catalog No. 857 on automatic controls is now available. It lists over 100 items. All the controls feature hermetically sealed mercury contacts.

The illustrated catalog gives controls for single and two-stage pressures, differential pressure, single and two-stage temperature, liquid level and mechancial movement. It also shows relays and a complete line of mercury switches. Each control, with accompanying description, specifications and engineering data can be located by a dual index included in the catalog. Mercoid Corp., Chicago 41, Ill.

Carbon Film Resistors 143

Form 307 listing characteristics and specifications of ceramic encased carbon film resistors and coated carbon film resistors is now available. It states that resistors are furnished in 1/4, 1/2, 1 and 2 watt sizes with ±1 per cent standard tolerance.

The illustrated form indicates that the resistors conform to MIL-R-10509 specifications, and can be used in test equipment, meters and hi-frequency circuits.

Among the features described are: operation at 100 per cent rated load at 70 C; tolerances of ±2 per cent or ±5 per cent; and each unit is fully insulated and suited for snap-in component clips. Continental Carbon, Div. Wirt Co., 5221 Greene St., Philadelphia 44, Pa.

Epoxy Glass Cloth 144

Technical data sheet on flame-resistant epoxy resin preimpregnated glass cloth, which is being used in laminates has just been released. It features such outstanding electrical characteristics as 83,000,000 megohm cm volume resistivity, 25,000,000 megohms surface resistance and 18,000,000 megohms insulation resistance, and the material has been engineered primarily for critical electrical and electronic laminates as in printed circuits.

The data sheet explains that epoxy glass is furnished in dry, non-tacky, easily handled rolls adaptable to all necessary operations. Included in the report are such items as the resin content, consistent optimum flow characteristics and extended shelf life which are insured by carefully controlled impregnating procedures, along with technical data, suggested curing cycles and samples. Standard Insulation Co., East Rutherford, N.J.

Upper Atmosphere Models 145

Twenty-eight page pamphlet called "Atmosphere Models" is now available. It presents in tabular and topological form much information about the upper atmosphere. The pamphlet should be helpful to readers who are interested in structure of upper atmosphere, and is made useful by tables which convert its metrical units of measurement to the English System. They include tables on abbreviations on Model Atmosphere 1956, Tabulations of Temperature and Molecular Weight above 300,000 ft. Also included are such graphs as pressure, density, inetic temperature, sound speeds, derived temperature and observed density data all vs. geometric altitude.

A large graph on the electron density model in the ionosphere is one of the added features of the catalog. General Electric Co. (cooperation of Air Force Cambridge Research Center), Missile and Ordnance Sys. Dept., 3198 Chestnut St., Philadelphia, Pa.

Thin Electrical Steels 154

Representative test results on three types and five different thicknesses of thin electrical steel are offered to electrical equipment designers in a manual of 56 pages. Some of the data, developed over a wide range of inductions and frequencies, are new. The steels are fully discussed with respect to advantages, applications, specific uses, fabrication, and mechanical, physical and magnetic properties. The booklet also contains sections covering test methods, conversion factors, supply information and other subjects. The 39 pages of design curves range from core loss to lamination factors. Core loss at elevated temperatures exciting RMS volt-amperes at elevated temperatures and a-c permeability at elevated temperatures are among them. These curves and the data pertaining to them are published for the first time in this booklet. Armco Steel Corp., Middletown, Ohio.

Aircraft Switches 155

A 32-page catalog, No. 78 on aircraft switches, entitled "Basic Switches for Airborne Equipment," covering complete line of phenolic encased switches as well as small, metal-covered hermetically sealed and high temperature switches, is now available.

The catalog is complete with photographs, dimensional drawings, electrical data and operating characteristics, describing over 140 different switches, auxiliary switch actuators and terminal enclosures. The switches are shown in a variety of actuator designs, terminal structures and contact arrangements, including single-pole double-throw, double-pole double-throw, double-break, two-circuit, four-circuit and split. Micro Switch, Div. Minneapolis Honeywell Regulator Co., Freeport, Ill.

Moly-Sulfide As Filler 156

The uses of Moly-Sulfide (Molybdenum disulfide) as a filler in nylon, phenolic laminates, teflon and other plastics, natural and synthetic rubber and asbestos is described in Bulletin LU-12 just released. It outlines the preparation and properties of Moly-Sulfide-filled products and shows that, with the addition of this filler to certain plastics materials it improves frictional and mechanical properties.

A table in the bulletin compares the physical properties of Moly-nylon extrusions with those of unfilled and graphite-filled nylon. There are also composition and performance details on sintered parts which have already been used in low impact gears, cams, bushings and bearings. The bulletin in addition cites applications in such phenolic laminate products as roll-neck bearings and slip rings for electric insulators. Climax Molybdenum Co., 500 Fifth Ave., New York 36, N.Y.

Analog Computers 163

Booklet on "High-Speed Analog Computers, Key to Rapid System Development," answers questions from engineers, who are concerned with automation and the development of control systems for industrial and military applications, is available.

The booklet is in question-and-answer style and defines certain types of computers and summarizes applications of each.

Interesting comparisons between analog computation and fields of photography and genetics are included to help set basic differences in computing techniques. GPS Instrument Co., Inc., 811 Boylston St., Boston 16, Mass.

Epoxy Resin Compounds 164

In Bulletin TB 10 techniques for casting with epoxy resin compounds are treated in detail. Metalset and Sonite epoxies are the compounds discussed, but the information given is applicable to all epoxy resin casting compounds. The bulletin covers the general handling characteristics of epoxies for casting, and the special handling required with wood, plaster, and plastic and flexible molds. The important aspects of curing these epoxies for both small and large castings are detailed along with the times and temperatures involved. Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City 4, N.J.

Tube Characteristic Sheets 165

Seven tube curve work sheet types have been added to a line already offered. The sheets are 8-1/2 in. x 11 in. with large curves to make vacuum-tube design easier and faster. They come in pads designated as 6AU6 Pentode, 6AU6 Triode, 6CL6 Pentode, 6CL6 Triode, 12AY7, 5670 and 6080. The curves show plate characteristics, positive-grid characteristics, u, g_m and r_p, and screen characteristics for pentodes. The screen curves are plotted in a form permitting construction of screen load lines. To simplify numerical data, all graph scales have been standardized at 1, 2 or 5 units per scale division. To assure reliable design, limits of maximum rated voltage, current, and dissipation are clearly marked on the curves. Tabulated on the reverse side of the sheets are electrical and mechanical data for the tube, and for all electrically equivalent types—single-unit, twin-unit, octal, miniature, subminiature, computer, military, industrial, etc. Shown are dimensions, base connections, capacitances, maximum ratings, typical operation and characteristics, characteristics limits and special properties. A sample sheet of any type will be sent on request. Technical Publishing House, 4 Tyler Rd., Lexington 73, Mass.

Making Printed

As the result of a recent development, printed circuits can be prepared by dry screen printing in the design and development laboratory. An inexpensive machine for this purpose, that speeds prototype development and helps designers quickly prove out and make changes in printed-wiring design, is available from Dry Screen Process, Inc., 1016 Madison Ave., Pittsburgh 12, Pa. It is known as the DSP Mark III Junior, shown in Fig. 1.

What Can Be Done?

Requiring only 20 x 40 in. table space, this dry screen process produces printed-circuit panels ready for etching. No baking or racking problems are involved, so time is cut from hours to a matter of minutes. Printing can be accomplished on either single or double copper-clad laminate up to 1/8 in. in thickness. Effective printing surface is 8 x 14 in. A translucent bed and precision micrometer registry make back-to-back designs accurate within 0.007 in. or better. Simplicity of the process is demonstrated by the block diagram of Fig. 2.

Principles Involved

This dry-screen process is based on the principle of printing thermoplastic resist through a temperature controlled wire mesh screen. The resist in its melted form is printed through the screen. On contact with the cooler copper surface of the laminate it dries instantly. Reverse side printing can be undertaken immediately by simply flopping the panel over and making a second pass with the squeegee. The panel can go directly to the etching bath without delay.

Screens for this dry screen process, made of stainless steel cloth from 165 to 230 mesh, can be of the direct photographic type, using sensitized polyvinyl alcohol emulsion; or they can be made with special stencil material developed expressly for the process by the M. D. McIntosh Co. of Cleveland. The latter material has a backing sheet which allows it to be exposed and processed before mounting on a clean wire mesh screen. A very simple

A new regular feature covering clever circuit and mechanical design ideas—individual contributors will be paid $10 for items published.

Circuits In the Laboratory

development step only is required and no dark room is involved following the production of a photo positive film.

The full-size film positive is prepared using conventional process photographic equipment. The image on this positive is then transferred directly, in the vacuum printing frame, to the stencil film. The screen is then developed and washed gently in warm water sprays, which causes the stencil material which was masked from the arc light exposure to be washed out, leaving a perfectly sharp stencil. After this operation, the stencil is adhered to the screen. Then this backing sheet is stripped off, completing the cycle.

The entire process cycle takes about 14 minutes, including printing, etching, resist removal and punching for assembly. No further processing is required other than a short period of drying, and either heat or solvent conversion for curing of the stencil material to the screen. The stencil is easily removed from the screen, for screen reclamation and use on another job, by a simple solvent-brushing operation.

Fig. 1. Operator removing a printed-circuit board, produced in a laboratory by the dry-screen process described here. Only a few minutes were required.

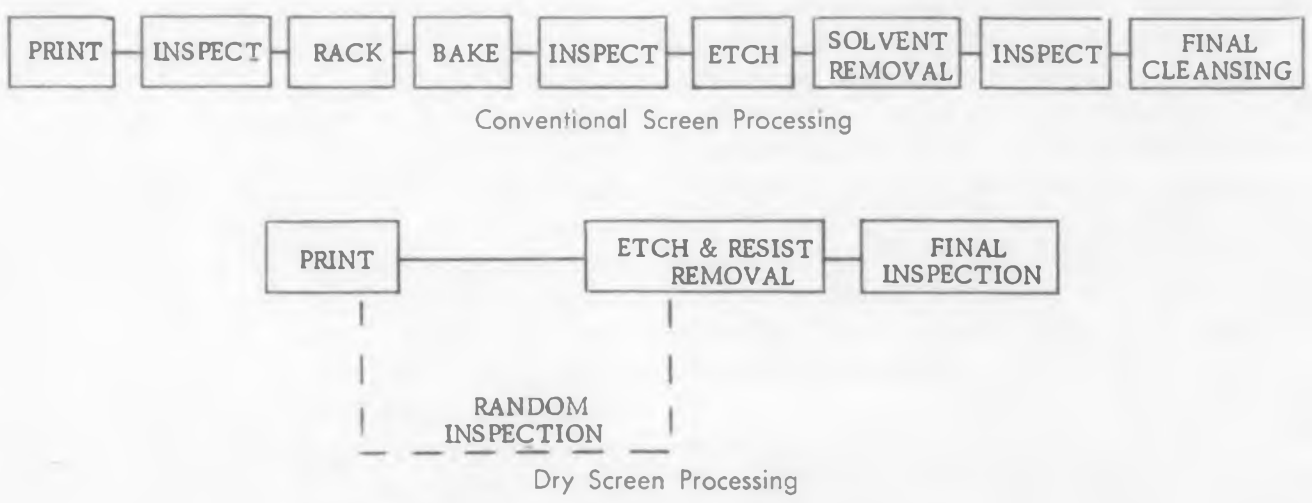
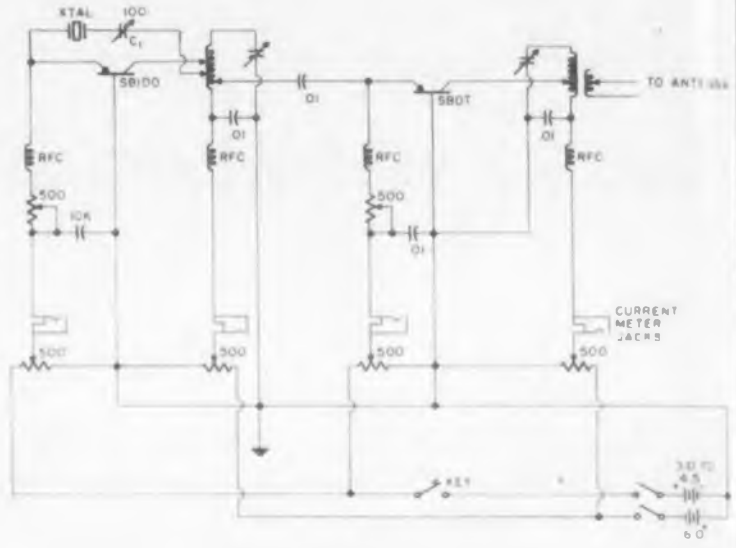


Fig. 2. Comparison between conventional screen processing steps and simplified dry-screen processing.

Photo courtesy of Associated Spring Corp.

Transistorized Transmitter

Although designed for Amateur Radio communications, the transmitter circuit shown may be of general design interest, as well. The complete transmitter, powered by two flashlight cells is a crystal controlled oscillator-amplifier running 120 milliwatts input and employing Philco type *SBDT* and *SB100* transistors. Communications, using this transmitter, have been carried on at 7 mc between Laverock, Pa., and Hawaii by Forrest Bigelow, *W3FBL*.



TRANSISTOR TRANSMITTER

Design Considerations

There are several features which improve efficiency and stability: Tank coils are large (4 in. dia. in the amplifier) and of heavy wire. This raises their unloaded Q, which is very important in such service. Bus wires and all connections are made heavy to reduce losses.

Grounded base configuration is used in the amplifier, to reduce feedback through the transistor; and, for this reason along with the relatively low capacities of the surface barrier transistor, neutralizing is not necessary. Further, the small capacity feedback present is thus regenerative instead of degenerative as it would be if common emitter circuitry were used. No difficulty has been experienced with oscillation or instability.

Numerous potentiometers are incorporated. This is because the transistor provides greatest power output at some certain collector voltage and collector current, which are not strictly predictable from the characteristic curves. Thus, as voltage and current increase, a point will be reached after which further increase of input results in no greater output, or a decrease in output. Exceeding this point is not only wasteful of realizable output but dangerously harmful to the transistor. It is desired to use the greatest possible collector voltage; yet, a point is reached where damage to the transistor occurs. This is a fracturing of the base layer, indicated by continuous high reading of collector current and by ohmic resistance of but several hundred ohms between collector and emitter. Further, a transistor having such breakdown voltage of (for example) 15 v will fail before 15 v from the supply is applied, because the peak of ac potential is added to the supply. Thus, when operating with high supply voltage, the tank should not be resonated without the antenna (or other) load.

Series dropping resistors or inductors in the collector supply should be minimized; although safe potentials may be achieved during operation, current reduction or stoppage (as in keying) causes collector voltage to rise. However, some resistance in the emitter is essential to temperature stability and to the lessening of danger from current "runaway" and ruination of the transistor. About 100 ohms would result in satisfactory current source to emitters. Excessive power input will also fracture the crystal through heating.

Both tank coils are tapped at every turn, for emperical determination of proper matching, which is quite important in this attempt to squeeze out the last available microwatt. It has been noted that in the "final," with given antenna load, one turn from optimum collector tap will reduce output by two-thirds.

Capacitor *C1* is not a simple blocking condenser; it is a phasing adjustment to be set at the point of best stable oscillator operation under keying. Both it and its tap to the coil should be adjusted. *C1* also permits modest frequency adjustment.

Operating Tips

Collector current in the amplifier should be monitored, but this is not a good indication of maximum power output. Some means of relatively measuring feeder current or (preferably) antenna excitation should be used. Obtaining maximum possible output is not without an element of risk. Such operation is beyond the maximum ratings of the manufacturer. It is possible that the transistor will operate satisfactorily for many (even hundreds of) hours then give up the "ghost." In this connection, the meter which monitors collector current should be watched for a gradual (sometimes rather rapid) increase of current, which is the sure call for immediate reduction of power input. The gamble is not great if some precautions are observed:

1. ALWAYS ground the frame of the soldering iron or gun to the chassis when soldering around the

circuit. Enough leakage voltage is present in most irons to cause damage. Even soldering with an ungrounded iron to transistor and circuitry held in one's hand is dangerous since the body has considerable capacity to ground; the charging of this capacity through the transistor can cause its demise. This simply because the base layer, to operate at very high frequencies, must be quite thin. The same precaution should be followed in applying any ac operated test equipment.

2. Monitor r-f output and use no more collector voltage for current than necessary to give maximum power output.

3. Keep the transistor transmitter away from close coupling to a high-power r-f amplifier. Enough energy may enter the transistor unit to damage the transistor, as it would any diode.

4. Watch collector current. If it gradually or abruptly rises, back off on collector voltage and current. This is evidence of thermal runaway or of altering of transistor characteristics.

5. If there is a choice between extra high voltage and extra high current for given r-f output, choose the current as the lesser danger.

6. Do not resonate the final tank, if pushing the transistor limits, without a load.

7. Avoid intermittent short circuits, especially in the collector area, which may cause voltage transients to be produced.

Cooling

The heat sink used at first was a tight-fitting brass tube to which fins were soldered. This slipped over the transistor case. Then, in an all-out effort, an ice bath was constructed. Since heat flows out over the leads, these too are cooled. A tin can tank large enough to hold two ice cubes was constructed and covered with asbestos sheeting to reduce "sweating." Soldered upright, at the side of the tank, is a 3/8 in. I.D. section of tubing with its bottom soldered shut to make a liquid-tight well. Coil dope is painted above the upper edge, to serve as an insulator should the transistor leads happen to touch the tubing. Into the well is inserted the transistor which has a section of tight-fitting tubing slipped over its case. The well is then filled with silicone oil to cover the transistor assembly, including a portion of its leads. Another version uses finely divided aluminum particles in the oil to increase its thermal conductivity. Thus, water and ice cubes in the tank cool the oil which, in turn, cools the transistor and permits increased power input by about 30%. Even without increase of input, it is considered to be a good insurance policy against transistor failure.

you'll see them A

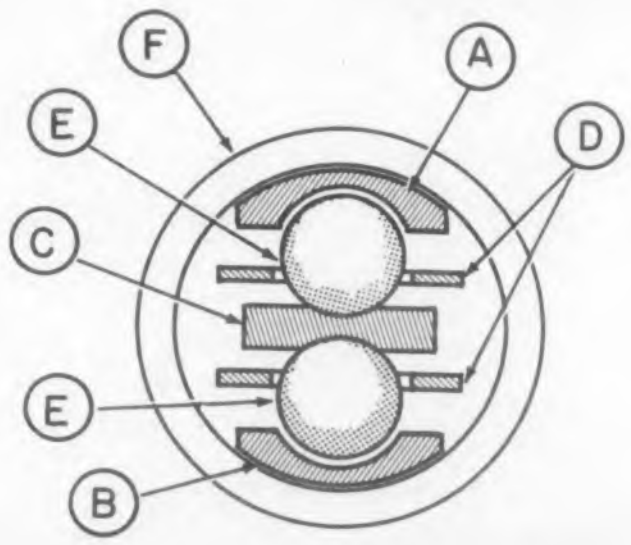
Ideas for Design

Push-Pull Flexible Control

Servo engineers may find good use for this precision push-pull flexible control which consists of a solid flexible stainless steel blade moving between rows of stainless steel balls and housed in flexible tubing. It can manipulate loads up to 300 lbs with a stroke up to 8 in. with as much as 900 degrees in bends. Despite its heavy load capacity, it has a backlash of only 0.009 in. for a small load and 180 degrees in bends, which puts it in the precision control category.

Since the frictional load does not increase with the applied load, efficiencies of 90 percent with small loads are achieved by this Controlex control manufactured by the Controlex Corporation of America, Westchester County Airport, White Plains, N. Y. The basic control consists of two outer races and a center moving race which is separated from the outer races by two lines of balls. The races are actually ribbons of stainless steel rolled to contour. The two outer races are items *(A)* and *(B)* in the figure, the center race is *(C)* and the balls are *(E)*. In order to keep the balls evenly spaced, a ball guide or spacer *(D)* is used which floats around the balls without impeding their rolling motion. This whole assembly is surrounded by a flexible casing that closely maintains the diametrical clearances, keeping the backlash to a low value.

As the control operates the center race moves and the outer races remain stationary, while the balls move at half the speed of the inner race. As only film lubrication is used, temperature does not affect the control. The outside diameter is 1/2 in. and the minimum bend radius is 3.5 in. It is available with aluminum tubing weighing 3-1/4 oz per foot, or in all stainless steel.



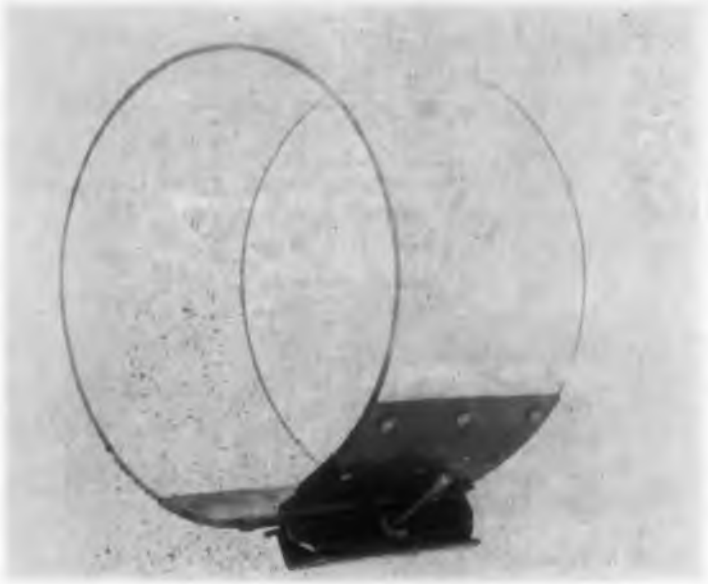


Fig. 1. Commutator Cover

Visual Commutator Inspection

The use of the plexiglas air blast cover shown, installed over the commutator of a generator, has proved to be of great assistance in conducting operational tests at Glenn L. Martin Co. The arcing between the brushes and commentator can be visually observed at all times. Any commutation trouble is quickly and efficiently detected, resulting in a greater saving of time and more thorough inspection.

This method has corrected many deficiencies encountered in the former method, where the solid air blast cover was removed for short periods of time during the tests. This resulted in insufficient inspection of commutation and possible overheating of the generator, since removal of the cover diverts the cooling air flow.

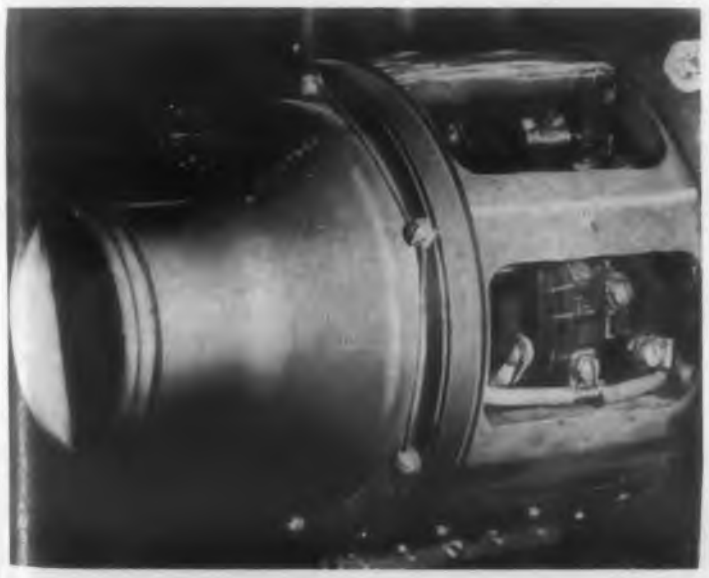


Fig. 2. Cover installed on generator.

Report Briefs

Ferromagnetics for VHF

An analysis and description of the properties of a number of new ferromagnetic materials tentatively termed ferroxplana. These materials have a preferred plane of magnetization and consequently a magnetic resonance frequency much higher than former iron oxides. *Philips Technical Review, Vol. 18 No. 6, Ferroxplana, Hexagonal Ferromagnetic Iron Oxide Compounds for Very High Frequencies, G. H. Jonker, H. P. J. Wijn and P. B. Braun, Order from N. V. Philips Gloeilampenfabrieken, Eindhoven (Netherlands), November 1956, $0.60 copy.*

Production of Semiconductors

Production techniques and package design of transistors and diodes (as of 1955) are presented in this detailed report. Subjects covered are germanium processing, the junction rectifier, the point contact transistor and the germanium high current rectifier. In addition to a thorough outline of production processes, methods of testing and evaluating components are described. *PB 121291 Industrial Preparedness Study of Transistors and Diodes, General Electric Electronics Div., OTS, U.S. Dept. of Commerce, Washington 25, D.C., July 1955, 402 pp, $8.00.*

Series-Tube Core Memory

A high-speed core memory for digital computers using a selection system which does not require close control of the characteristics of the magnetic cores has been developed by the Air Force. A series-tube core memory, similar in operation to the coincident-current memory and using the same storage element as that system and the core-diode memory was used. This report contains a theoretical analysis and synthesis procedure for the series-type driving circuit. Experimental results from the operation of 16 single-bit registers with the series-tube selection is also included. *PB 121558 Series-Tube Core Memory, E. J. Otis, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Sept. 1955, 44 pp, $1.25.*

Noise Statistics In Circuits

Theorems on noise are surveyed and statistics are formulated of noise ensembles created by transforming other noise ensembles in different circuits. Transformations discussed are addition, multiplication, differentiation, linear combination of derivatives, integration with respect to a weighting function, and function with a noise argument. Since sums occur almost everywhere, products arise in amplitude modulation and mixing, differential and integral transformations arise in linear circuits, the formulations of the transformed statistics treated in the report are very general, providing comprehensive solutions of a large number of elementary problems. *PB 121515 Noise Statistics After Transformations Commonly Found in Circuits, W. M. Brown, Johns Hopkins Univ. for the USAF, OTS, U.S. Dept. of Commerce, Washington 25, D.C., 76 pp, $2.00.*

Standards for Vibration Pickups

A method for standardizing electrodynamic calibrator for vibration pickups consists of a vibration service for vibration pickups is reported. The calibrator for vibration pickups consists of a vibration exciter with a built-in vibration measuring device. It produces mechanical vibrations by electrical means and, simultaneously, generates an electrical output that depends on the vibration. The calibrator is standardized by determining the relationship between its electrical output and the vibratory motion. The NBS method for standardizing the calibrator is based on an improved mathematical analysis of the problem. A description of the electrodynamic calibrator, an analysis of the reciprocity technique, standardization procedure, and the calibration of pickups is presented. *Article from NBS Technical News Bulletin, U.S. Dept. of Commerce, Washington 25, D.C., Jan. 1957, pp 11-14.*

Air Exposure Effect on Cathodes

The impracticality of replacing the nickel and tungsten matrix cathodes of a demountable vacuum system after it has been shut down for airing is investigated. Emission measurements were made on both types of cathodes and compared to the standard oxide cathode. Both nickel and tungsten cathodes had the disadvantages of lengthy activation time and susceptibility to self-poisoning. The standard oxide cathode showed most promise for the application, provided the problem of flaking could be overcome. *PB 121563 The Effect of Air Exposure on Various Cathodes for Demountable Vacuum Systems, G. A. Haas and J. T. Jensen, Jr., NRL, OTS, U. S. Dept. of Commerce, Washington 25, D.C., Nov. 1956, 10 pp, $0.50.*

Printed Circuit Assembly Design

Four systems for packaging and integrating Auto-Sembled card-type printed circuit assemblies are analyzed in Part I of this report. The systems, devised for use with r-f, i-f, and a-f amplifiers, include plug-in, stacked mechanical, distributed connector, and mechanically cascaded packages. Data is presented from analyses of ruggedization, climatic protection, thermal adequacy, size and weight, and maintenance of the packages. Part II contains a design guide for packaging and integrating the four successful Auto-Sembled assemblies. A five-step procedure is described which allows pre-fabrication evaluation of a proposed design to assure adequacy of circuitry, the above properties and integration. The procedure involves selection of system and techniques, design, fabrication, and analysis. Features of each of the four systems are presented to aid designers in determining compatible assemblies. *PB 121163 (Part I) and PB 111714 (Part II) Packaging and Integrating Printed Circuit Electronic Assemblies, E. D. Alfred, L. G. Brodrick, C. W. Everhart, and M. E. Hinebaugh, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Sept. 1954, Part I: 52 pp, $1.50, Part II: 144 pp, $3.75.*

Storage Tube

The NRL regenerated electrical output storage tube described in the Nov. Reports of NRL Progress differs from other types in that the reading time can be extended to hours or even days, with negligible pattern decay. This article presents a qualitative analysis of the tube and design techniques for constructing a two-sided storage mosaic.

Other articles in the report contain information regarding ionization in combustion zones, distributed-power amplifiers, effect of air-exposure on cathodes, and a description of NRL's transonic whirling arm. *PB 121668 Report of NRL Progress, Regenerated Electrical Output Storage Tube, F. H. Harris, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Nov. 1956, 54 pp, $1.25.*

Test for Cable Mechanical Noise

A simple, objective, readily reproducible test method was developed to provide a "noise index" for cables designed to create a minimum of spurious voltages when subjected to shock, vibration, or transient pressures. The method is treated in detail in this report. Theoretical and experimental considerations are included, along with sample noise indices for three widely used coaxial cables. *PB 121583 A Simple, Objective Test For Cable Noise Due To Shock, Vibration Or Transient Pressures, T. A. Perls, NBS, OTS, U.S. Dept. of Commerce, Washington 25, D.C., May 1955, 24 pp, $0.75.*

Test Equipment For Radechon Tubes

Described is a versatile storage tube tester which performs complete and complex electrical tests and measurements on two types of radechon storage tubes. The tubes are tested for persistence of storage surface, resolution, freedom from blemishes, and other pertinent characteristics. Basic parts are a dot pattern generator, write and read pulse generators, a manual and automatic sequencer, and a mixer. *PB 121401 Design of Laboratory Test Equipment for Radechon Storage Tubes, D. Haratz, OTS, U. S. Dept. of Commerce, Washington 25, D. C., Sept. 1955, 36 pp. $1.00.*

Linear System Analysis

A study is made of the use of the incomplete time response to a unit impulse as a device to analyze lightly damped linear systems. The results indicate that such a system can be described adequately by this method. *NACA TN 3897 Incomplete Time Response to a Unit Impulse and Its Application to Lightly Damped Linear Systems, J. J. Donegan and C. R. Huss, NACA, 1512 H St. NW, Washington 25, D.C., Dec. 1956, 17 pp, Diagr.*

Transistor Life Under Pulse

Theoretically, the life of a point-contact transistor should be long and useful, but only predictions could be ventured prior to this research. Over 13,000 hours of continuous flip-flop operation are accumulated by three types of commercially available transistors in high-speed switching circuits. Very little deterioration is noted. The transistors are illustrated and life testing procedures are described in this report. *PB 121560 A Point-Contact Transistor Life Test Under Pulse Conditions, J. A. DiGiorgio, AF Cambridge Research Ctr., OTS, U.S. Dept. of Commerce, Washington 25, D.C., Feb. 1956, 21 pp, $0.75.*

Alkaline Storage Batteries

Two studies are made of the self-discharge of the positively charged nickel oxide electrode in alkaline storage batteries. The first analyzes the role of water in the process, and it is determined that the rate of oxygen evolution is proportional to the square root of the thermodynamic activity of water in the electrolype. The second study examines potential as a function of time on open circuit and of the active oxygen on nickel oxide plates. *PB 121430 Alkaline Storage Batteries: The Self-Discharge of the Positively Charged Nickel Oxide Electrode, Part 1; PB 121483 Part 2, OTS, U. S. Dept. of Commerce, Washington 25, D. C., Oct. 1956, 7, 17 pp. $0.50 each.*

Monotron Analysis

This report deals with starting current single cavity oscillation in the TM_{01n} modes. A calculation of the minimum current required for the start of oscillations is made. The theoretical treatment shows that a beam current of 600 ma at a millimeter wavelength is sufficient. Simple single cavity construction is important at such wavelength ranges, where resonators become microscopic in size. *PB 121402 A Starting Current Analysis of Monotrons With a Cylindrical TM_{01n} Resonator, H. D. Zrnett and A. J. Ruhlig, NRL, OTS, U. S. Dept. of Commerce, Sept. 1956, 17 pp. $0.50.*

Dosimeter Field Reader

A field reader with a range of 20 to 1000 roentgens is described in this NRL report. The instrument, a self-contained unit—except for the high-voltage power supply—was used successfully both in the field and in the laboratory with small-volume phosphate glass needle dosimeters. Also contained in the report are articles dealing with cosmic noise background with high-gain antennas, and applications research in engineering psychology. *PB 121755 Report of NRL Progress, A Field Reader for Small-Volume Dosimeter, P. A. Caldwell, OTS, U. S. Dept. of Commerce, Washington 25, D.C., Dec. 1956, 55 pp, $1.25.*

Silicon Power Rectifiers

This progress report dated Oct. 1955 describes production procedures and improvements in the manufacture of silicon power rectifiers. Significant improvements in the power handling capabilities of silicon rectifiers have resulted from refining and standardizing their design. Pilot line experience with production processes indicates that quantity production is entirely feasible. *PB 121274 Industrial Preparedness Study: Silicon Power Rectifiers, Signal Corps Supply Agency, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Oct. 1955, 45 pp. $1.25.*

Half-Wave Magnetic Amplifiers

Half-wave magnetic amplifier circuits proposed for servomotor control are examined experimentally with a-c input control signals. Magnetic cores of Mumetal, Permalloy and HCR alloy are used to establish the importance, or otherwise, of rectangular B-H properties. Interaction between stages in cascade is investigated and the advantage of a 3-phase supply is described. *N-46943 Half-Wave Magnetic Amplifier Behaviour, J. Baranowski, Royal Aircraft Establishment, available on loan only from NACA, 1512 H St. NW, Washington 25, D.C., May 1956, 38 pp, Diagr.*

Patents

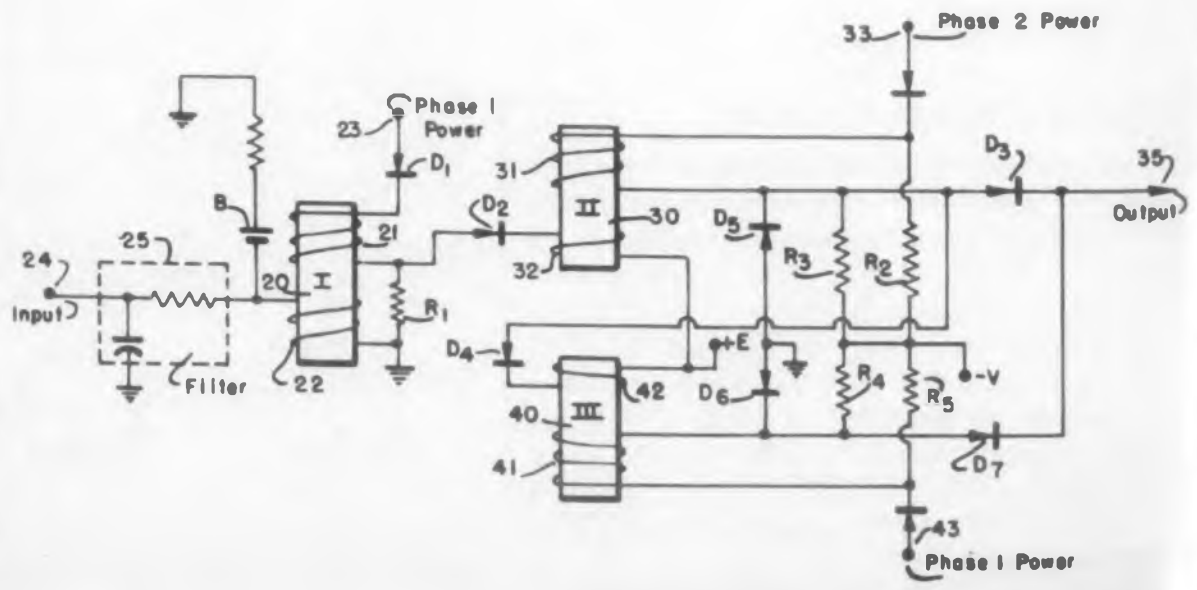
Full Wave Magnetic Amplifier

Patent No. 2,751,510. T. H. Bonn. (Assigned to Remington Rand Inc.)

Carrier type magnetic amplifiers have half waves of an alternating potential applied thereto which may be of any desired form. An input signal determines the transmission of this wave through the amplifier so that the output is generally a group of half wave pulses. The output circuit which is connected with the amplifier must be designed particularly to be operable on such half wave pulses which design encounters difficulties. Sometimes it requires considerable filtering of the output signal in order to provide a signal which can be used effectively in the connected circuits. The amplifier of the patent is somewhat similar to a full wave amplifier in that there will be no gaps between half waves in the output signal. If the power wave is a square wave then the output signal will be dc with a substantial reduction in any ripple. The amplifier is rugged and also secures improved operating characteristics.

The amplifier as illustrated in the figure has power pulses applied from a source *23* and through a rectifier *D1* to the coil *21* of a magnetic amplifier *I*. An input signal of substantial duration as compared to the power wave is applied through the filter 25 to the coil *22*. Normally the core *20* of the magnetic amplifier is in the negative remanence condition so that positive power pulses drive the core from negative remanence to positive remanence on the hysterisis loop. In this area the amplifier has a high impedance so that practically no signal is transmitted through a rectifier *D2* to the coil 32 of a second magnetic amplifier *II*. Upon a positive input signal being applied to coil *22* of substantial duration relatively to the power wave, the core is driven to saturation and the waves of power source 23 appear across the resistor *R1* and is transmitted to the coil 32 of the amplifier *II*. During the negative portion of the wave at source 23, a current is supplied through coil *22* from a battery *B* to restore the core to negative remanence.

A power source phase 2 supplies at the terminal 32 a positive portion of a second wave of the same form but 180° out of phase with respect to the wave of source 23 which wave is transmitted through a rectifier to the coil *31*. If there has been no input



ignal this wave drives the core *30* from negative remanence to positive remanence where the impedance is high and practically no output signal appears. If an input signal has been applied to amplifier , the core *30* is driven to saturation and n output signal is passed through the rectifier *D3* to the output *35*. During the negative halves of the power phase 2 wave, a current is supplied in the coil *31* from ground through rectifier *D5*, coil *31*, resistor *R2* and a negative source $-V$ to restore the core to negative remanence.

The amplifier *III* operates in the same manner as amplifier *II* excepting that the power wave applied at terminal *23* may be applied at terminal *43* o rthe wave may be from a separate source but of the same phase. An input signal applied at the terminal *24* drives the core *40* to saturation so that a half wave output signal is transmitted through the rectifier *D7* to the output *35*. The output signal from amplifier *III* is interlaced with the output signal from the amplifier *II* to produce a d-c output which is substantially a continuous d-c output signal. If the power waves are square waves of the same frequency, amplitude and proper phase a very uniform output d-c signal is secured without ripple or appreciable ripple.

Pulse Forming Network

Patent No. 2,769,903. (Inventor, G. D. Paxson, AEC)

This patent relates to a radio frequency synchronizer for synchronizing a low repetition rate triggering pulse with a predetermined point on a sinusoidal voltage signal. It was developed for use in a cyclotron for synchronizing the deflector trigger voltage with the accelerating voltage signal. The circuit consists of a first and second stage multi-element tube with the sinusoidal voltage signal being applied to the first stage control electrode, the triggering voltage to the first stage screen electrode, and the first stage anode to the second stage screen electrode. An adjustable phasing means is connected between the second stage anode and the output pulse source, resulting in the latter being synchronized with the sinusoidal wave voltage.

Remote Control Manipulator

Patent No. 2,764,301. (Inventors, R. C. Goertz et al, AEC)

This patent describes a master slave type remote manipulator suitable for handling radioactive or toxic substances. This manipulator has the novel capability of being inserted through a small hole in the barrier by means of a joint that may be extended and linearly aligned with the transverse and slave arms. When inserted, the joint may be distended and connected to provide the necessary leverage for manipulation of the slave arm. This feature permits the use of one manipulator in many positions with maximum safety, where previously either many manipulators were necessary or dangerously large appertures were required in the barrier.

Metallic Bond And Method

Patent No. 2,768,433. (Inventor, T. J. O'Donnell, AEC)

This patent relates to a method for bonding metal sleeves to cores. The outer member or sleeve is of such dimensions that it will fit loosely over the core when both are cold. After being placed on the core, the sleeve is heated rapidly to a temperature high enough to allow plastic flow of the metal, while being held in a clamp or apparatus which prevents radial expansion of the sleeve. The sleeve is thus deformed inward, i.e., changed in such a way that its inner diameter is less than what it was at the start of the operation. The sleeve is then allowed to cool, and in so doing, shrinks to a tight fit on the core.

Automatic Beam Stabilization

Patent No. 2,770,756. (Inventor R. J. Klein, AEC)

This patent describes an improved memory system for a computer utilizing cathode ray tube storage of binary information. The signal is stored in a predetermined position on the tube screen and, periodically, the cathode beam is directed to that position to sample the stored information, means for detecting and amplifying the signal, produced by the incidence of the beam on the area where the information is stored, is provided along with a circuit designed to regulate the beam current magnitude with respect to the signal produced so as to keep the signal magnitude substantially constant thus resulting in improved operation of this type of an information storage system.

Books

Modern Mathematics For the Engineer

Edited by Edwin F. Beckenbach, McGraw-Hill Book Co., 330 W. 42nd St., New York, 36, N.Y., 514 pages, $7.50.

Written by experts known for theoretical competence and practical experience in applied mathematics, this book presents a broad survey of the application of advanced mathematics to modern technology. It is based on a series of extension lectures given at the University of California. Directed toward engineers and applied scientists engaged in research, design, and administration, the lectures were designed to generate an awareness of the recent rapid advancement in applied mathematical thought.

The text is unique in its emphasis on the importance of stochastical analysis, the theory of games, operations analysis, and linear, nonlinear, and dynamic programming in modern engineering. The methods and applications of the new high-speed computation procedures is extensively covered. Broad treatment of methods show the reader the scope of what is involved, yet with sufficient detail to enable him to attack specific problems. As is usual in applied mathematical discussions, each of the chapters touches both on the mathematical formulation of physical problems, and on constructive methods of solution.

The book is divided into three parts. The first entitled "Mathematical Models," dwells successively on physical problems expressed in terms of ordinary differential equations, integral equations, and partial differential equations. Next, in "Probabilistic Problems" are chapters on the use of probabilistic methods in solving problems. Finally, in "Computational Considerations" the emphasis is on numerical solutions.

Solid State Physics, Vol. III

Edited by Frederick Seitz and David Turnbull, Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 587 pp, $12.00.

In the third volume of Solid State Physics (Advances and Applications), the authors chosen by Messrs. Seitz and Turnbull present clear, concise and informative articles in their chosen fields.

Articles in the third volume are: Group III-Group V Compounds by H. Welker, and H. Weiss; Continuum Theory of Lattice Defects by J. D. Eshelby; Order-Disorder Phenomena in Metals by L. Guttman; Phase Changes by David Turnbull; Relations Between the Concentrations of Imperfections in Crystalline State by H. J. Vink and F. A. Kroger; and Ferromagnetic Domain Theory by C. Kittel and J. K. Galt.

Designed as a reference work, this series proves to be an exceptional source of information on a series of topics of importance to the contemporary physicist and physics student.

Many of these fields have never been surveyed in as thorough a manner, and all articles present, in addition to a development of the formal theory from fundamental principles, broad bibliographies and lists of references enabling the reader to easily follow the development of the field from original source material.

Written for the experimentalist as well as the theoretician, each section contains a more than adequate description of experimental techniques supplementing discussions of specific applications of the theory.

All sections are written so as to be readable by those with a mere acquaintance with the subject as well as by the researcher in the specific field.

Analog Computers Their Industrial Applications

Midwest Research Institute, 425 Volker Blvd., Kansas City 10 Mo., 210 pages, $5.00

The proceedings of a symposium for management held April 10 to 11, 1956, this publication contains 13 technical papers and a transcript of the round table discussion. The papers presented are intended to furnish a broad background to management of the role which analog computers fulfill in the solution and refinement of technical and nontechnical problems. The collection is a valuable survey and status report of the analog computing field. The book is generously illustrated with graphs, photographs, and circuit diagrams.

Metallic Rectifiers Principles and Applications

Leonard R. Crow, Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 5, Ind., 280 pages, $3.00.

The theory and application of metallic rectifiers are treated in a simple and practical way in this book. The text is directed toward the vocational or technical student, or the not too recently graduated electrical engineer. Appendixes at the back of the book give sources for metallic rectifiers and references to more advanced reading. The listings are divided into copper-oxide, magnesium-copper sulfide, and selenium rectifier groups.

Electronic Computers

Edited by T. E. Ivall. Philosophical Library, 15 E. 40th St., New York 16, N.Y., 175 pages, $10.00.

Primarily for those possessing some knowledge of electricity or electronics, this is a nonmathematical introduction to the principles and applications of computers employing tubes and other electronic devices. The treatment has been made as general as possible in order to give a broad background picture of the whole field of computing.

Both digital and analog computers are covered, and comparisons are made between the two types. Circuitry and construction are stressed, and computer applications in industry, commerce and science are outlined. The future evolution of computers is also discussed.

Mechanisms and Dynamics of Machinery

Hamilton H. Mabie and Fred W. Ocvirk, John Wiley & Sons, 440 Fourth Avenue, New York 16, N.Y., 442 pages, $8.50.

Of an elementary nature, this text provides discussions of analytical cam design, nonstandard spur gears, computing mechanisms, synthesis, and vibrations. It contains chapters in linkages; cams; spur gears; bevel, helical, and worm gearing; gear trains; computing mechanisms; synthesis; kinematics of machinery; force analysis of machinery; balance of machinery; and vibration in machines.

Manufacturing Methods and Processes

Arthur C. Ansley, Chilton Co., Chestnut & 56th Sts., Philadelphia 39, Pa., 561 pages, $12.50.

With this broad presentation, the author has attempted to summarize for the executive, the purchasing agent, and the design engineer, the newest developments in manufacturing methods and processes.

Although the text covers well-known processes like sand casting, stamping, and machining, it gives special attention to new developments such as powder metallurgy, investment casting, plastics, ultrasonic machining, dielectric heating, electronic printed circuits, and automation. The chapter on assembly processes emphasizes the tremendous savings that can be made in this phase of manufacturing.

Describing briefly the methods and equipment used in each process, the book places its chief emphasis on the type of parts made by the process, their main applications and cost. The more than 450 illustrations give a clear idea of the equipment used in the processes described and of the end products.

Most-Often-Needed 1957 Radio Diagrams and Servicing Information

Compiled by M. N. Beitman, Supreme Publications, 1760 Balsam Rd., Highland Park, Ill., 192 pages, $2.50.

Large schematics, alignment data, voltage values, and other information needed for the repair of all popular sets released during the past 12 months are presented in this volume. The book contains circuits and essential service material for home radios, portables, combinations, auto sets, hi-fi, and transistor receivers.

Cathode Follower Nomogram

Output Impedance and Bandwidth

THE DEPENDENCE of the output impedance of a cathode follower on the tube parameters and on the value of the cathode resistance is given by

$$Z_{out} = \frac{R_c}{1 + SR_c}$$

where S is the tube transconductance, ma/v, R_c the cathode load in ohms, and Z_{out} the output impedance of the cathode follower, in ohms.

Example 1: S = 7 ma/v, R_c = 200 ohms.

From scales 1, 2, and 3 of the monogram we find Z_{out} = 83.5 ohm.

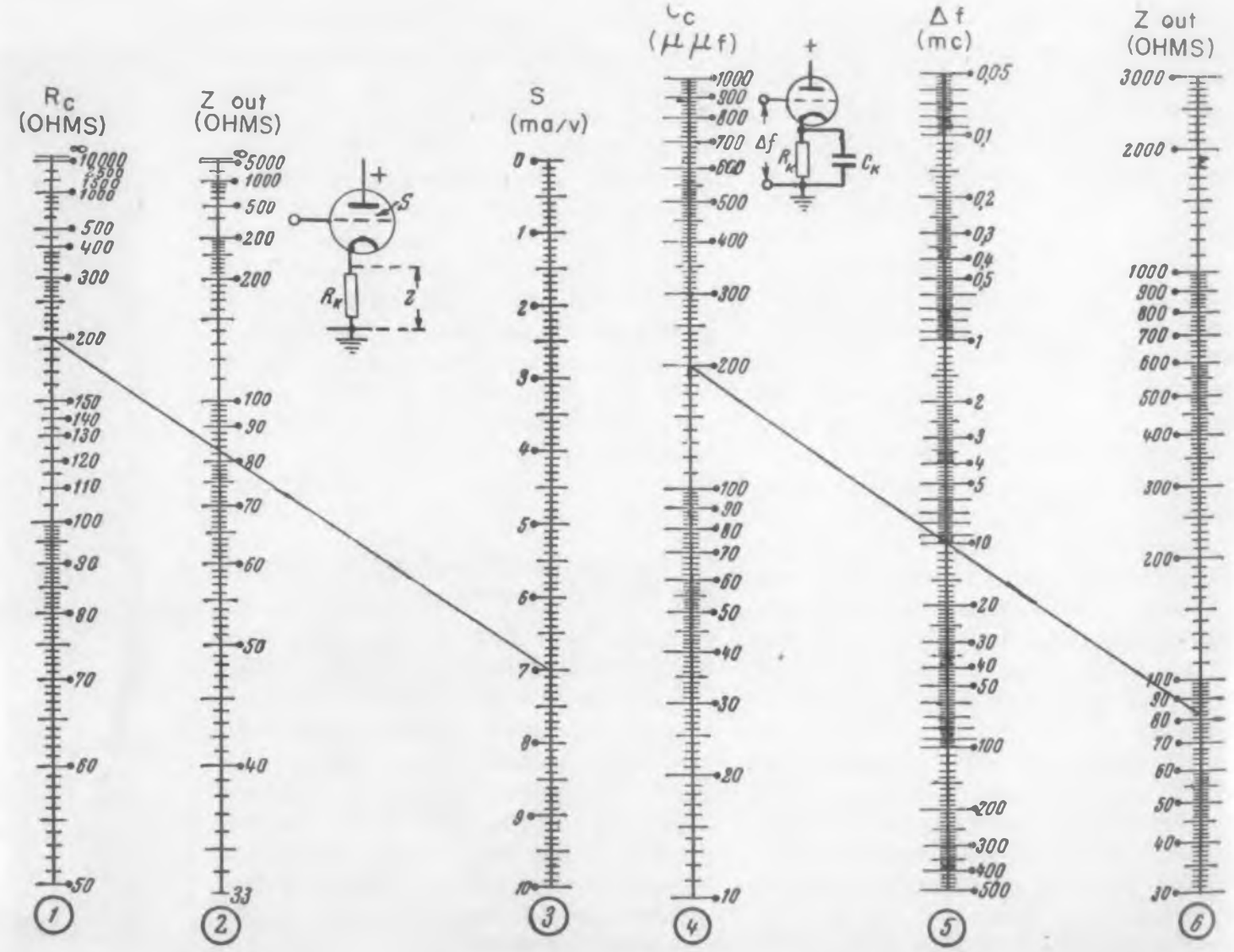
Knowing Z_{out} and the value of the bypass capacitor C_c we can obtain the bandwidth Δf of the cathode follower (measured at a 3db level), using the following equation:

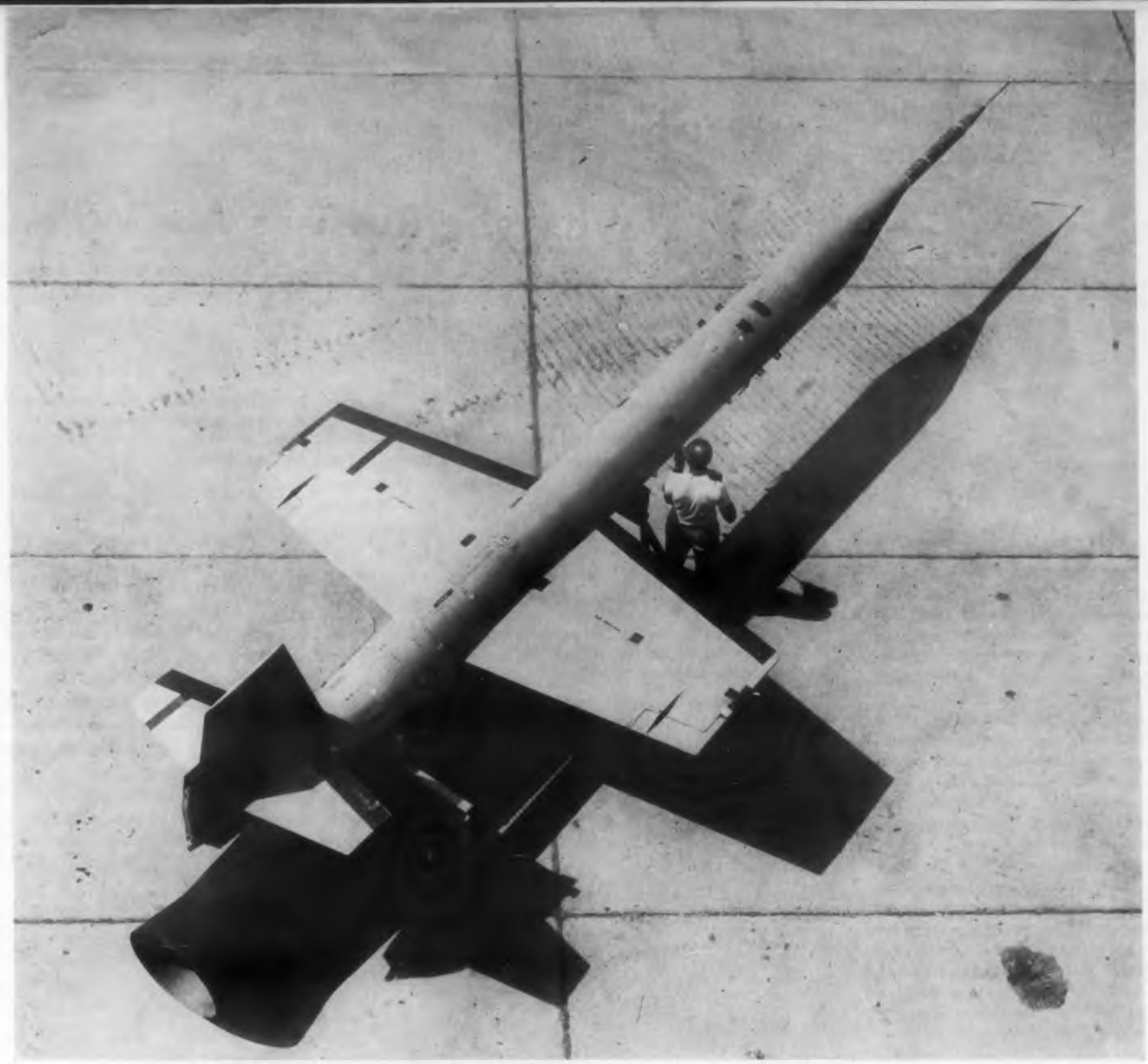
$$\Delta f = \frac{1}{2\pi C_c Z_{out}}$$

The nomogram to the right (scales 4, 5, 6) is used for this relationship.

Example 2: Z_{out} = 83.5 ohm, C_c = 200 μμf.

We get Δf = 9 mc.





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What the Russians Are Writing

J. George Adashko

Radiotekhnika i Elektronika, No. 7, 1956

This issue is devoted in its entirety to papers dealing with radio-engineering and electronic phases of the design of high-energy proton accelerators. These papers were delivered at the Conference on the Physics of High-Energy Particles, held by the USSR Academy of Sciences in Moscow on May 14-22, 1956.

The following papers contain material of interest to workers in electronic design and in allied fields:

Automatic Tuning of Output Stage of 10 Bev Synchrophasotron, G. M. Drabkin, L. M. Gurevich, B. M. Gutner, N. K. Kaminski, 9 pp, 8 figs.

Variable-frequency control circuitry used for the output stage. A block diagram of the system is shown in Fig. 1, and the circuit itself is shown in Fig. 2. A phase discriminator circuit is used as an error detector and a special automatic-gain-control circuit is used in the preamplifier to prevent background amplitude modulation and to maintain the output voltage constant.

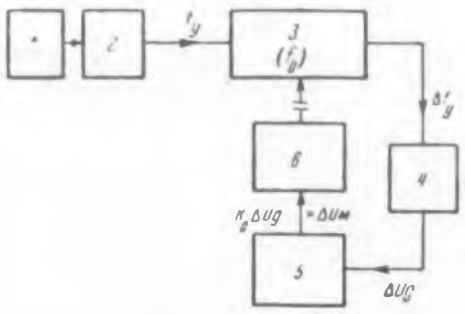


Fig. 1: Block diagram of control circuitry. 1—master oscillator, 2—broadband amplifier, 3—output stage, 4—error detector, 5—amplifier, 6—modulator, which varies output frequency by changing the magnetizing current.

Measurement of the Instantaneous Frequency of Frequency-Modulated Signals, S. M. Rubchinski, A. A. Vasilev, V. F. Kuz'min, and N. I. Fedorenko, 15 pp, 11 figs.

Discusses four precision measurement methods: 1) the selectivity method, based on the use of the selective properties of the resonant circuits; 2) the stroboscopic method, based on visual observation of Lissajous figures; 3) two-channel heterodyning method, which makes use of special voltage conversion resulting mixing a standard fixed frequency with the measured one in two channels; 4) phase method, which involves measuring the time interval required to change the phase of the measured signal by a multiple of 2π. The accuracy of all these methods is shown to be better than $\pm 5 \times 10^{-4}$. Refers to "Instantaneous Measurement of a Varying Frequency" by Hibbard and CarO (*Rev. Sci. Instr*, 1952, 29, p 366), "Measuring a Varying Frequency" by Chase (*Electronics*, 1950, 23, p 110), and "Variable Frequency Electric Circuit Theory" by Carson and Fry (*BSTJ*, 1937, 16, p 513).

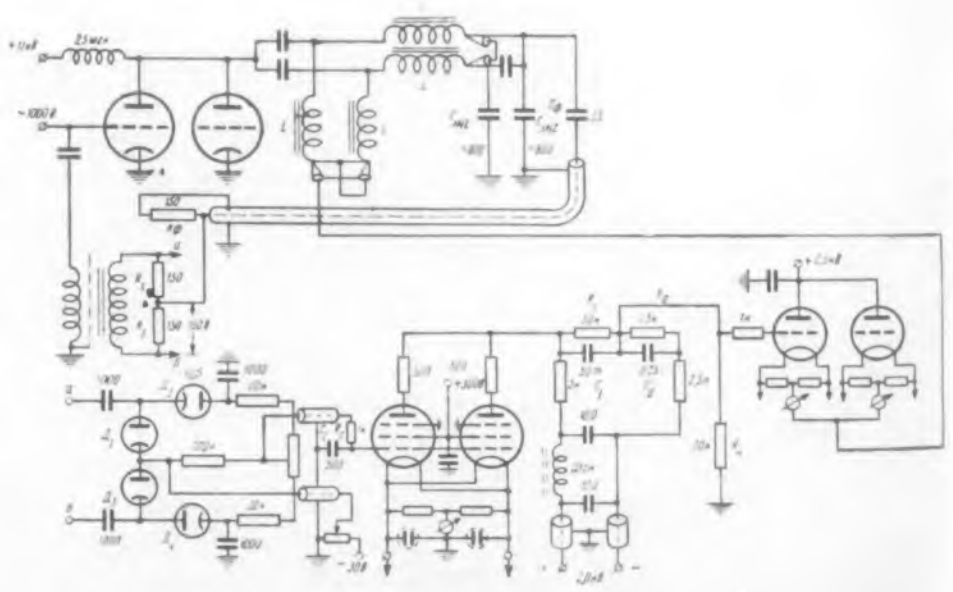


Fig. 2

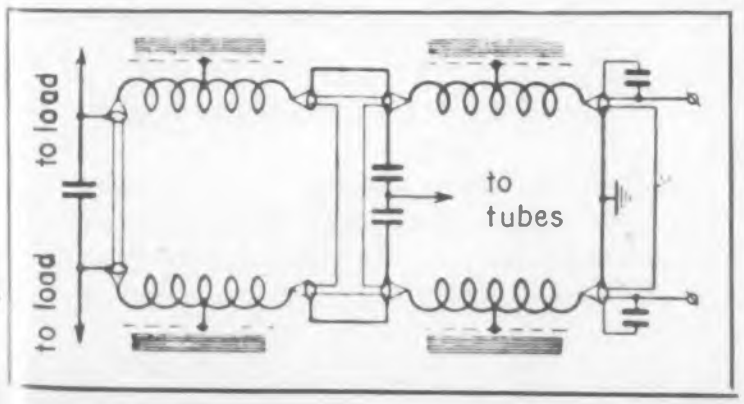
Measurement of Instantaneous Intensity of Varying Magnetic Fields, S. M. Rubchinski, M. P. Zel'dovich, S. S. Kurochkin, 13 pp, 8 figs.

Discusses the design of various circuits used for precision measurement (better than ± 0.05 percent) of magnetic field intensity, using the nuclear magnetic resonance method, and gives the relative accuracy of the measurement circuits. Cites numerous American References.

Use of Ferrite-Core Inductances in Power Stages of the Synchrophasotron, I. Kh. Neviazhski, G. M. Drabkin, V. F. Trubetskoi, A. S. Temkin, 11 pp, 9 figs.

The design objective was a variable inductance to form, with the capacitance between the accelerating electrode and ground, the tuned circuit of the hf output stage. A feature of this stage (used in a 10 Bev accelerator) is that the resonance frequency varies during the process of particle acceleration. The voltage in this circuit is 20,000 v, the capacitance about 2000 micromicrofarad, the maximum current about 380 a, and the reactive power reaches 3800 kva. The initial acceleration frequency is 0.18 mc, rises within 0.3 seconds to 1.5 mc, where it stays constant for three seconds. The voltage is then switched off for 6 seconds, and the cycle repeated. Mechanical tuning of the circuit being almost impossible, the variable permeability of ferrites is used. The article is devoted to the choice of ferrite materials for such high power, and to electrical and mechanical design of the tuned circuit.

Below is the equivalent diagram of the tuned circuit. The h-f current-carrying conductor is in the form of a coaxial pipe. The exciting winding is in the inner tube, while the outer tube carries cooling water. The ferrite core is air cooled.



Measuring Techniques for Nonlinear Networks

E. Brenner

A METHOD for determining the even-harmonic content of a distorted signal is based on adding to the signal another signal which is identical in waveform to the original but delayed in time by a half-cycle of the fundamental frequency. Such an operation is indicated in Fig. 1 for the periodic signal $f(t)$. This follows from the well-known fact that a wave with "mirror" symmetry has no even harmonics. In actual practice such a time displacement cannot be performed with sufficient accuracy for determining distortion factors for even harmonics.

It is possible however to sample a certain value of the function by using a small control pulse at a given instant of time to charge a capacitance. Examples of this are found in pulse modulation systems and in clamping circuits. The capacitor charge is then compared with the value of the function a half cycle later. Between the two sampling times the signal is reversed in polarity as indicated in Fig. 2. The change in charge on the storing capacitance is then a direct measure of the asymmetry of the half wave. In order to examine in the course of time all portions of a period of the signal it is necessary that the control pulse repetition rate be somewhat different from the actual frequency, f. The relative frequency difference $\Delta f/f$ must be small because it leads to a proportional null effect also in the absence of even harmonics. This null effect can be compensated if it is possible to keep the absolute frequency difference Δf constant. Fig. 3 shows a block diagram of a measuring system which may be used in this connection.

Two RC-oscillators for 25 kc and 2 cps respectively are used. Each of these furnishes two voltages which are precisely 90 degrees out of phase with each other. Such oscillators can be constructed with good stability so that both outputs can be obtained in push-pull. By using the four available potentials one can form the sum frequency 20.002 kc with the aid of two push-pull modulators. The signal is modulated with the first carrier (25 kc) and the lower side band is eliminated with a quartz filter. The upper side band can now, with the aid of the second carrier, be demodulated and the desired translated frequency band is obtained.

The control pulses are obtained without difficulty by the method shown in Fig. 3.

In the procedure which has just been described the shifting of the frequency band causes the harmonics, after shifting of the original signal, to be no longer exact harmonics. The shape of the signal changes therefore with the frequency Δf. The points at which the signal passes through zero compared to the points at which the original unshifted signal passes through zero depend on the amplitude and phase of the harmonics. For even harmonics the null points move

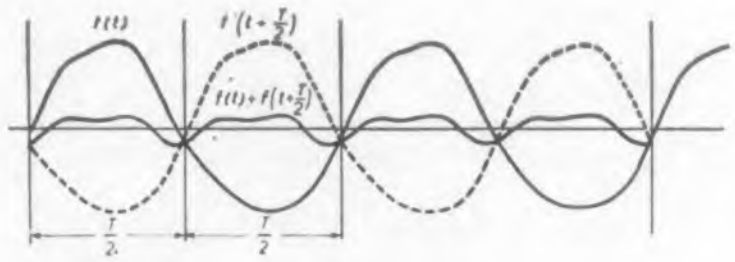


Fig. 1: Adding a periodic signal to a version of itself which has been shifted by T/2 yields the even harmonics of the signal.

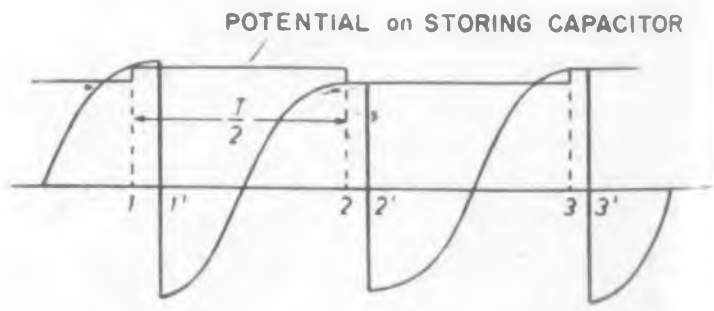


Fig. 2: Halfwave asymmetries may be measured through sampling, storing, and polarity inversion. Points 1, 2, and 3, are the sampling points. Points 1′, 2′, and 3′ are the points of polarity inversion.

towards each other while for odd harmonics they move in the same direction. For the even harmonics this effect can easily be measured if the signal is limited symmetrically with the respect to the zero level as shown in Fig. 4. The motion of the null points of such a rectangular wave manifests itself as a variable d-c component. The effective value is for distortion factors of less than ten percent given by:

$$g_{eff} = \frac{2}{\pi}\sqrt{\sum_{m=1}^{\infty} B_{2m}{}^2 \cdot \cos^4\left[(2m-1)\cdot\frac{\pi\cdot\Delta f}{2f}\right]}$$

where B_{2m} represents the harmonic components of $2m$. The quantity g_{eff} is except for the factor $2/\pi$, the distortion factor due to the even harmonics. The number of harmonics which can be taken into account is determined by the relative frequency ratio. With signals of 40 cps and a frequency shift of 2 cps the twelfth harmonic can be included. This alternate method has the advantage of direct measurement for the (even) distortion factor. In addition, because of the limiter used, the result is valid over a wide range independent of signal amplitude.

An analytical treatment of harmonic distortion in which the distortion is related to the Taylor series of the nonlinear characteristic is also included in the paper.

Abstracted from an article by H. Nottebohm,, Elektronische Rundschau, *Volume 10, No. 4, April 1956, pp. 99.*

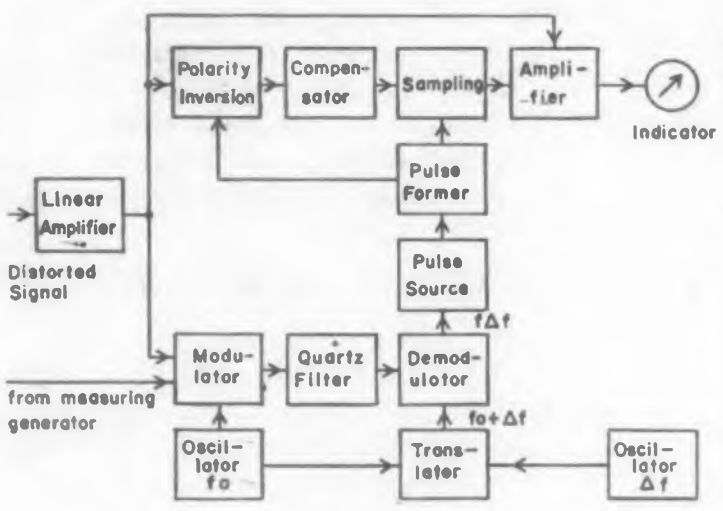
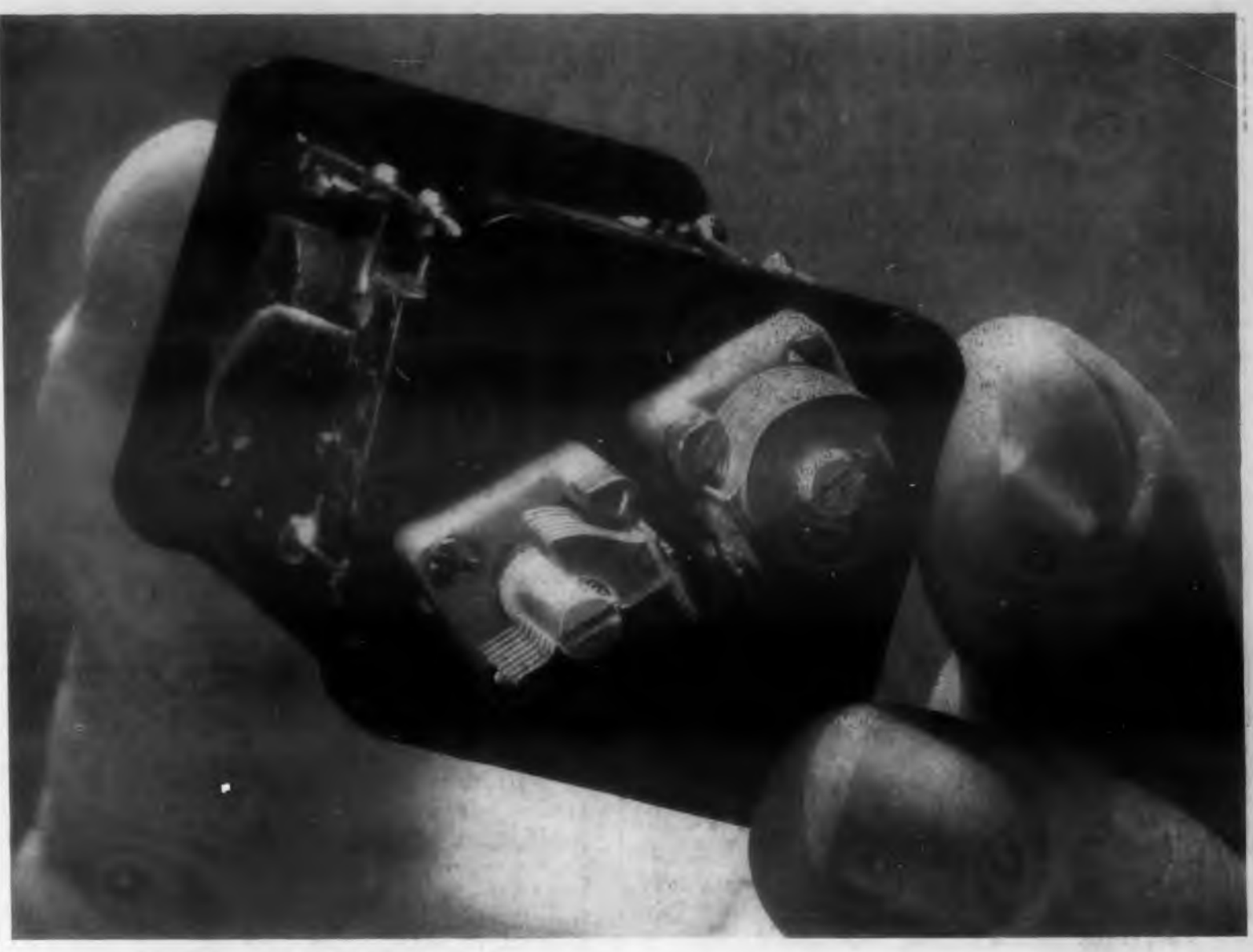


Fig. 3: Block diagram of measuring system.

Fig. 4: Even harmonic distortion can be recognized and measured through the movement of null points, after frequency translation and amplitude limitation of the signal.



Standards and Specs

Sherman H. Hubelbank

Connectors

MIL-C-71A, Connectors, "N", for Radio Frequency Cables, Supplement 1A, 9 October 1956

The "MS" military standards which form a part of the spec are listed by the supplement. Ten standards cover assemblies, 12 cover piece parts, and six cover common piece parts.

MIL-P-642A, Telephone Plugs, Amendment 1, 17 December 1956

The shell dimension for the cap of type PJ-636 plug is now 1/4 inch instead of 3/16 inch. Reference to the mating jack in table VI is changed from JJ-018 to JJ-015. The list of referenced specs, and publications, and the requirements for packing, packaging, and marking for shipment have been revised.

MIL-J-641A, Telephone Jacks, Amendment 2, 10 December 1956

Type JJ-015 replaces type JJ-018 wherever it is referenced in the basic spec. Type JJ-015 has an "open one, close two" switching action. The schematic diagrams for types JJ-078 and JJ-106 have been corrected. The list of referenced specs, and publications, and the requirements for packing, packaging and marking for shipment have been revised.

Electronic Modules

MIL-E-19600 (AER), General Specification for Electronic Modules, 1 September 1956

The general requirements for the design and test of electronic modules are covered by this spec. In accordance with this spec modules shall be designed (1) to provide a "building block" which will allow a flexible overall form factor for the equipment involved; (2) to permit the redesign or modification of an existing equipment in a minimum length of time; (3) to allow the integration of a number of equipments into a system, operating from a common power source, and with a common source of cooling air; and (4) in keeping with the standardization of the module form factor, mounting and cooling, thus decreasing engineering time for new design.

Batteries

MIL-B-18B, Dry Batteries, Amendment 2, 20 September 1956

Two categories have been established for Leclanche and Mercury cell batteries. Table III concerning capacity requirements has been replaced by table IIIa, entitled Capacity Test Requirements, table IIIb, Sampling Plan and Acceptance Numbers for Capacity Tests, and Table IIIc, Vibration Test I and Mechanical Shock Test I Acceptance-Inspection Test Acceptance and Rejection Numbers, and table IIId, Minimum Acceptable Value of the Median .

Cables

MIL-C-17B, Cables, Radio Frequency; Coaxial, Dual Coaxial, Twin Conductor, and Twin Lead, 14 January 1957

Two spec sheets were revised and four spec sheets were added. The new spec sheets cover miniature, high-temperature coaxial cable.

MIL-C-3849, Electrical Cord (Tinsel), Amendment 1, 10 December 1956

All references to the properties, test requirements, and test methods relating to insulating and jacketing compounds, formerly described in the body of the spec, have been deleted and replaced by reference to MIL-I-3930, entitled Insulating and Jacketing Compounds. Electrical (for Cable, Cord, and Wire). The test for breaking the load of the core is referenced to Method 3021 of Federal Spec J-C-98. The eight revised spec sheets now specify the particular type of Buna-S material, as indicated in MIL-I-3930, for the insulation and shield material.

Test Equipment

MIL-B-15421B (Ships), Capacitance-Inductance-Resistance Bridge, 12 September 1956

A test set for checking capacitors, resistors, inductors, and transformers aboard Naval vessels and at shore stations is described by this spec.

Transistors

MIL-T-19500A, General Specification for Transistors, 19 October 1956

The general requirements for transistors for use in electronic equipment are covered by this spec. This spec supersedes MIL-T-19500 (Ships), dated 7 May 1956; MIL-T-12679A (SigC) dated 23 September 1953; and MIL-T-25830 (USAF) dated 17 May 1956. The effective date for the supersession of MIL-T-12679 (SigC) will be November 1956

MIL-T-19501A (Ships), Transistor, Type 2N175, 11 October 1956

An audio, low level, low noise, germanium alloy PNP transistor, type 2N175 is covered by this spec.

MIL-T-19504 (Ships), Transistor, Type 2N119, 13 October 1956

A silicon NPN Grown Junction Transistor type 2N119 is covered by this spec.

Resistors

MIL-R-19518 (Ships), Resistors, Variable, Wirewound, Precision, 31 August 1956

Precision variable wirewound resistors capable of producing an output voltage (in terms of percent of applied voltage) proportional to the angle of shaft rotation are covered in this spec. It includes linear and nonlinear, single turn and multi-turn, single section and ganged assemblies of variable resistors. The resistors are capable of full load-operation at ambient temperatures of 40° to 100°C. A typical type designation for this spec is RK09AEKM 203P.

MIL-R-19074A (Ships), Resistors, Fixed, Nonwirewound, Accurate, High Stability, 4 October 1956

Accurate wirewound, fixed resistors whose metal resistance element is thermally fused to a ceramic or glass tube are covered in this spec. The resistors have a resistance tolerance of 1% and 5%, and are capable of continuous full-load operation at any ambient temperature up to 85°C and derated, up to 150°C. A typical type designation for a resistor meeting this spec is RI94E1000F.

Electronic Equipment

MIL-P-1755C (Ships), Preparation for Delivery of Electronic Equipment; Accessories, Auxiliary Equipment, and Associated Repair (Maintenance) Parts, 13 August 1956

The cleaning, preservation, packaging, packing and marking requirements for electronic equipment, accessories, and auxiliary equipment, furnished as part of a complete electronic system and associated repair parts are established by this spec.

Identification Plates

MIL-P-15024B (Ships), Plates, Identification—Information and Marking for Identification of Electrical, Electronic, and Mechanical Equipment, 5 November 1956

The material requirements for identification plates and information plates and the marking information for identification plates mounted on units, assemblies, and equipments of BuShips material are established by this spec. The types of plates classified by this spec are etched, engraved, stamped, cast, stenciled, laminated, decalcomania or adhesive-backed metal foil, photographic, and embossed.

Capacitors

MIL-C-11693A, Capacitors, Feet Through, Radio-Interference Reduction, Paper Dielectric, AC and DC (Hermetically Sealed in Metallic Cases), Amendment 1, 11 October 1956

This amendment adds two Military Standards covering style CZ24 and CZ23 capacitors.

Resistors

MIL-R-22A, Resistors, Variable (Wirewound, Power-Type), Supplement 1B, 12 October 1956

This supplement adds 12 "MS" Military Standards to the spec covering the following styles of resistors: RP10, RP11, RP15, RP16, RP20, RP25, RP30, RP35, RP40, RP45, RP50, and RP55.

Transformers

RETMAS RS-174, Audio Transformers for Electronic Equipment, Decembrer 1956

Iron-core transformers for use in electronic equipment in which long life, reliability, and continuity of operation are essential are covered in this standard. These transformers are required to transform voltages with fidelity over a designated frequency band and operate within specified impedances. It is not intended that the frequency band be limited to the region of audible frequencies. This standard is a revision of TR-121. Copies of the standard may be obtained from the Radio-Electronics-Television Manufacturers Association, 11 W. 42nd St., New York 36, N.Y. for 90 cents each.

RETMA RS-176, Pulse Transformers For Radar Equipment, December 1956

Covered in this standard are iron-core pulse transformers for use in radar transmitters and similar equipment where long life, reliability, and continuity of operation are essential. Copies of this standard are available from RETMA for 60 cents each.

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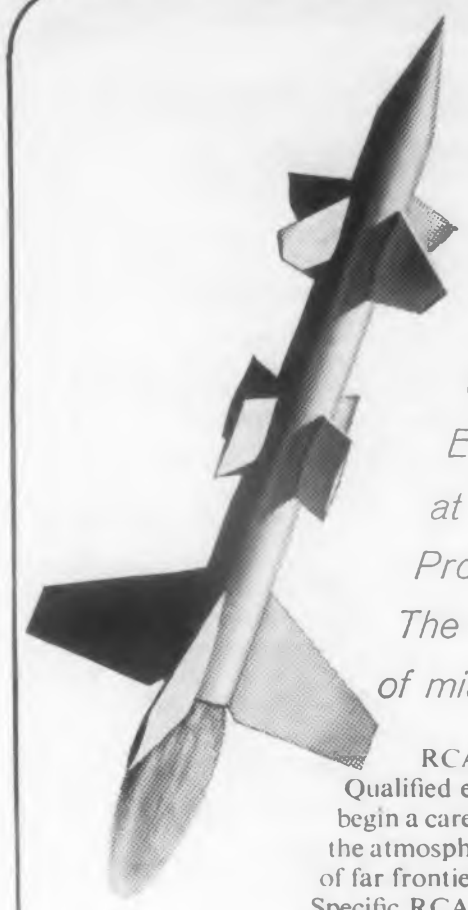

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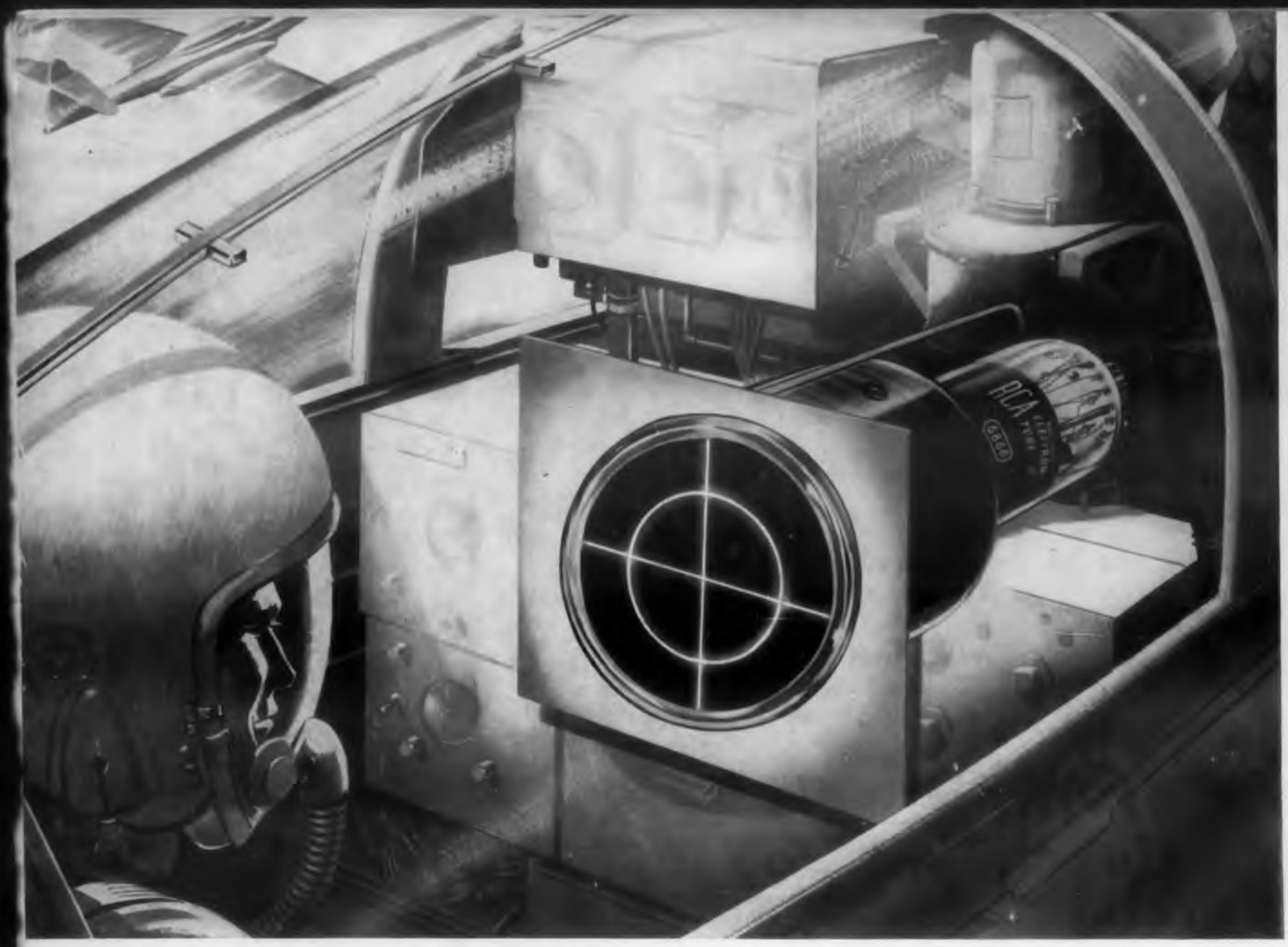

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