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DESIGNING FOR SHORT-RUN PRODUCTION

An ELECTRONIC DESIGN *Staff Report*

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RONIC ESIGN

NOVEMBER 24, 1959

HIGHLIGHT OF THIS ISSUE

Designing for Short-Run Production (Cover) 32

Designing for low-quantity production poses many unique problems. In this 30-page report, dozens of illustrations show hundreds of design techniques culled from the "bags-of-tricks" of scores of engineers.

Though there is no single solution to the problems in designing for short-run production, these pages show many approaches, many "nuts-and-bolts" techniques, and many broader philosophical measures which can be used to smooth the way.

(Plant photo used in cover design is courtesy of Rivins & Caldwell, Inc., High Point, N. C.)

SIDELIGHT OF THIS ISSUE

Let's Go, George!

In his Editorial in this issue, page 31, associate editor George Rostky wisely advises engineers to learn when to stop engineering and start getting a design into production. Rostky learned this lesson the hard way: he didn't take his own advice.

For months he gathered material for his report on short-run production. (It appears in this issue.) He visited dozens of plants, spoke to hundreds of people—he wouldn't stop.

A week late getting his copy to the printer, Rostky was still calling the coast for more information. The printer was screaming at editorial production manager Dollie Viebig. Viebig was screaming at managing editor Jim Lippke. Lippke was screaming at what was left of Rostky. And Rostky was screaming "But there's more out there."

And there is. Rostky promises to deliver it in future issues.

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An ELECTRONIC DESIGN *Staff Report*

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New Navy Report Raises Possibility:

Can Research Be Organized Mathematically?

A NEW REPORT prepared for the Navy to determine the nature and value of basic research raises an intriguing possibility. Could a mathematical model be constructed to guide the distribution of effort in research?

Such a model would simplify the organization of a research program. It would also aid in ensuring optimum distribution of money and effort between basic and applied research. At some point its effects would reach the design function, where it could help clarify many problems.

The theory of the model is outlined in a report, "Basic Research in the Navy," prepared by Arthur D. Little, Inc. This study examines the nature of basic research, its growth in Navy programs, and its importance to the country. The study's major conclusion: Navy basic-research spending, once adequate, is no longer enough. Successful industrial companies are spending for basic research twice the Navy's percentage of its R & D budget—16 per cent versus 6-8 per cent.

In investigating the nature of research, the Arthur D. Little team developed a preliminary model for study and application of knowledge. The model is based on the idea that research can be considered the discovery of individual facts in a body of facts; at any moment in the research process some of the facts have been uncovered, and the rest are awaiting discovery. Certain facts are "key facts"—the last ones that must be found before a useful invention can be developed.

The process of discovering the key facts is compared in the study to a two-stage chemical reaction, $A \rightarrow B \rightarrow C$, where A represents the key facts not yet discovered, B the key facts that have been discovered, and C the final applications.

The first major step in the research process is finding the key facts. The second step is the process of invention.

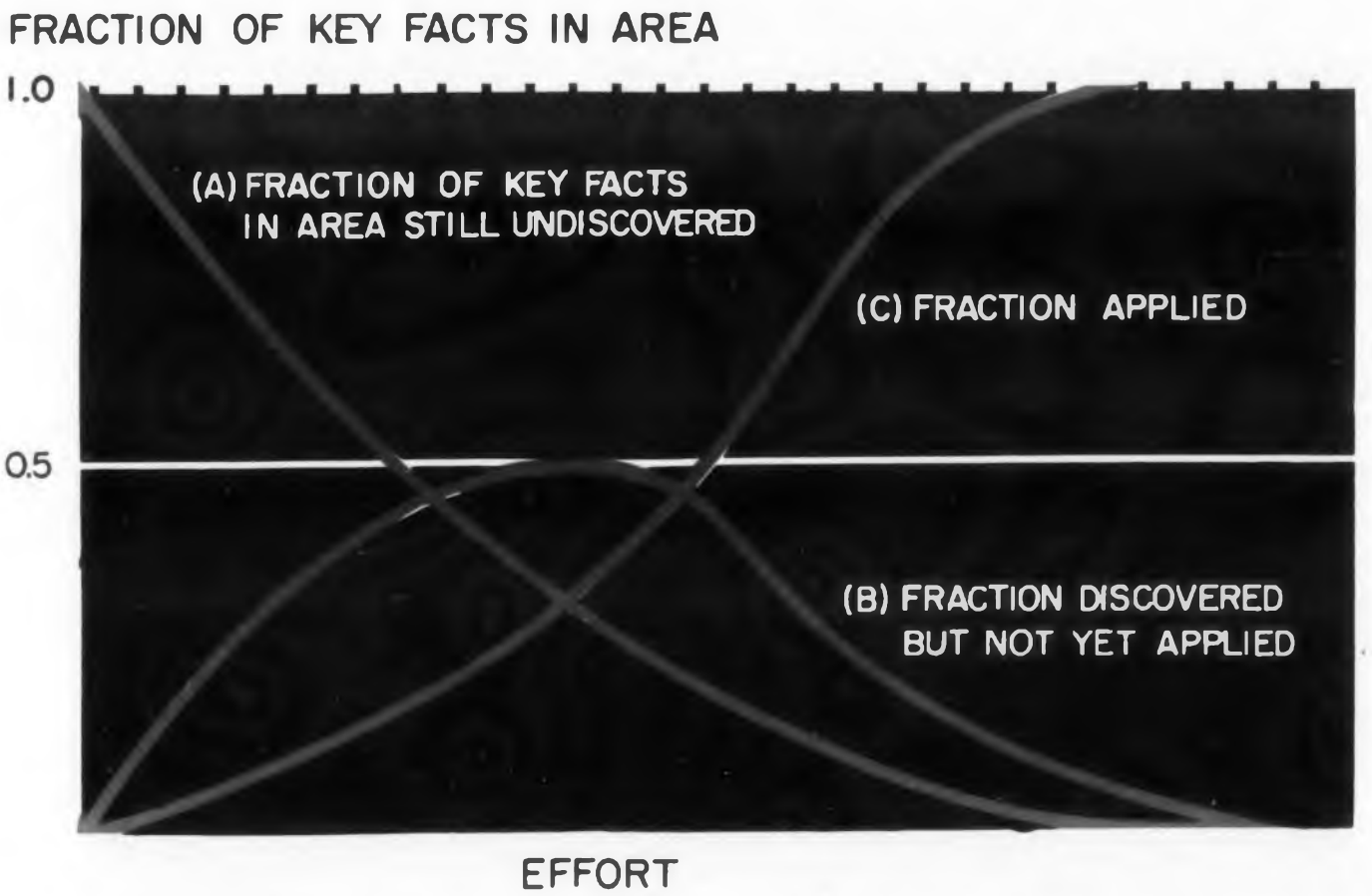
"The development of a field proceeds as a step function, with a breakthrough opening a new body of knowledge, which is then explored and applied," the investigators reported. "Within the region of a single step, the development follows the familiar S-shaped growth, or logistic, curve."

According to the researchers: "The chemical analogy suggests, and the theory of search developed during World War II reinforces, the idea that the rate of the first step is proportional to the effort put into the process and to the number of undiscovered facts. Similarly the rate of the second step should be proportional to the effort put into it and to the number of discovered but unapplied facts."

Thus the first rate should be of the form k_1E_1A, and the second, k_2E_2B, where E_1 and E_2 are the respective efforts, and k_1 and k_2 are the two constants of proportionality, with the dimensions of reciprocal time.

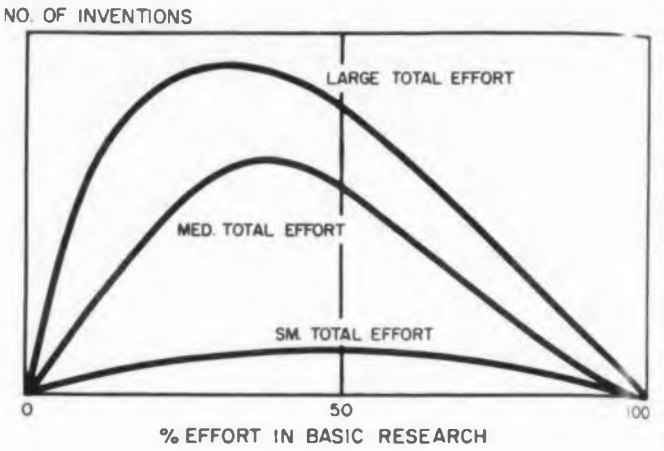
The constants k_1 and k_2 are measures of the relative ease with which the two processes can be carried out. If k_1 and k_2 are equal, the two processes are equally easy. If $k_1 = 10\ k_2$, it is 10 times as easy to find a fact as to apply it, and so on.

"To find the proper balance of effort between



A typical history of a research process aimed at exploiting an area. At any stage of research, the facts to be discovered and applied are distributed as shown. The curves were developed in studies for a mathematical model that would lead to optimum research efforts.

NEWS



How should research effort be applied for best results? Each curve here shows how the total result of the effort, as measured by the number of inventions, changes as the distribution of the effort between basic research and applied R & D is varied. The curves happen to be plotted for an effort in which it is easier to find a fact than to apply it.

the two steps, it is clearly necessary to find a way of determining these 'ease factors,'" the investigators said. "One approach to this is by the analysis of past experience."

Plotting the Research Process

If during the development of a field, the effort put into each of these two processes is held at a constant ratio, the system can be formulated and solved as follows:

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

$$\frac{dA}{dt} = -k_1 A$$

$$\frac{dB}{dt} = k_1 A - k_2 B$$

$$\left.\begin{aligned} A &= 1 \\ B &= C = 0 \end{aligned}\right\} \text{ at } t = 0$$

$$\frac{dC}{dt} = k_2 B$$

for the intermediate step, B

$$B = a_1 e^{b_1 t} + a_2 e^{b_2 t}$$

$$a_1 = -a_2 = k_1/(k_2 - k_1)$$

$$b_1 = -k_1 \qquad b_2 = -k_2$$

for the final step, C

$$C = a_0 + a_3 e^{b_3 t} + a_4 e^{b_4 t}$$

$$a_0 = 1 \qquad a_3 = k_2/(k_1 - k_2) \qquad a_4 = k_1/(k_2 - k_1)$$

$$b_3 = -k_1 \qquad b_4 = -k_2$$

This solution gives the set of curves for A, B and C, (see Typical History graph), where the C-curve corresponds to what is empirically ob-

served; the curves taken together show the facts in each category and how they move with time.

But this is a simplified picture, which presents a distorted picture of the *B* state. It implies that the unit of knowledge once applied, cannot be reapplied with experience. The facts are not applied in units but in combination. The k_2 process, in yielding to application of knowledge, does not generally apply to a unit of knowledge, but to a conclusion drawn from a number of units of knowledge.

Thus a fact may be applied many times, in different combinations with other facts. This, the researchers report, leads to two difficulties in the model outlined:

- The number of combinations available from a number of facts increases extremely rapidly as the number of facts increase, so that neither the *B* nor the *C* curves will approach a limit, much less decrease.
- If combinations of *A*-state units are assumed to be *B*-state units, the dimensionality of the equation for dB/dt is wrong.

To remove these flaws, the study team proposes a more complicated model based on continued syllogisms that reduce to Boolian algebra.

The simpler system shows the promise of the basic idea, however, and gives an insight into the operation of the ease factors. If it were possible to observe all three of the curves, the analysis of the research process would be relatively simple. But data are hard to get, the team reports. The only data obtainable were for a few cases, which gave only the *C* curve.

"These few cases, however, are in excellent agreement with the prediction of this theory," the researchers said. "Furthermore they indicate a ratio of k_1/k_2 in the neighborhood of 2"—which means it is twice as easy to discover a fact as to apply it.

Handle With Care

But, the researchers warn: "It would be risky in the extreme to draw the conclusion that this ratio is universal. It may very well be that this ratio varies widely from one field of research to another."

If the theory could be accepted, it would be possible to study the problem of the correct distribution of effort between the two steps. Both kinds of effort are necessary; the question is: how should a given total effort be divided?

"If too much effort is put into the first step, and too little into the second," the investigators reported, "the result will be the discovery of a large fraction of the key facts but the application of only a small fraction of those discovered. If too much effort is put into the second step, and too little into the first, only a small fraction of the key facts will be found. While a large frac-

tion of the discovered facts will be applied, the number of applications will be small, because the number of discovered facts is small."

Generally if the total effort is small, the best result is obtained when the two efforts are equal. As the total effort is increased, the position of the maximum shifts. How this shift takes place depends on the ease factors, k_1 and k_2.

If, as studies so far indicate, the actual ratio of k_1 to k_2 is about 2, the optimum fraction of basic research in a large program to develop a field should be in the neighborhood of 30 per cent, the team reports. "This suggests that a larger effort should be placed in basic research than is now the case," the researchers said.

What's next? The team concludes that its program "has shown enough basic promise to warrant consideration for further development."

This would take the form of:

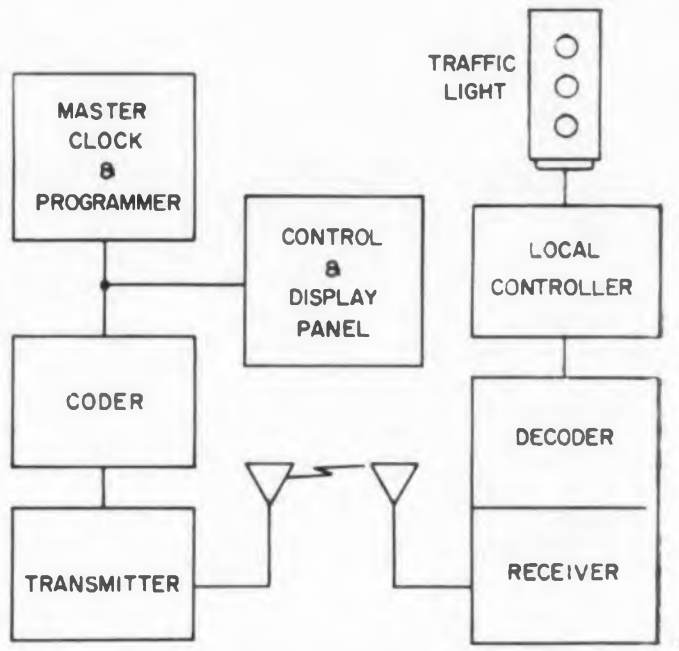
- More elaboration of the mathematics, probably involving computers for numerical integrations. Numerical rather than analytical solutions seem indicated.
- Elaboration of the relationship between time, manpower, and other factors in the effort function.
- Development of independent criteria to measure the model's effectiveness. ■ ■

World's Largest Traffic Control System Being Installed

Installation of the first phase of the world's largest radio traffic-control system has been completed in Washington, D. C. The new system, being installed by Motorola, will provide for synchronization and coordination all of Washington's 1000 traffic lights and for the automatic change of their cycles.

At the master control station will be the master clock and programmer, a coder, two master dial cabinets, and a control display panel. The clock and programmer is a high-speed, high-capacity punched-tape readout device. The signal cycle variation, determined by traffic study, is coded on punched paper tape.

As the tape is fed through the readout device, the cycles for specific intersections for specific periods of time are selected. This information is translated into audio tone codes, which are generated by the central-station coder. These tone codes are transmitted by the radio base station to the various intersections. The time cycles, in effect, are shown on the display panel, which also includes manual control buttons for emergency use.



Radio control system now being installed will ultimately synchronize all of Washington's traffic. Economics determined use of radio in place of usual cable.

Independent of the function change tone codes and the working of the master programmer are the generation of the synchronization codes by the master time-cycle units. These tone codes are decoded and applied to the regular local signal controller, causing the desired effect—time-cycle change and synchronization.

Improved Airborne Sonar Due For Submarine Detection

A Navy method for detecting submarines from helicopters is scheduled for formidable improvement with a Sonar system of "greatly increased range."

The system uses a transducer, dunked periodically by a long cable from a helicopter, to spot enemy submarines by Sonar echo ranging. The 'copter then unleashes homing torpedoes to destroy the undersea craft.

The Pacific Division of Bendix Aviation Corp. is producing the improved Sonar, which is reported in limited production. Fleet evaluation tests are scheduled for January, to be followed by volume production.

The transducer in the system is similar to a direction-sensitive microphone. But it not only picks up reflected water-borne vibrations, as a microphone picks up airborne sound waves, but shows visually in the 'copter cockpit the position and nature of the reflection.

The airborne Sonar scans 360 degrees with range comparable to shipboard equipment, Bendix reports. Hundreds of square miles of ocean can be searched in an hour with it, the company adds.

NEWS

Space Communications Net In 5-10 Years Is U.S. Goal

Ambitious plans for a world-wide communications network in space in the next 5 to 10 years have been disclosed by the Army.

Relay satellites "hovering" over the equator would constitute the heart of the network. The system envisions the transmission and reception of both voice and pulse signals from point to point on the earth via the satellites.

Announcement of the plans last month preceded by two weeks a decision by President Eisenhower to transfer the Army Ballistic Missile Agency to the civilian National Aeronautics and Space Administration (NASA). The transfer order is subject to Congressional amendment or rejection.

In telling of the space communications plans, Brig. Gen. Earle F. Cook, Deputy Chief Signal Officer of the Army, reminded the Radio and Television Executives Society at a New York meeting that the military had already taken the first step toward space communications. He referred to Project SCORE (Signal Communications by Orbiting Relay Equipment), an Army-developed communications package placed in orbit by an Air Force Atlas missile in December, 1958.

SCORE demonstrated, General Cook noted, that voice, teletypewriter and even multiple teletypewriter signals could be received, stored and retransmitted by a satellite.

Series of 'Tasks' Slated

Further advances, the general said, will be grouped as "tasks" under Project Notus.

In a three-year period beginning the middle of next year, he continued, several new communications satellites will be launched at relatively low altitudes of about 650 miles minimum. These will act as couriers of messages (Task Courier). As a satellite whirls over a ground station, it will receive a message, store it on magnetic tape and feed the communication to another ground station to which it is addressed.

"The trick, of course," General Cook explained, "is to transmit and receive all of this traffic at exceptionally high rates of speed during the short period that the satellite is passing over each ground station. Our system has a traffic-handling capacity equivalent to 20 teletypewriter channels each operating continuously at a rate of 100 words a minute."

Real-time or instantaneous satellite repeaters are a further goal of Project Notus. Two-way communications in the polar regions, the general said, will be covered by satellites to be launched by the Air Force (Task Steer) and the Army (Task Tackle).

For world coverage—aside from the polar regions—a real-time communications relay station (Task Decree) will be placed in a 24-hour equatorial orbit, General Cook related.

"Operating at about 23,300 statute miles above the earth's surface," he said, "a Decree satellite will travel at such a speed that the rotation of the earth will keep the space vehicle in a fixed position with respect to the earth. It will effectively 'hover' over a given location along the equator.

"At this great distance, a large portion of the earth is visible to the microwave transmissions of the satellite, which acts as a relay between points on the earth separated by several thousand miles."

Many voice channels, including one for aircraft communications, are planned for the equatorial satellites. General Cook estimated that three or four of the stations, "properly placed in space, would be sufficient to literally cover the world—except for the small polar areas."

He cautioned, however, that before the communications network could be set up, engineers and scientists must solve such key problems of transmission and reception as propagation. "Atmospheric interference, cosmic influence, fading, distortion and other effects," he noted, contribute to the sometimes "tantalizing and unpredictable behavior" of kilomegacycle waves.

President Orders Transfer

A fortnight after General Cook's speech, the President, acting under the Government Reorganization Act, ordered the Army relieved of its space activities. The move was explained as in no sense a cutback of space explorations but rather an attempt to accommodate and accelerate the work under a central control.

Two kinds of activities were recognized by the White House in its explanation: super-booster space vehicles with 1,500,000 pounds thrust, "not looked upon as having any military significance," and ICBMs of some 300,000 pounds thrust, which have a military purpose.

About 90 per cent of the effort of the Army Ballistic Missile Agency, headed by Dr. Wernher von Braun, has been concentrated on the Saturn rocket engine, designed to provide 1,500,000 pounds of thrust. This work would be transferred to NASA.

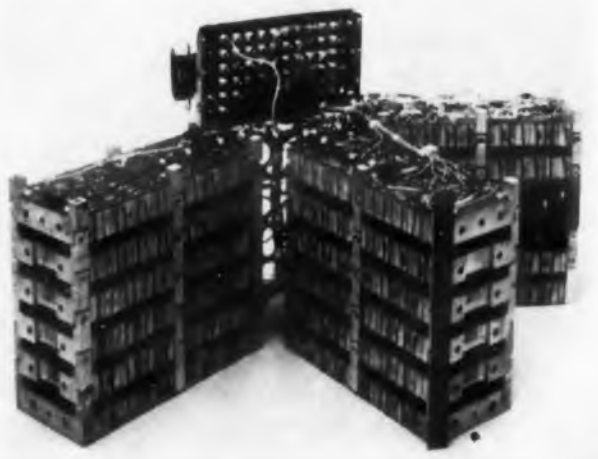
The President's order included "provision"—not otherwise specified—for continuation of the Army's military missile programs. It was believed the Air Force would inherit this work.

Congress has until Dec. 20 (sixty days under the reorganization law) to amend or reject the transfer order. If neither the House nor the Senate votes against it, the switch will become effective.

The transfer has been recommended by the Defense Dept. and NASA.

NEWS

Telebit System Shown Unpackaged



Telebit telemetering system now circling earth in Vanguard VI accepts analog and digital inputs from various experiments and converts data to a binary coded, 1024-cps subcarrier that modulates a 5-watt transmitter signal. System is serving in satellite primarily as test for use in space probes. Transmitter of 150 watts is expected to provide 64 pulse-per-second data transmission from distance of 55 million miles.

RF Head Fits On Antenna In Radars Designed for Weather Tracking

An antenna designed specifically for meteorological use incorporates a piggy-back radio-frequency head to supply r-f energy to the antenna. This unit fits directly behind the antenna reflector and is said to eliminate changing the complete waveguide run for changeover.

The S-band storm finder can be converted for

Weather Bureau S-band radar can be switched to X or C band without changing complete waveguide run.

operation at X- or C-band frequencies by changing the rf head. A servo system remotely controls antenna position and mode of operation. It provides the normal slewing, tracking, azimuth and elevation scanning functions.

Currently, the Weather Bureau is operating 75 low-power, short range radars originally designed for tracking aircraft. The storm-finding radar network now being installed will blanket the country with an electronic warning system. The radars are being produced for both the Bureau and the Navy by Raytheon Manufacturing Co., Waltham, Mass. ITE's Special Products Div. is building the antenna systems under subcontract from Raytheon.

SIGNIFICANT CONTRACTS . . .

. . . **To Stromberg-Carlson,** Rochester, N.Y., $1,200,000 from the U. S. Navy Bureau of Ships for the design and development of an advanced, completely transistorized single-sideband communication system.

. . . **To Melpar, Inc.,** Falls Church, Va., $550,800 from Wright Air Development Center for a two-phase study and development for a speech compression system.

. . . **To Electronic Engineering Co.,** Santa Ana, Calif., $358,000 from the F.A.A.'s National Aviation Facilities Experimental Center for range instrumentation work. The contract covers the engineering study of the over-all range instrumentation system and recommendation for a complete system to meet NAFEC requirements.

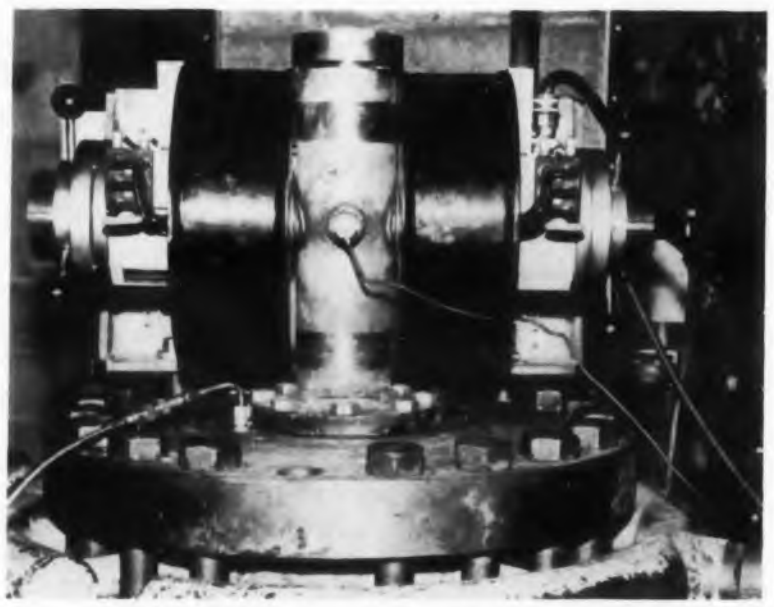
. . . **To Electronic Systems Development Corp.,** Ventura, Calif., $200,000 from the Navy for the development, manufacture and installation of a precision radar synchronization system linking all the tracking surveillence radar facilities of the Pacific Missile Range.

. . . **To Polarad Electronics Corp.,** Long Island City, N.Y., $300,000 from the Western Development Laboratories of Philco Corp. for special microwave receivers with extremely precise calibration.

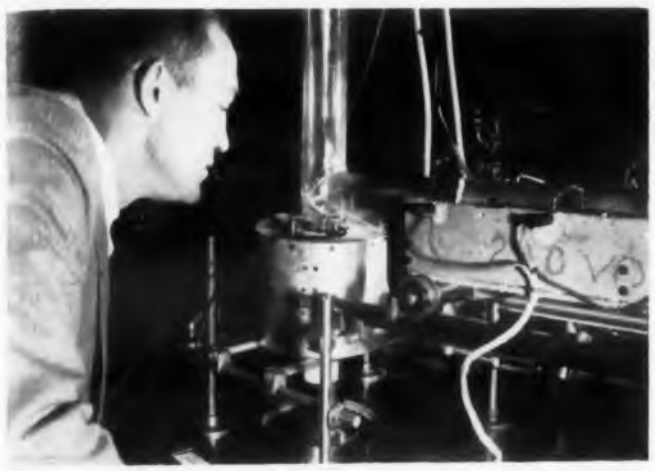
. . . **To Daystrom Instrument Div.,** Murray Hill, N.J., from ITT Laboratories for the development and manufacture of two militarized random-access memory systems for use with data-processing equipment servicing the Strategic Air Command's control set up. The value of the contract was not disclosed.

Design News in Photos

The Army's latest master aircraft navigation system, developed by Sperry Gyroscope, is now undergoing prototype flight tests in a Douglas R4D. Map display on pilot's knee is pierced by a moving light to continuously show exact position of plane. Other instruments enable pilot to fly a pre-test flightpath without resorting to outside navigational aids. By flipping overhead swiches, pilot can navigate automatically with respect to grid north, true north, magnetic north or inertial gyro.



First photos of General Electric's magnetohydrodynamic energy converter show configuration (left photo) and the heart of the converter (right photo). The vertical cylinder flanked by electromagnet pole pieces houses the molded-quartz generator shown in the photo at right. Hot ionized gases directed up through the vertical cylinder cut the magnetic flux and create a voltage. Energy is extracted through two electrodes, one of which is shown in the smaller photo.



"The purest crystal ever made of any compound" is being produced in this apparatus at Battelle Memorial Institute. Indium antimonide with less than 1 ppm impurity is being made for low-temperature detectors.

Countermeasure simulator, developed by Sylvania Electric Products Inc. and being installed at air-defense stations, simulates four types of marking jamming for radar training.

Second Generation data processing system developed by IBM for American Airlines will keep track of a million or more reservations, inform any of 1,100 ticket offices of the availability of seats, record data on new reservations retrieve data on an electric typewriter, automatically indicate an omitted detail, search files to confirm reservations, and make spelling corrections. The system is expected to be installed in 1962.

NEWS

New Components Featured At Devices Meeting

State-of-the-art reports on tunnel diodes, new tubes, low-noise amplifiers and functional devices highlighted the 1959 Electron Devices Meeting in Washington, D. C. In addition, design improvements were described in traveling-wave and backward-wave devices, cathode ray tubes and semiconductors.

Dr. R. N. Hall, of GE's Research Laboratory, presented the basic characteristics of tunnel diodes and outlined their future use with transistors and tubes. He predicted that several years development time would be necessary to fulfill the applications predicted for the device.

H. Heffner, of Stanford Electronics Laboratories, discussed the comparative merits of traveling wave tubes, parametric amplifiers, masers and tunnel diodes as low-noise amplifiers. He cautioned the audience to examine noise contributions offered to microwave systems by antennas, transmission lines, and other noise contributors preceding the amplifier; further reduction of amplifier noise might be of no avail if other noise sources override the input signal.

Multifunctional devices, specifically designed to perform a system function, are being developed by Bell Telephone Laboratories, revealed Dr. I. M. Ross. Conventional circuit design and interconnecting

Advanced cathode ray tube being described by Sylvania's H. E. Smithgall has a heater-cathode assembly said to be 25 times smaller than comparable standard assemblies.

wiring are dismissed in favor of a new approach in system concept. Outstanding examples of simplification giving increased reliability in telephone equipment were shown.

A 220-mc negative-resistance parametric amplifier, described by Dr. G. Schaffner of Motorola, Inc., uses only 0.1 mw pump power and provides 13 db gain.

A heater-cathode assembly, requiring only a 1.5-v, 140-ma heater supply, has been developed by Sylvania Electric Products. Requiring only six per cent of the heater power normally needed for 6.3-v, 600-ma tubes, the new design centers around a cathode-radiating surface of 0.0054 sq in., (see photo). Conventional structures have 0.136 sq. in. surfaces.

Among the other tubes described at the technical sessions was a "thin" picture tube called a reflected-beam kinescope, which displays its image on a screen 20 in. or more in diameter, and is only 10 in. deep. RCA reports that its recessed area is large enough to hold most of the receiving circuitry.

In this tube, the phosphor screen is mounted on the rear inner surface, near the gun. The electron beam is sent to the front of the tube, where it is reflected back from the transparent tubeface to the phosphor screen.

TWT Delivers 10 kw

RCA also reported on a developmental X-band traveling wave tube capable of delivering a peak rf power output of 10 kw. The electrosatically focussed tube uses different types of slow-wave rf structures rather than a bifilar helix to increase its power and frequency capabilities.

Papers from Europe and Asia described a silver-bonded diode for parametric amplification (Japan), a series of pulsed, high-perveance, high-power klystrons for linear accelerators (France), and a beam-power multiplier tube (Egypt).

About 1300 engineers attended the Oct. 29-30 meeting in Washington, D. C., sponsored by the IRE Professional group of Electron Devices.

NEWS

Pigeon in secondary trainer has passed his first flight tests and is now learning how to track targets that will be shown on display screen in front of "missile." For pecking the image on the nose the pigeon will be awarded with corn. Wire leading from pigeon's beak closes control loop when beak touches electrically conducting glass of display screen. Project was a wartime idea for a jamproof control system for homing missiles.

Navy Declassifies Details of Pigeon Guidance Project

A STUDY of missile guidance by pigeon pecking has been taken out from under wraps by the Navy. At the same time, perhaps to calm fears of guidance designers, the Navy made clear that the project has been discontinued (*ED*, Sept. 30, 1959, p. 11.)

Started during World War II, Project Orcon (for organic control), was a try-anything approach to solution of some then-current problems. Guidance systems for homing missiles were being easily countermeasured and the Navy thought animals might have potential as a jamproof control element.

Pigeons were selected for trial because they were light, easily obtainable and adaptable. Their job was to ride inside a missile and peck at an image of a target picked up by a lens in the missile's nose. The pigeon's pecking of the target image was translated into an error signal that corrected the simulated missile's simulated flight.

The project was revived in 1948 and carried further. In simulated rocket tests the pigeons produced "surprisingly good results." The researchers were convinced that a pigeon could successfully guide a speeding missile under optimum conditions, compensating for his own and the missile's errors.

But after three years of equipment development and testing, the project was abandoned because range of the Orcon system could be no greater than the range of any optical system and the system could be used only in the daytime.

The study was divided into two phases. The first, involving a primary trainer, tested the capability of pigeons. Could they peck fast enough? Could they distinguish between images of targets and backgrounds? How much training would they need?

Both the trainer and the pigeons passed their tests and a secondary trainer was developed. It used target images specially photographed in color by a jet

Pigeon in tracking position waits for image to appear.

plane, which made picture-taking dives at a destroyer and a freighter in the open sea. Highly original electronics provided a realistic situation for the birds.

Trainee pigeons were started out in the primary trainer pecking at slowly moving targets. They were rewarded with corn for each hit and quickly learned that good pecking meant good food. Eventually pigeons were able to track a target jumping back and forth at five inches per second for 80 seconds without a break. Peck frequency turned out to be four per second. More than 80 per cent of the pecks were within a quarter-inch of the target.

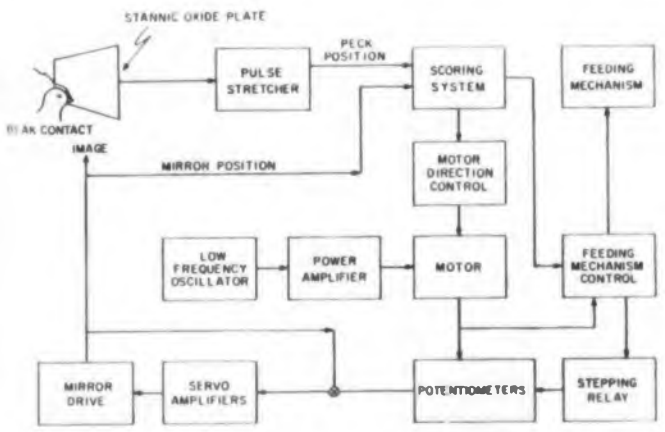
In guidance terms, the bandpass frequency of the pigeons was seven radians per second.

In the secondary trainer, the pigeon rode in a harness and actually changed the course of the target image by his pecking. The image was shown under a glass screen coated with stannic oxide to make it electrically conducting. Through circuitry based on the Wheatstone Bridge principle, pecks on the glass were translated into distance right and left and up and down from the center lines.

The target was moved by a small mirror controlled by a servo. The control circuits were such that if the pigeon stopped tracking, the target image would drift rapidly away from the center of the screen. This forced the pigeon to correct not only his own pecking errors, but those introduced by the yawing of the "missile."

A complete recording system provided data for analysis. It turned out that 55.3 per cent of the "runs" made were successful—that is, the pigeons were able to keep the target image on their screens for the duration more than half their flights. Four pigeons, however, were about 80-per-cent successful, raising the possibility that picking better tracers would result in still greater accuracies. The training conditions simulated

(continued on following page)



Highly original electronic design went into the circuitry for this secondary trainer, which permitted pigeon pecks to control movement of a target image on a screen.

missile-flight speeds of about 400 miles per hour.

If pigeon guidance did not get very far in the Navy, it did have one valuable offshoot. The electricity-conducting glass later used in many radar displays was developed originally for project Orcon.

NEWS BRIEFS . . .

. . . **MAGNETIC-DOMAIN** computer progress has reached the working-element stage at Servomechanisms, Inc., (*ED*, 10/14/59, p25). Goal is logic element of iron-nickel sheet made bistable by domain-domain interaction. Switching speed will reach 0.3 microsec.

. . . **THE TUNNEL DIODE COMPUTER** being designed by Leo Esaki and a Tokyo University group will incorporate a basic circuit using 30 tunnel diodes. Each diode will have a 30-mc switching speed. The first model is scheduled to be ready early next year about the same time that Sony is expected to start commercial production of tunnel diodes. The university computing group is also working on early designs for a computer with the same switching capacity as the human brain—100,000 diodes with a 100-mc switching speed will be required.

. . . **EXPERIMENTAL TV** colorcasts are being made with a low light-level image orthicon developed by GE originally for military use. The Z-5351 is said to produce acceptable pictures with 40 foot-candles of light, roughly the amount available at night baseball games and auditorium events.

UNIVAC solid-state computers will be available with this magnetic tape attachment, now being adapted for use with the Remington Rand units. Presently only punched-card capability is available with Univac solid-state computers.

. . . **TUNNEL DIODES** now being offered as samples by General Electric have resistive cutoff frequency of over 1100 mc, with peak tunnel current and voltage of 1 amp and 55 v.

. . . **COMPONENT SHIPMENTS** during the first half of 1959 were definitely up more than 30 per cent over those of the comparable 1958 period. According to the Dept. of Commerce, this is the greatest rise in component output since the Korean War, and confirms estimates based on earlier, less complete data.

. . . **COMPUTER** that would use solid-circuit modules has been proposed to the Air Force by Texas Instrument's Apparatus Div. Advantages of the computer over one of standard miniaturized-component design would line up this way, according to the company: Component density—5,000,000 parts/cu in. vs. 50,000; manufacturing steps per flip flop—14 vs. 188; components per flip flop—1 vs. 20; computer volume—12 cu in. vs. 864 cu in.; computer weight—1.2 lb vs. 10 lb.

SILENCER for Explorer VII satellite is a 2-in. cube designed to turn off the satellite's transmitter after one year. The Bulova unit draws 0.000000001 watts, has 9000 hour capacity.

. . . **THE AMERICAN STANDARDS ASSOCIATION** has approved the IRE's standard for television luminance signal levels. Designated C16.31-1959, "American Standard Method of Measurement of Television Luminance Signal Levels," the standard describes methods of measuring the significant amplitude levels of a monochrome or color TV signal, either composite or noncomposite.

. . . **THE AUDIO ENGINEERING SOCIETY** has honored Dr. Harold S. Black of Bell Labs, for "outstanding achievement in the field of audio engineering" and "in recognition of his original enunciation of the feedback principle." Dr. John G. Frayne, Westrex Corp., was honored by the AES for "outstanding development in the field of audio engineering" and "in recognition of his contributions to the development of photographic and magnetic motion picture sound recording devices, and of feedback cutters for monophonic and stereophonic disc recording."

NEWS BRIEFS . . .

. . . **PASSIVE** communication satellites are nearer because of successful launching last month of NASA's 100-foot aluminized balloon, shot into space from Virginia and effectively inflated.

. . . **THE INSTRUMENT SOCIETY OF AMERICA,** aided by an NSF grant will continue publishing translations of the 1959 issues of four Soviet technical journals: *Measurement Techniques, Instruments and Experimental Techniques, Automation and Remote Control,* and *Industrial Laboratory.*

. . . **THE SOVIETS** have ordered a medium-size transistorized British computer, the Elliott 802. The computer, which has a memory of about 1000 33-bit words, will probably be used for scientific work.

. . . **A THERMOELECTRIC** water purification apparatus developed by the Whirlpool Corp. uses thermoelements simultaneously for evaporating and condensing. Idea is to eliminate the large quantities of cooling water normally required in purification devices.

. . . **AN ELECTRONICS CENTER** at Hanscom Field, Bedford, Mass. will be established within the next eight months. Main objective is to establish a one-location organization for acquisition and delivery of large complex ground electronic systems.

. . . **A DIGITAL TELEVISON** transmission system, for long-range transmissions, jointly developed by the Colorado Research Corp. and the Signal Corps, is reported to give clear pictures under high-noise conditions.

PRICE CHANGES . . .

. . . Germanium scrap processing charges have been reduced up to 25 per cent by Sylvania Electric Products, Inc. . . . Single crystal Germanium prices have been cut from $296 to $285 per pound by Semimetals, Inc., Richmond Hill, N.Y. . . . Hyperpure-silicon, single-crystal prices have been cut by up to $150 per pound by the Du Pont Co. . . . Zener diode price cuts by Motorola Semiconductors, Phoenix, Ariz., have resulted in basic prices of $4.00, $2.90, and $2.90 for the company's 1N620, 3/4M7.5Z-through-56Z, and 1M7.5Z-through 56Z diodes.

WASHINGTON REPORT

Ephraim Kahn

New Defense Dept. Cost Principles Mean Aid, Trouble for Electronics

Uniform contract cost principles, set by the Defense Department after years of discussion—and dispute—with industry, promise both help and hindrance to the electronics industry. Use of the new regulation, formally titled Revision No. 50, Armed Services Procurement Regulation, may start at once. It is mandatory for contracts made after July 1, 1960. Existing contracts need not be amended to reflect the new cost principles, but they will apply in the negotiation of contract terminations.

Preliminary judgments by industry men indicate that these cost principles may slightly liberalize terms of cost-reimbursement contracts while possibly tightening the squeeze on holders of fixed-price pacts. Though the new regulations are considered "guidelines" by the military, it is generally believed that government officials will try to adhere to them as closely as possible. This could easily result in a decreased recovery of costs for firms working on fixed-price contracts.

This is acknowledged in the regulation itself, which notes that since the military "have not provided specific guidance in the past, these new principles will, at least in some instances, result in reduced recovery by contractors for certain particular items of expense."

Electronics firms that do independent research in addition to working on government contracts stand to gain from the cost rules change. Under the new rules, "a contractor's costs of independent research . . . shall be allowable as indirect costs . . . *provided* they are allocated to all work of the contractor." In other words, the government will pick up its share of the tab for basic research that is not sponsored by a contract, grant, or other arrangement if the company's other customers make a proportionate contribution.

Some Independent Development Chargeable

Costs of independent development directly aimed at specific products are chargeable to the government to the extent that it is related to the product lines for which the government has contracts. But such costs must be reasonable and be allocated to all work of the contractor on these product lines. Contractors who do not engage

in production work may charge the government for development to the extent that it is "related and allocated as an indirect cost to the field of effort" of government R & D contracts.

No blank check will be written for independent R & D. The Defense Department will assume a share of a reasonable amount of current R & D "in line with the national policy of encouraging independent research." But company expenditures must be consistent with "a broad planned program, which is reasonable in scope and well managed." Spending, especially for development, will be scrutinized with great care in connection with contractors whose work is "predominantly or substantially" with the government. Recognizing that cost-sharing may provide "motivation for more efficient accomplishment" of R & D, the new rules say that "it is desirable in some cases that the government bear less than an allocable share of the total cost of the program."

Incentive pay, cash bonuses, and other compensation are considered allowable costs by the government, except for stock options. These, as well as fringe benefits, must be reasonable and consonant with the company's past practice.

Contract termination costs are also subject to the new principles. In general, the government will not allow a charge for items that can reasonably be used on the company's other work, unless the contractor can show he would suffer a loss by retaining the items. The government will, however, pay for costs that can not be discontinued immediately after contract termination. In figuring termination costs, certain initial expenditures may be included, as are settlement expenses.

"Reasonableness" is probably the key word in the application of the new cost principles, and the one that will provoke the most debate. The regulation says that a cost is reasonable if it "does not exceed that which would be incurred by an ordinarily prudent person in the conduct of competitive business." But it is made clear that "what is reasonable depends upon a variety of considerations and circumstances involving both the nature and amount of the cost in question."

Not All Costs Covered

Not all cost items are treated in the regulation. This "is not intended to imply that it is either allowable or unallowable." Sample allowable costs include advertising in trade or technical journals (the ads can not offer specific products for sale); help wanted ads; cost of participation in exhibits under certain conditions; bonding costs; Civil Defense costs; wages, salaries, and other compensation; training and education expenses; depreciation; manufacturing and production engineering costs; and other normal business expenses.

Most interest will not be considered a charge

allowable by the government. In the past, interest costs were not allowed when contracts were completed, but the government considered rental paid for money in negotiating contract terminations. This is no longer the case. In addition, many other financial costs—bond discounts, costs of financing and refinancing, certain legal and professional fees paid in connection with stock issues—can not be passed on to the government. Interest levied by state or local government may, under specified conditions, be an allowable cost to the government.

The final word on cost principles has not been said in the new regulation. It is believed that some industries feel that the new rules do not meet their needs. They are expected to press for revisions.

Government Studies Computer Economics

Computer economics—whether to buy or rent automatic data processing machinery—is being studied by the Government. More and more agencies that handle substantial quantities of information are turning to computers to speed their work. So far, the inter-agency group that has been studying the question has not been able to come up with a single hard and fast rule for all agencies. It is indicated, however, that most agencies will, for the time being, rent rather than buy. After developments in the costly machines begin to be less rapid, there may be a swing to buying. (One of the government's largest users of computers, the Census Bureau, already buys its machines.

Biggest problem that faces government officials who have to decide whether to rent or buy computers is obsolescence. This is reflected in the government's tendency to rent machines with an option to buy. The government is also trying to figure out, well in advance, what to do with old computers.

It seems to regard trading-in obsolescent computers with misgivings, feeling, apparently, that predicting values in used equipment is at best an uncertain game. Besides, from the point of view of an agency processing cut-and-dried data (income tax returns, for example), technological obsolescence is not a real factor if there is no real need for equipment that embodies major improvements. In order to justify replacement of a data-processing system, such an agency would have to find a new one that promised savings large enough to offset the undepreciated part of the old system.

THE UNIVERSAL TRANSISTOR

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MEETINGS

Calendar of Events

December

*1-3 1959 Eastern Joint Computer Conference, AIEE, ACM, PGEC, Statler Hilton Hotel, Boston, Mass.

*1-2 4th Midwest Symposium on Circuit Theory, Marquette University, Milwaukee, Wis.

3-4 Professional Group Vehicular Communications, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

3-4 2nd Semiconductor Surfaces Conference, Silver Spring, Md.

*3-5 3rd Annual International Visual Communications Congress, Society of Reproduction Engineers, SRE, Statler Hilton Hotel, New York, N. Y.

*8-10 2nd National Conference on the Application of Electrical Insulation, AIEE, NEMA, Shoreham Hotel, Washington, D.C.

26-30 American Association for the Advancement of Science, Chicago, Ill.

January

6-9 Institute of High Fidelity Manufacturers 1960 High Fidelity Music Show, Shrine Exposition Hall, Los Angeles, Calif.

11-13 6th National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C.

12-15 Society of Plastics Engineers' 16th Annual Technical Conference, Conrad Hilton Hotel, Chicago, Ill.

25-29 Stress Measurement Symposium, Arizona State University, Tempe, Ariz.

February

2-4 15th SPI Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

3-5 1960 Winter Convention on Military Electronics, PGME, Ambassador Hotel, Los Angeles, Calif.

10-12 7th Annual Solid-State Circuits Conference, IRE, AIEE, Philadelphia, Pa.

11-12 7th Annual Cleveland Electronics Conference, IRE, ISA, AIEE, Engineering and Scientific Center, Cleveland, Ohio.

11-13 1st Annual Electronics Representatives Association, Drake Hotel, Chicago, Ill.

19-23 3rd International Electronic Parts Show, Paris, France.

*Includes meetings described herewith

9th Annual Eastern Joint Computer Conference, December 1-3

Delegates from industry, educational institutions, government agencies and nonprofit research centers will spend three days at the Statler-Hilton Hotel, Boston, Mass., exchanging technical information on computers, their current and future use, and the changes they are making in the nation's economy. A total of 27 technical papers—carefully selected to represent a wide range of current application and research in computer technology—will be delivered during the conference. In addition to listening to technical papers, many delegates will discuss current problems in the field during four concurrent evening panel sessions slated for December 2. Others will make inspection trips to either MIT's Lincoln Laboratory in

Lexington, or the Arthur D. Little Company in Cambridge. Thursday evening, December 3, a cash award for the best delivery of a technical paper during the Conference will be made. The main speaker for the evening will be Dr. Willis W. Ware, of the Rand Corp., Santa Monica, Calif. The Eastern Joint Computer Conference and its western counterpart are cosponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the Association for Computing Machinery. For additional information write to: George Wood, Office of Public Relations, MIT, Room 3-339, Cambridge 39, Mass.

2nd National Conference On The Application Of Electrical Insulation, December 8-10

Latest developments in the field of electrical insulation will be exhibited at the 2nd National Conference on the Application of Electrical Insulation, to be held at the Shoreham Hotel in Washington, D.C. The conference features a three-day technical program on the various phases and application of all types of electrical insulation. Particular emphasis will be placed on high temperature insulation, new insulating products, and new testing methods. The conference is co-sponsored by the American Institute of Electrical Engineers (AIEE) and the National Electrical Manufacturers Association (NEMA). For additional information write to: T. F. Hart, Chairman, Publicity Committee, C/O Silicones Division, Union Carbide Corp., 30 E. 42nd St., New York 17, N.Y.

3rd Annual International Visual Communications Congress, December 3-5

The 3rd Annual International Visual Communications Congress will be held in the Statler Hotel in New York City. Each morning there will be a technical session at which speakers from in-plant graphic reproductions-visual communications departments and manufacturers of materials and services will discuss the latest available techniques in the field of electrostatic printing, microreproduction and retrievables, office copying machines, offset, diazo and other methods of reproduction. The conference is sponsored by the Society of Reproduction Engineers. Everett Kaestner, Bell Telephone Laboratories, New York City, is the general chairman.

4th Midwest Symposium On Circuit Theory, December 1-2

The program for the 4th Midwest Symposium on Circuit Theory is as follows:

Tuesday, December 1—9 a.m.

Session I. On Analysis of Networks

A Primary and Secondary Aspect of the Equations of Electrical Networks, M. B. Reed and M. L. Wolla, Michigan State University

Determination of Transient Response in Electric Circuit Analysis by Use of Mikusinski's Opera-

MEETINGS

tional Analysis, K. D. Struthers and T. J. Higgins, University of Wisconsin

Axiomatic Formulation of Circuit Analysis, W. M. Brown, University of Michigan

Tuesday, December 1—1:30 p.m.

Session II. On Realizability and Synthesis

Simplified Formulation of the Properties (Foster and other) of the Driving Point Impedance of LC-Networks, L. C. Wilcox and M. B. Reed, Michigan State University

Low Q Filters, R. O. Rowlands, Pennsylvania State University

Synthesis of Grounded Two-Terminal-pair RLC Networks, S. L. Hakimi, University of Illinois

Passive Network Synthesis by a Matrix Transformation, R. P. Schuh, Oregon State University

An Extension of Prony's Method to Frequency Domain Approximation, J. B. Cruz, University of Illinois

Wednesday, December 2—8:30 a.m.

Session III. From Analysis to Design

A Useful Extension of the Nyquist Criterion to Stability Analysis of Multiloop Feedback Amplifiers, B. R. Meyers, University of Waterloo, Canada

Topological Consideration of the Realizability of a Communication Network, Omar Wing, Columbia University

Approximations to Wiener Optimum Filters and Predictors, F. J. Beutler, University of Michigan

Design of Combinational Switching Circuits Using an Iterative Configuration, D. L. Epley, University of Illinois

Wednesday, December 2—1:30 p.m.

Session IV. Of Active Networks

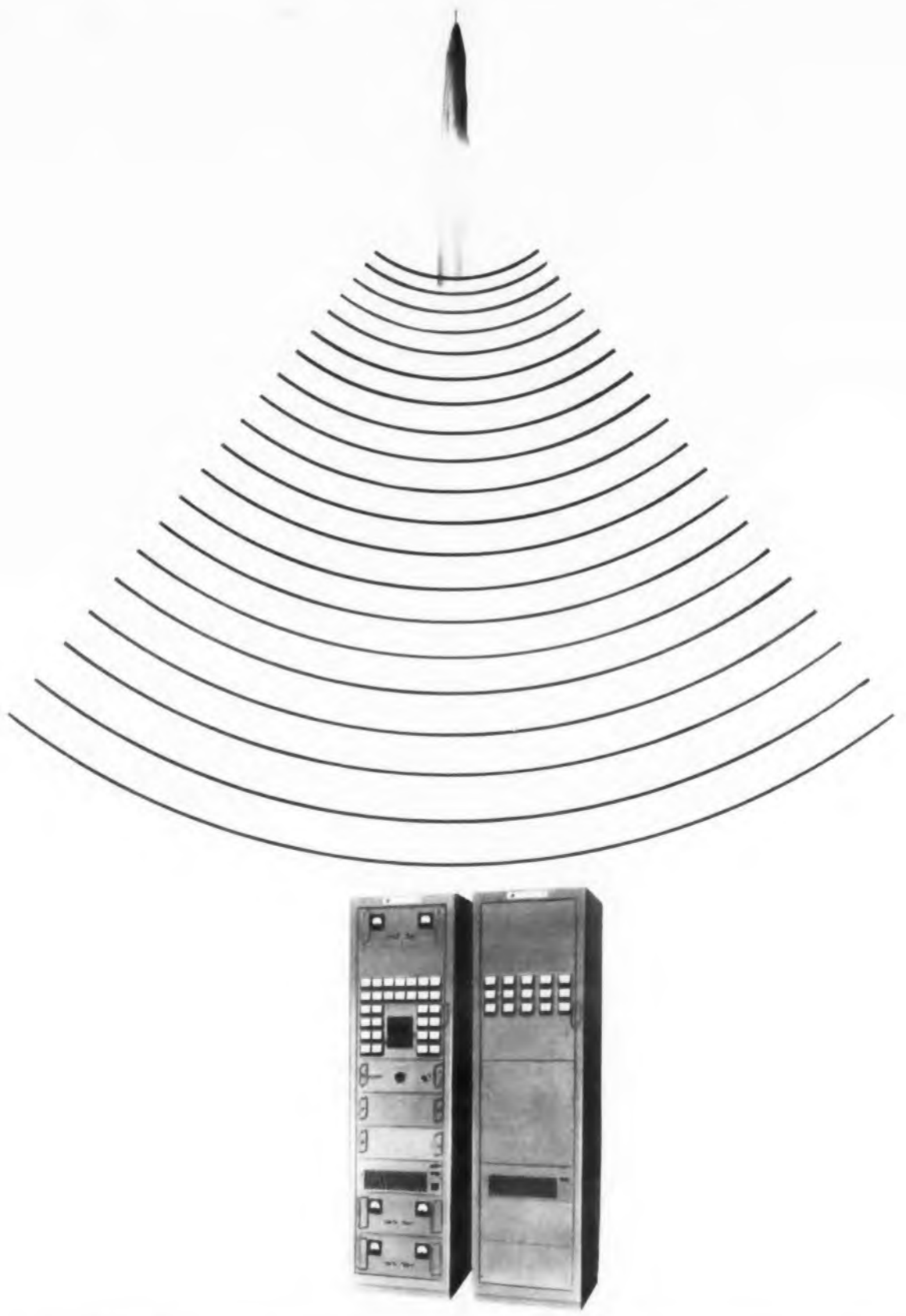
Recent Advances in Active Network Synthesis, M. E. Van Valkenburg, University of Illinois

Multi-terminal Representations in the Analysis of Control Systems, R. C. Dubes, Michigan State University

Multi-terminal Representations in the Analysis of Electronic Circuits, D. P. Brown and J. J. Land, Michigan State University

The Analysis of Large Systems Using Subsystems as Components, W. A. Blackwell and H. K. Kesavan, Michigan State University.

The location of all sessions will be Marquette University. For further information contact: Stanley Krupnik, Jr., Assistant Director, Dept. of Electrical Engineering, Marquette University, Milwaukee 3, Wisconsin.



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EDITORIAL

"To Hell with Engineering. Let's Ship."

Production runs are getting shorter. Large-quantity orders are becoming a fond memory. Lead times get shorter and shorter, while more and more we hear—"To hell with engineering. Let's ship."

The problem boils down to the fact that too many engineers know *how* to finalize a design, but not *when*. It's true that many engineers fall in love with their first design, but then they want to improve it, and refine it, and clean up that last bug before they'll let it go. Then everyone else wants to clean it up—production, quality control, even purchasing.

When the design passes the sketch pad, the breadboard, the mockup, the model shop, the preproduction prototype—when it's made several scurries back and forth between some of these stages—when it finally gets to the production line—then it's really late. By this time, everybody's frantic, and the customer is screaming.

Everybody along the line contributed to the havoc, but with the best intentions. The electronic design engineer wanted to deliver the most sure-fire circuitry. He was sure he could squeeze another few watts out of a 6L6. He knew he could eliminate two resistors. He was certain he could knock the hum level down a few db. And of course, he wanted to try the very latest components—the ones that came in just as he was about to OK the design.

The production engineer wanted to make the product as easy to manufacture as possible. He wanted it to breeze through the production line with no problems at all—no lost nuts to chase, no impossible-to-get-at mounting holes.

The purchasing agent wanted to buy the engineer's specified parts at the best possible price, with the fastest delivery, from the most reliable vendor.

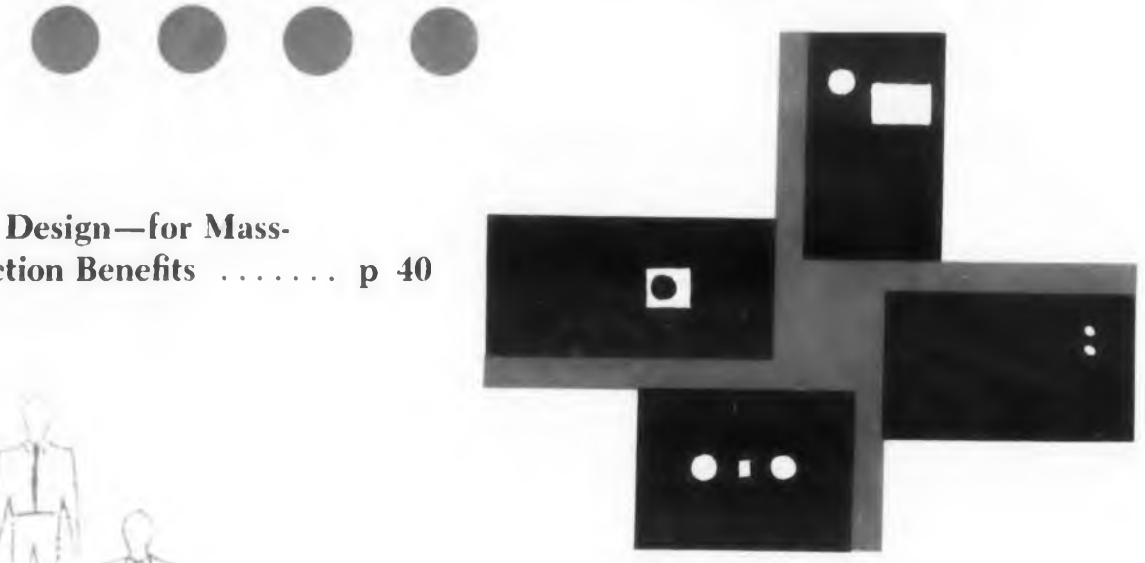
Everybody wanted to make the equipment the best that ever left the back door. But everybody held it back. Everybody was engineering the job too long.

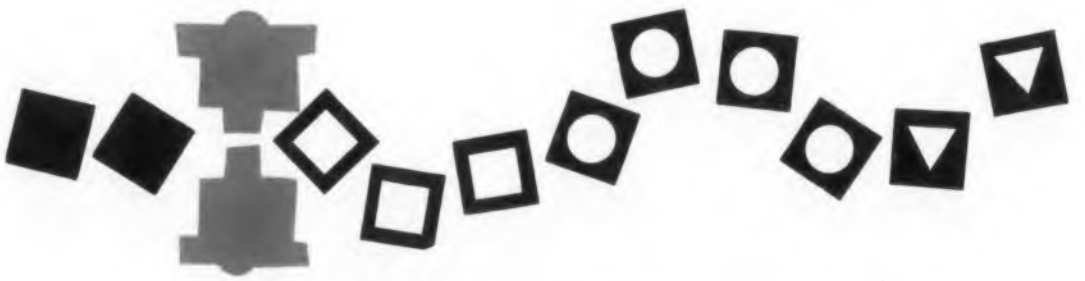
In short-run production, just as in mass production, it's important to know when to stop improving, when "that little extra" isn't worth while, when it's time to let go.

George H. Rostky

Designing For Short-Run Production

George H. Rostky
Associate Editor





IN DESIGNING for short-run production, there are no universal truths. There are no short-cuts, no bee-lines, no direct through-ways to economical design for the low-quantity run. But there are many approaches, many techniques, many tools to ease the job and cut the cost. Each has its place.

Tricks of the Trade

The short-run designer uses many tricks of the trade in trying to produce more efficiently. He looks for alternate and less expensive designs for the same job. He uses the same design for more jobs. He uses fewer parts for more functions. He uses standard, commercially available materials, parts, and processes.

Starting with the idea of designing for simplicity in production, he looks for what's easy to obtain. If he needs a chassis or a cabinet, for example, he checks a trade magazine or a catalog to see what's most suitable. He knows there's little excuse for not at least looking into commercial parts. But he also knows when to stop looking and start building.

He tries to design with in-the-shop supplies—stock room parts. But he tries lots of them. He doesn't want to select "hot" tubes or transistors.

He doesn't build a circuit that depends on a tube or transistor characteristic which isn't well controlled. He knows that a particular tube may have carefully-controlled G_m, but a poorly-controlled cut-off characteristic. If he's concerned with cut-off, he'll use a different tube type.

When he's forced to make something in the shop, he'll see if it's worthwhile to make a surplus.

He's wary of adjustments and knows that interacting adjustments are not the best way to win friends among production personnel.

In encapsulating assemblies, the designer doesn't mount a 10-cent resistor, which may burn out, with a $50 transistor. He'll encapsulate reliable components that function together so he can minimize leads to be brought out.

He knows the road his product must take from his sketch pad to the back door, and he tries to save steps along the way—even small steps.

He watches for those "less important" characteristics of components. He doesn't bury himself in details, but neither does he scoff at them. He

Our Special Thanks

We wish to thank

Mr. James M. Brearley
U. S. Navy Bureau of Aeronautics
Col. Marion C. Smith
Lt. Col. Lester E. Manbeck
Lt. Col. Kenneth J. Kiel
Mr. Leslie G. Ozier
U. S. Air Force

and the many others in industry and in the military for their special help in supplying information for this report.

knows that small details can hit him when he really doesn't need added troubles.

The successful short-run designer is mindful of changes in his preproduction prototype. He won't make those "nice" changes for a longer run or a redesign.

He dreads changes on the production line, so he won't carry engineering model shop designs into production.

He prefers catastrophic failures during the design stage. Subtle changes hurt.

Problems Galore

The short run brings with it many problems not normally encountered in large quantity production. Some of these problems will never be solved. Others can be solved—at least in part. The many problems include:

- Expensive capital equipment cannot be purchased for one short run as the costs cannot be spread over many items.
- Efficient, high-output, production machinery can seldom be justified economically.
- Time spent for setting up a production line and time for setting up test facilities are large compared with the total time spent on a project.
- Parts purchased in small quantities tend to be most expensive.
- Fabricated parts may have to be made by the most expensive processes and by the most highly skilled labor.
- Experience gained in one short run may not seem useful in another.
- Training operators takes a relatively long time. A project may be completed before manufacturing personnel operates at peak efficiency.

Approaches to coping with the short run take many forms—some of them diametrically opposed. The philosophy that serves one manufacturer may be a woeful hindrance to another. But experts agree: In most cases, the best way to cope with short-run production is to make it as much as possible like long-run production.

Just how to make the short run look like a long run is the subject of the following pages. ■ ■

Standardization—

A Powerful Tool

STANDARDIZATION is one of the most trenchant tools in economical design for short-run production. It is used extensively in one form or another. Standardization can be applied to parts (or a family of parts), to procedures and techniques, or to processes. If properly implemented, standardization can become an enormous money-saver.

Standards Program Really Works

One of the most effective systems of standardizing on the parts level is that used by the General Radio Co. in W. Concord, Mass. Says manufacturing manager Harold Wilson, "Our standardization program really works. We don't compel an engineer to use materials or parts from the preferred list, but he finds the list a great convenience."

Under the supervision of Henry Littlejohn, supervisor of Experimental Shop and Test Facilities, the standards program has many unusual features. First of all, it was designed by engineers, not by stock room supervisors.

Engineers have notebooks, kept up to date by almost daily revisions, which list all the preferred components, materials, and design standards. An up-to-date wall display (Fig. 1), of all preferred components shows samples and lists prices.

The engineer knows that he can find all preferred parts in the stock room and knows that they can be purchased in quantity, readily. He knows also that his company has thoroughly tested samples of each part and can provide data which even the vendor may not have.

As an example, for a dpdt toggle switch, G-R will list dissipation factor of the dielectric, dielectric strength to ground, capacitance between ter-

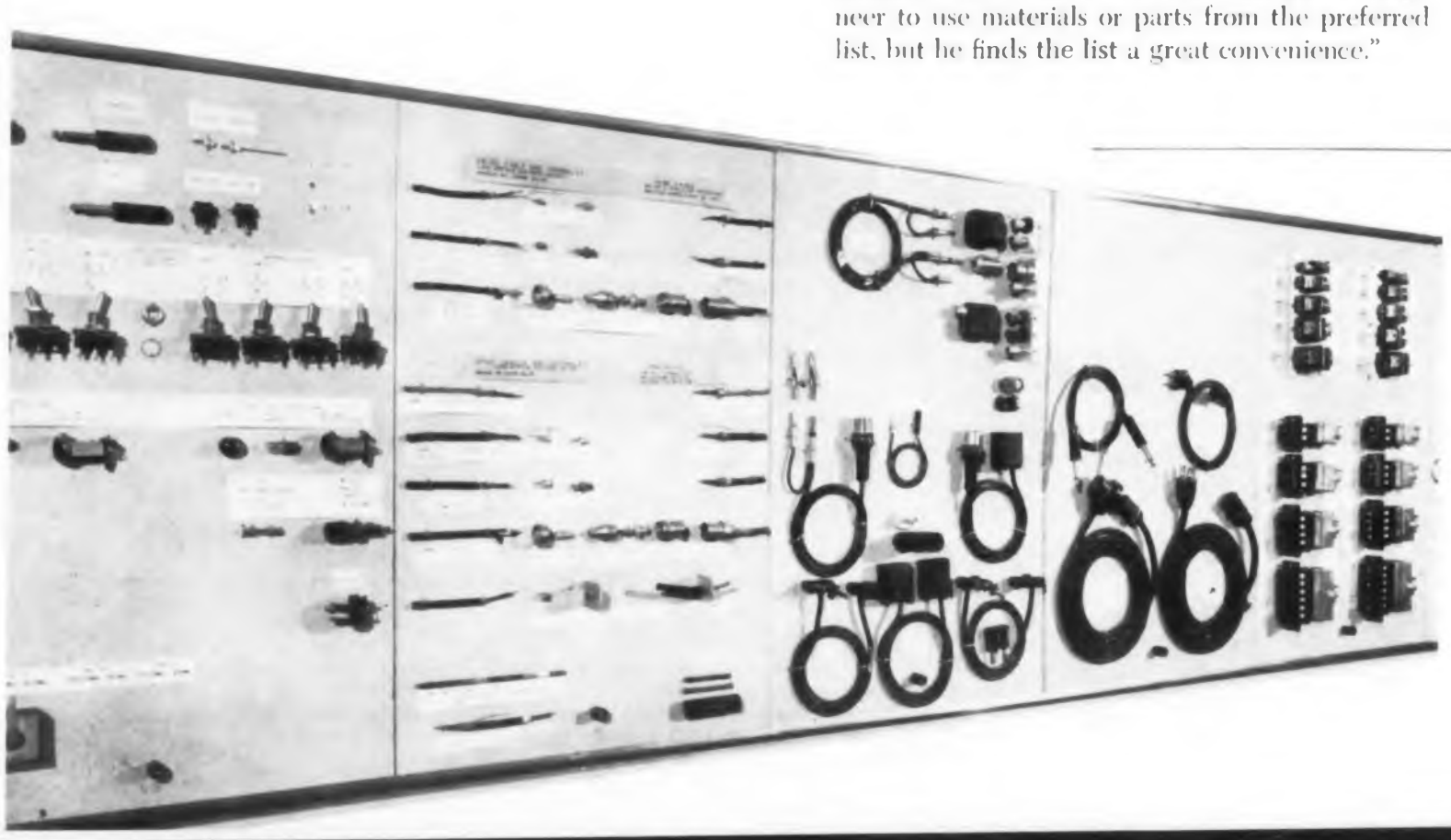


Fig. 1. One of several displays showing "Components Preferred for New Designs." General Radio uses these boards to help engineers select and use standard parts. Other boards show resistors, capacitors, diodes, and a host of other parts.

minals and to ground, and other information not normally found in catalogs.

It took years to develop this program, but it pays off. The standards program takes a lot of engineering time out of selecting components.

Lastest G-R equipments, according to Littlejohn, have 95 per cent of preferred parts applied according to recommended practices. The program has reduced the number of general purpose components catalogued and stocked from 12,000 to about 2500.

As specific examples, 10-32 machine screws, formerly stocked in seven head styles and 25 lengths, are now used in only one head style and 13 lengths. The number of electrolytic capacitor types has been reduced from 60 to 12 types.

"Flexible Standardization" Begins Early

In an entirely different field, Avien, Inc., of Woodside, N. Y., uses an approach called "flexible standardization." This is just another name for the philosophy of making a new product as adaptable to change as possible, without the need to alter any major component. Such standardization begins early in the design stage.

Avien has applied the principle to panel-mounted, servo-type instrument such as temperature sensing and recording instruments and fuel gage systems. Though these instruments provide a wide variety of displays of an even wider variety of input signals, they are all composed of three basic subassemblies: amplifier, motor and gear train, and rebalance potentiometer.

Amplifiers are all built to the same basic outline dimensions and are designed to tie into the instrument structure in the same manner. Motors fit into a standard frame size. Regardless of the characteristics of an individual motor, it is mechanically identical to any other.

Gear trains are designed so that, with the addition or deletion of one or two passes, any required response may be obtained. Provision is included for tap-offs for vernier sub-dial shafts.

The rebalance pots use a common housing and a common set of accessories. This results in pots with a required degree of accuracy conforming to almost any mathematical law. The housing allows for addition of a concentric winding for telemetry. A commutator and switches for control signals can be added to the instrument without any design changes.

Standardization Has Many Forms

Standardization can take many forms. It need not take the form only, of standardizing on specific products. It can take the form of a standard approach to purchasing and manufacturing.

Dr. Beatrice Hicks, president of Newark Controls Co., Bloomfield, N. J., has established a

Fig. 2. This high-density package, designed by The Sippican Corp., uses standardized welds for all connections. Mylar film jigging provides simple positioning for all components prior to welding and encapsulation.

"standard" priority system for parts. Leading her list, in order of decreasing desirability are:

- Use standard parts manufactured in large volume by other manufacturers—such as military standard parts, electrical connectors, automatic screw machine products, panels, handles, etc.
- Use standard parts, manufactured in large volume, which can be modified easily.
- Use standard parts manufactured in short run lots by other manufacturers. These include purchases from companies which own a tremendous number of dies, molds or tools, etc.
- Use simplified special parts that can be subcontracted to short-run specialists such as companies which handle automatic screw machine work, stamping, casting, forming, etc. These manufacturers should be skilled in inexpensive low-life tooling.

There are circumstances when Newark Controls will fabricate parts in their own plant. They will fabricate their own parts when:

- Parts will be made at lowest cost. (They must have the tools and experience.)
- Time is at a premium.
- The part is experimental and the company wants engineering personnel to follow the process till standards have been established.
- Adequate control of the process is not obtainable through sub-contracting.

Some Standards Don't Look Standard

For certain types of work, standardization may take a paradoxical twist. In the "high-density package," using conventional components closely packed together and encapsulated, it may appear that there is no standardization whatsoever.

A first glance at such a package (Fig. 2), seems to reveal no effort at standardizing. But extensive standardization is used for the process of welding all the connections.

Each joint in a planned assembly is studied and standardized before any production takes place. This involves choosing the welding machine; welding head; electrode material, configuration and size; welding pressure; and welding current.

First units of a short production run take advantage of this pre-engineering and standardization of connections. In practice, the majority of welds in a package are found to have been standardized during previous work.

It is even possible to automate several aspects of low volume production using the high-density process. In one application, it was possible to build quantities of *NOR* switches and to apply separate logic matrices later.

These matrices were designed entirely through a computer-programmed layout which resulted in a line-printer sheet. The sheet was reduced photographically to form a logic matrix positioning film. Usually, component positioning and jigging are obtained through Mylar films which are photographic scale reductions of drafted layouts.

Testing these packages is also automated to a high degree. One particular end connector involves up to 1000 pins which are interconnected through some 200 circuits involving perhaps 3000 connections.

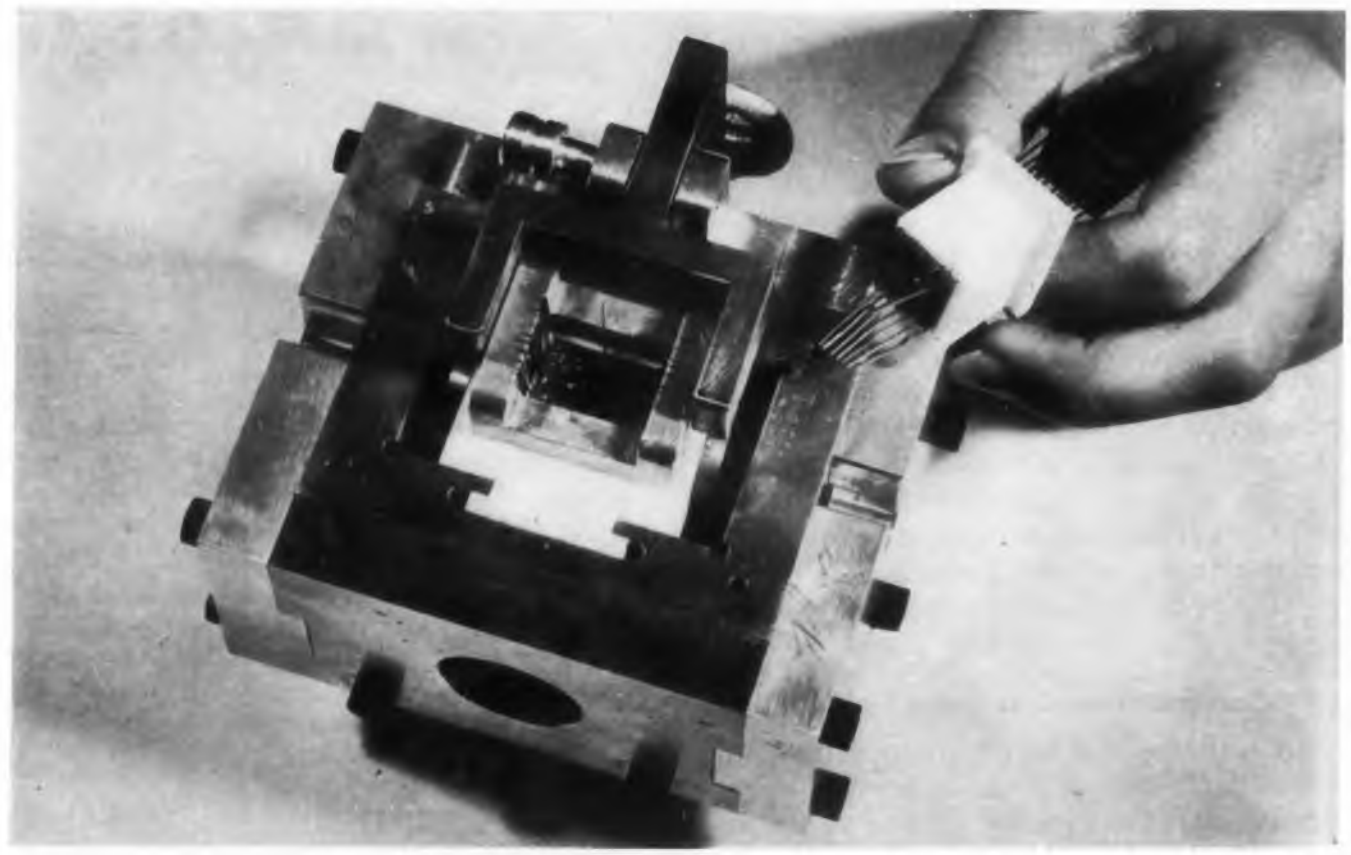


Fig. 3. The value of early standardization of module size is emphasized by this encapsulation mold. The Sippican Corp. uses this mold for a high-density welded assembly.

A converging test of this subassembly may take 100 man-hours; this can be automated to involve only a few hours on a punched-card comparator. According to W. Van Alan Clark, president of the Sippican Corp. of Marion, Mass., "For short run production, using this process, it is neither necessary nor desirable to standardize on lead spacing or component location. Any standardization would be a hindrance rather than a gain."

But he goes on to stress the value of using standard molds where possible. Fig. 3 shows an example of the usefulness of a standard mold.

Try to Standardize a Missile

Standardizing is not always easy. In missile equipment, space limitations may prevent the use of standard modules. At Bendix Products Div.—Missiles, in Mishawaka, Ind., mechanical design engineers Grant Michael, Tom Collins, and John Cunningham point to configuration as a major limiting factor.

But even in this realm, they try to standardize as much as possible. They're trying to standardize on the size of printed circuit boards—at least in two dimensions. The length of the board, they may vary, or they may tie boards in series for larger circuits.

They use standard hardware where possible. They standardize on mechanical assemblies and try to use the same container wherever they can. They'll standardize on chassis and subchassis mounting bolts, and will specify only the easier-to-buy machine screw sizes: 2-56, 4-40, 6-32, 8-32, 10-32, 1/4-28, etc. They try to lean heavily on a preferred parts list, issued to all designers.

Their work is made more difficult by the fact that, though they may be designing for but a few assemblies, they must assume that someday they may be making thousands.

Try Standard Circuits

At Lear, Inc., in Grand Rapids, Mich., the emphasis is on using standard circuits or minor modifications for new applications. Cliff Voice, electronic design section head, shows, as an example, a transistorized 400-cycle servo amplifier. "We can use this in dozens of applications," says Voice. "We may have to modify the output transformer to drive different loads. Or we may have to adjust the input stage for different gain requirements. But we can use it again and again."

To emphasize his point, Voice shows how the one-watt amplifier can be used to drive an eight-watt servo-motor. "It's simple," he says, "it's a two-phase motor. We take seven watts from the line to power the fixed phase, and take one watt from our amplifier to power the control phase.

"Motor dissipation is the same as with balanced operation. We lose about 30 per cent efficiency in the torque for so large an unbalance, but it's

Standardization

worth it because we can use small power transistors--units we know and trust."

Lear engineers have been designing with transistor circuits since 1954. According to electrical engineering department head Mel Frontjes, ". . . some of our engineers scarcely know what vacuum tubes are."

All the basic circuits use silicon transistors rather than germanium. In many cases, the engineers could use germanium. But they feel that it's not worth redesigning reliable circuits to see if germanium will work. Besides, they don't have the time.

Coupled with Lear's emphasis on standard circuits, there is a drive to standardize packages —or at least—to go to standard packaging techniques and standard processes. An electronic packaging design section, headed by Roy Malarik, handles all the packaging.

This group tries to use standard transistor brackets, standard chassis types or other standard hardware items. Most important, it tries to package all the electronics with a view to using available machinery and available techniques.

Confronted by space limitations, the packaging engineers aren't always successful in using a standard chassis. But they're looking into new packaging techniques.

A promising package, they feel, is the micromodule which uses layers of 1/3-inch square ceramic wafers with components coated on them.

Lear engineers plan to investigate these micromodules for their servo voltage amplifiers, quadrature rejectors, modulators, and demodulators. If these packages work well, Lear will standardize on these micromodular subassemblies—at least—for many applications.

What's the Government Doing

In view of the enormous value of standardization, and in light of the cost-cutting role it could play in our country's space-age requirements, it seems strange that the government has contributed so little in an area where it could be so powerful.

But the picture may change. Since 1945, the Department of Defense has been active in establishing a complete line of certain kinds of standard components. Today, MIL-S-20708 encompasses drawings and specifications for 60 and 400 cycle synchros from size 8 to 37.

These units, available from several sources, can give design engineers excellent instrumentation at low cost. Since their use is mandatory under MIL-STD-710, they can play a vital role by reducing spares inventories.

By using these components, designers and manufacturers can avoid duplication of engineering charges as well as high costs due to short production runs.

Commenting on this progress, Samuel Sherwin, manager of the Ketay Dept. of United Aircraft Corp.'s Norden Div., in Commack, N. Y., says: "The benefits of MIL-S-20708 are available today. They are a good start. But the government should not stop at standardizing synchros. It should extend the standardization effort into other types of precision rotating components and allied equipment."

Standardize Printed Circuits

Edward Kasner, project engineer of Stavid Engineering, Inc., in Plainfield, N.J., views another area where standardization could be invaluable—printed circuitry.

Says Kasner, "Though printed circuit boards are used by practically every firm that designs electronic equipment, and though each firm has established some standards, no comprehensive military standard has yet been evolved which is acceptable by all branches of the armed services.

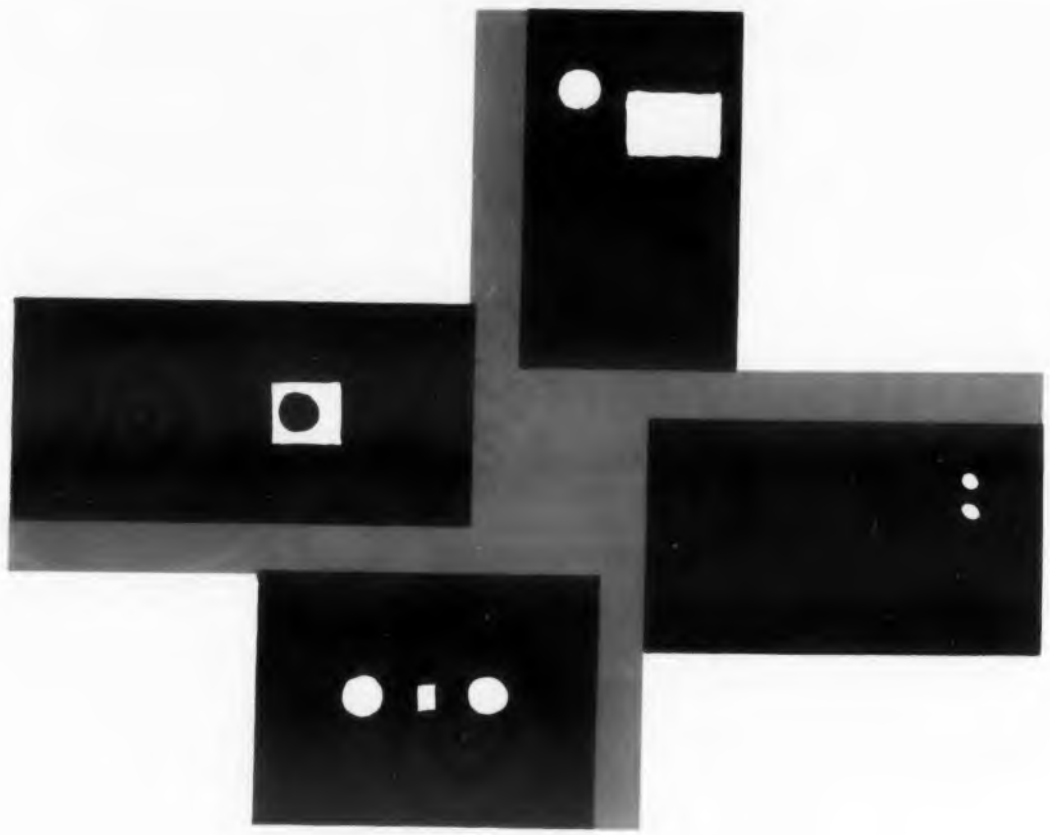
"Various military agencies have issued their own standards—MIL-STD-275 (Ships), MIL-P-21193 (Nord), SCL-6224—but their contents too often conflict."

Kasner points with pride to Stavid's company-wide standards on printed wiring board design, layout, drafting, photography, preparation, fabrication, and inspection.

As if in answer, Louis Schlesinger of the Office of the Chief Engineer of the Navy's BuOrd points out that the government does indeed intend to extend standardization to other precision rotating components. The government also expects to sponsor the development of a standard series of amplifiers to match standard resolvers and servo motors. They hope to be able to package resolvers and amplifiers in single disposable containers—an answer to the trimming problem.

BuOrd hopes that standards, soon to be made available, will help simplify complex testing, evaluating, and inspection of many servo-type components. Some of these specs should standardize amplifiers, resolvers, servo motors and tach generators. In the distant future, there may be a spec for standard gyros.

DOD is currently sponsoring projects to insure and increase the benefits of standardized components in tomorrow's systems. The aim is to have components which can be interchanged among systems. ■ ■



Modular Design—

Mass-Production Benefits

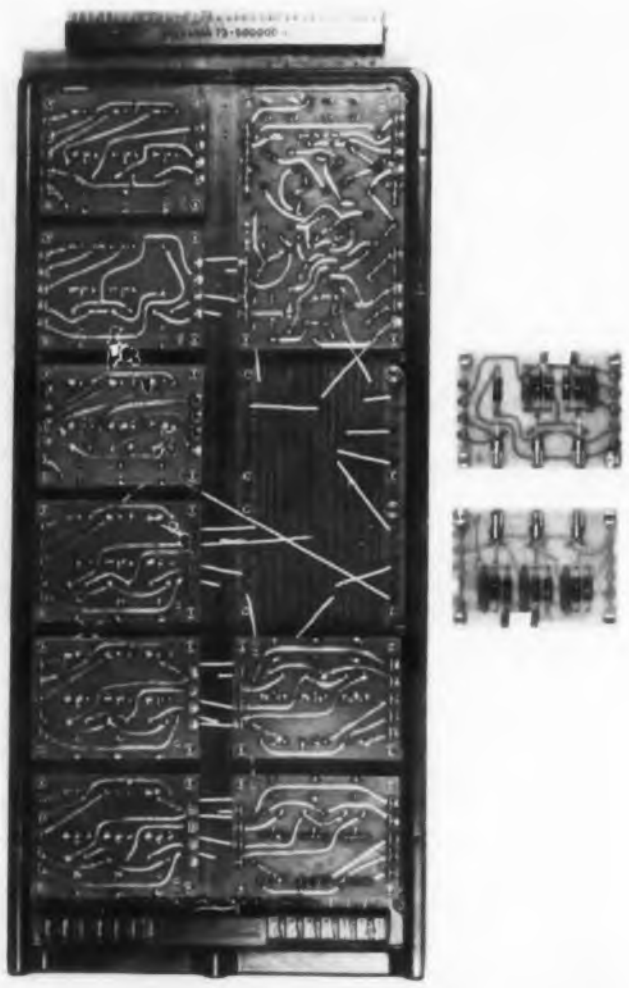


Fig. 1. Sylvania's "universal package" has one logic card and as many as 12 single-element component cards. The straight conductor runs, on the back of the board, can be seen through the glass-base epoxy laminate.

MODULAR design, a powerful weapon in the war against the high cost of short-run production, is much akin to standardization. Many consider it a special form of standardization.

Its merits are impossible to evaluate in dollars and cents alone. How can one compute, for example, its value to logistics? Can one assign a money value to the fact that a military field computer may require an inventory of only 50 spare modules rather than thousands of spare parts?

Yields Mass-Production Benefits

Modular design enables designers to reap some of the benefits of mass production. Multiple-application modules can often be mass-produced by hundreds or thousands, though the system for which they were originally designed may require only dozens. In this way, the designer can often take advantage of cost-break quantity buying.

Like any good thing, modular design has its drawbacks. For one, use of standard, modular, building blocks may result in inefficient packaging density. But for many applications, this is outweighed by compensating advantages.

Modules Should Be Logical

Modules must, of course, be designed with care. The designer must not fall into the trap of designing half a function on one module and the other half on another. He must make his modules logical units wherever possible.

He has to be careful about interconnections; he should minimize them between subassemblies. He must remember that his subassemblies may have to be handled, stacked, tested, and shoved around from position to position, even before they land in the final product.

Keep Circuits Simple

The aim of most modular design is to use simple and universal circuits. One of the most fruitful applications of such modules is in computers which use hundreds of identical circuits.

Often, six or eight basic module-types can serve as the backbone of a computer, while 15 or 20 others complete the machine.

Fig. 2. This single-element card is one of the bricks Sylvania used in building MOBIDIC.

Fig. 3. Librascope's universal-pattern circuit board permits assembly of logic modules before the computer design is firmed.

Like standardization, modular design takes different forms. One form is exemplified by the printed circuit card which carries one or more basic circuits. This card may be used in many applications without any change. Essentially, this type of module is used like an encapsulated assembly.

One of the newest module forms, the "micromodule," consists of components deposited on tiny ceramic wafers, stacked in layers to form complete circuits. Pioneered by the Signal Corps, with RCA as the leader contractor, these micromodules are slowly finding their way into military equipment.

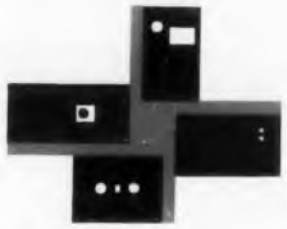
A very popular module form is that of the basic card (or chassis) which can easily be modified to serve in many roles. It has basic circuitry or wiring which can be altered easily into many variations.

The Universal Package

An excellent example of this type of module is the "universal package" designed by John Marzilli and Michael Berberian of the Data Systems Operations of Sylvania Electronic Systems at Needham, Mass.

This package is intended to serve an unlimited variety of digital equipments. As shown in Fig. 1, it consists of one logic card with a maximum of 12 single-element component cards attached to it.

The logic card, with 35 straight conductors etched on one side of the board, has provision for inserting jumper wires at every contact with the element cards. At discrete intervals, there are provisions for jumpering between conductor runs or from a conductor to a contact point. Where



Modular Design

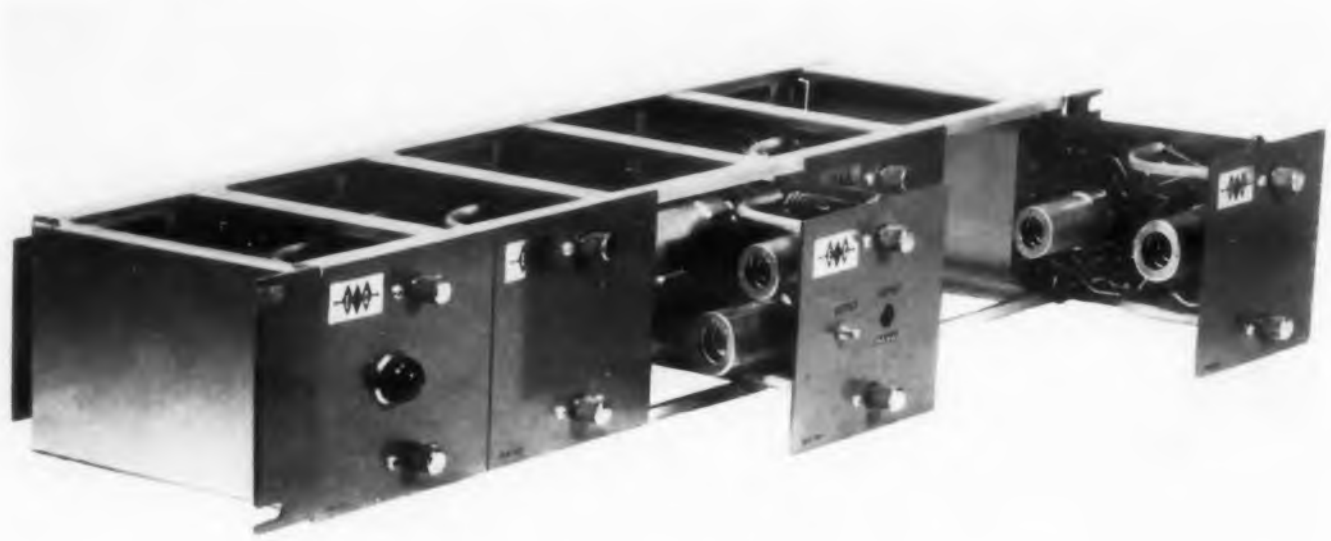


Fig. 4. A "special" pulse generator, designed and delivered quickly, at low cost, by using minor modifications of standard, compatible modules. Electro Precision Corp. calls them "Digitrol" building blocks.

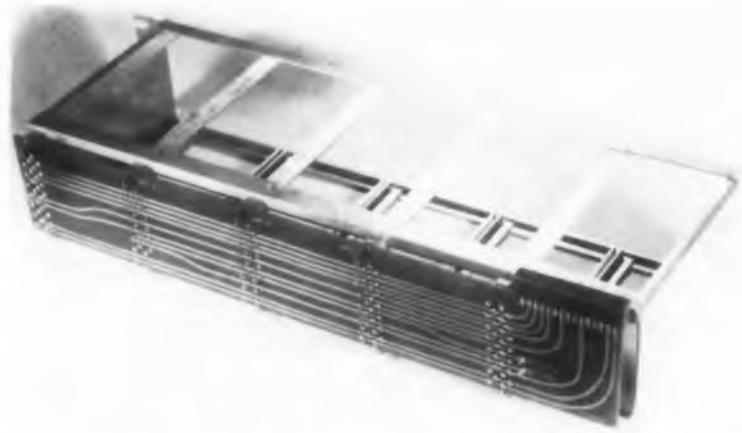


Fig. 5. The basic frame for Electro Precision's "Digitrol" building blocks can carry a printed circuit card on its back for interconnections between modules.

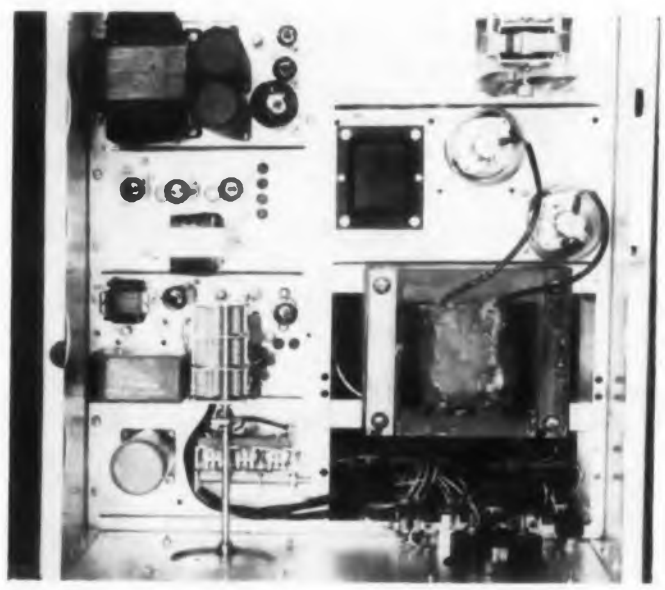


Fig. 6. TIC's basic modules can be combined to form a wide variety of frequency converters.

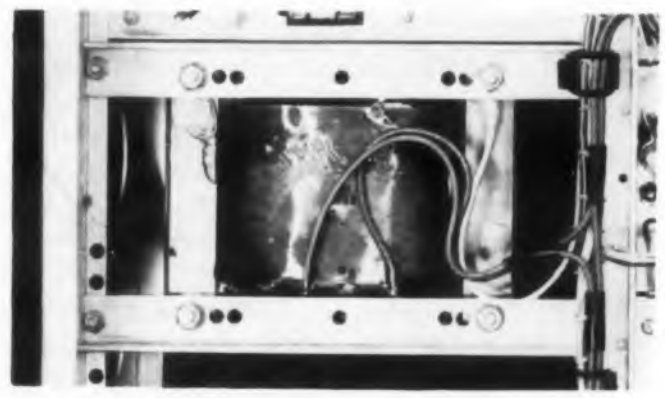


Fig. 7. Output transformers for 100-watt frequency converters or 1000-watt units can be mounted on the same frame. The frame members are drilled and tapped to take several transformer sizes and they can be moved closer together or further apart.

necessary, the straight conductor runs can be interrupted by knifing away part of the conductive material.

The element cards, (Fig. 2), house the circuitry. They plug into the logic card through sturdy, conductive, contact fingers. The element cards have guide pins and alignment studs, coded to insure that the cards will be properly positioned on the logic card.

These small cards, available as single- or double-element units, can accommodate any digital circuit within the limits of the system. The logic packages, with combinations of etched circuitry and jumper wires, provide almost all the logical interconnections.

Together they are the building blocks of the mobile military computer MOBIDIC, and of the detection radar data take-off portion of BMEWS (Ballistic Missile Early Warning System).

Computer "Stock" Card

For similar applications, Librascope engineers have developed a "stock" card shown in Fig. 3. With a universal printed pattern, this card can be modified by interconnections to yield many circuit functions.

Before final design of a computer, components can be added to the card to form as many as 33 individual logic modules. When the design is firmed, the modules can be interconnected.

This "stock" card technique, according to project engineer E. M. Zuehlke, permits a large amount of fabrication prior to full-scale production. Though it doesn't provide the most compact packaging, and though it's not particularly adaptable to mass production, the card saves a great deal of time in short runs.

On these cards, the printed circuitry is carried through from the base plug connector to a duplicate connector at the top of the card. This permits the card to be plugged into the computer and to have the entire plug available for testing or trouble-shooting. Troubles are quickly diagnosed without recourse to circuit-crawling with a scope.

Analyze, Then Design

Electro Precision Corp. of Arkadelphia, Ark., cuts the cost of special-purpose control systems and computer designs by using a compatible set of predesigned functional components.

After analyzing a large number of special-purpose computers, instruments, and control systems, Electro Precision broke them up into block diagram form, and regrouped the block diagrams to

establish a minimum of functional elements which would yield the largest number of configurations.

Modular units, to work from a common supply voltage, were built for functional elements like servo preamps, power amplifiers, servo multipliers, crystal clocks, frequency dividers, decade counters, and voltage regulators.

Each unit has its own front panel, so when an instrument is made up by plugging in the right combination of elements, the front panel is also completed. (See Fig. 4.)

Use of the plug-in modules slashes the time spent in detailed circuit design and in preparation of instruction manuals. Connectors, with in-line pins, are placed in the same relative position on the back of each module. As shown in Fig. 5, this simplifies wiring B-plus, ground, filament, input and output connections.

Build Large Circuits From Small

Though modular design is a natural for computers, it shows its great value in other fields as well. One can take, as an example, the frequency converters manufactured by Tel-Instrument Electronics Corp. of Carlstadt, N.J.

Using basic circuit modules, shown in Fig. 6, TIC was able to economize on a wide variety of one-, two-, or three-phase frequency converters with power outputs ranging from 100 to 1000 watts.

Larger systems could be made from smaller ones, or two- and three-phase systems from single phase units, by adding basic modules and making minor wiring changes. The same size chassis is used for any output from 100 to 1000 watts.

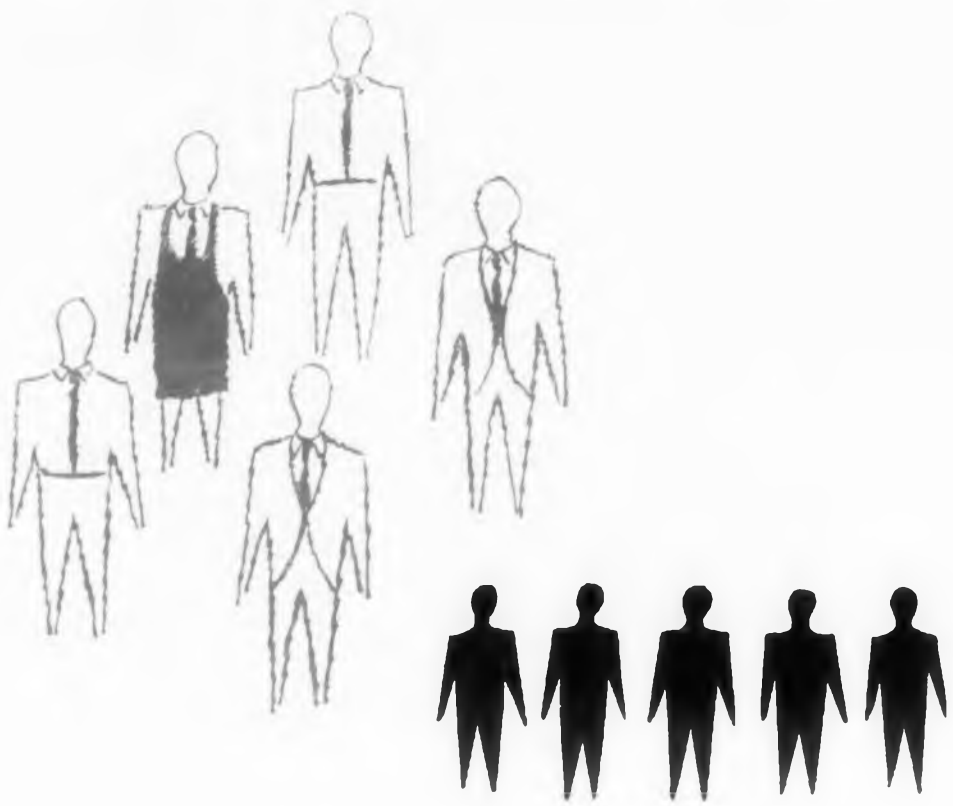
For converters with power outputs greater than 250 watts, forced air cooling was easily provided by a blower and pressure box underneath the chassis, and an exhaust box on top of the output chassis.

Output transformers, in a multitude of sizes, can be mounted on the same frame, suitably drilled and tapped as shown in Fig. 7.

TIC's modular design reduced size and weight dramatically. The modular version of its 500 watt unit, for example, weighs 140 pounds and occupies 4-1/4 cubic feet. This compares with 600 pounds and 16 cubic feet for the original, standard-construction counterpart.

TIC's senior mechanical engineer, George Kostick points to additional advantages of the use of modules: "They mean easier handling, storing, wiring, testing and fabrication because of the small size of individual modules. They increase flexibility of design and permit tighter cost control over parts and labor.

"And let's not neglect the more efficient use of machine time," Kostick continues, "due to fixed bending and fabrication set-ups regardless of chassis type." ■ ■



Planning for Production

THE SPECIAL problems of the short run have forced manufacturers to evolve a whole new pattern of procedures—on the production line—and on back through the inception of design.

In groping for solutions, manufacturers have wandered down many strange pathways before arriving at "the best way" to organize for short-run production.

Most of the prevalent philosophies involve parallel courses of production planning and engineering. Many firms advance production planning to an early stage of design engineering. On the production line itself, techniques are in use which would be unheard of on a high-volume run.

Use Technicians for Short Runs

An International Telephone and Telegraph Corp.'s Laboratories, in Fort Wayne, Ind., they use highly skilled men for short-run production. Especially for very short runs, they feel there is great advantage in using technicians instead of unskilled assemblers.

Ralph Bruce, manager of Services, Ed Byer, executive engineer in the Instrumentation Lab., and Lambert Johnson, electronics engineer, all agree on the major advantage in using technicians: "You don't have to spell out production requirements so much when you encourage labor to think."

"Flex" Shop Helps

For similar reasons, but in a different way, Lear, Inc. uses skilled labor. The Grand Rapids firm takes advantage of a "flexible" shop. The "flex" shop, a cross between a model shop and a full-scale production facility, improves liaison between engineering and production.

Since this shop has more highly skilled people, engineering can supply simpler drawings, thus saving time and expense.

The One-Man Job

At General Radio Co., in W. Concord, Mass., the people on small-run production lines are all highly skilled. Each man on the line knows just what he's doing; he knows how to read a print and how to understand it; he thoroughly knows the instrument he's building.

One engineer is in complete charge of developing a piece of test equipment. And one skilled assembler (Fig. 1), puts it together. All parts are brought to his bench. For particularly complex instruments, one man may make a part of the overall instrument, while another will put the parts together. But the instruments stay put—the man moves.

Assemblers get to know their instruments. Working under an incentive pay plan, they learn to produce their instruments most efficiently.

Move Parts or People?

Hewlett-Packard, of Palo Alto, Calif., and the Kin Tel Division of Cohu Electronics, of San Diego, use production-line approaches which are diametrically opposed. H-P uses a conventional mass-production technique of moving components past the assemblers, while Kin Tel moves the operators past the components.

On a different plane, both of these companies use an approach unlike those of G-R or ITTL. Both H-P and Kin Tel use unskilled assemblers; G-R and ITTL use highly skilled assemblers.

Fig. 1. A highly-skilled man assembles General Radio's new impedance bridge.

Fig. 2. A small part of Hewlett-Packard's "push-along" assembly line. H-P has more than a mile of conveyor like that shown in the foreground.

"Push Along" Slashes Delivery Time

By going to "push along" production, H-P's in-process inventory was cut directly in half. According to production manager Stan Selby, an inventory of $1.5 million worth of uncompleted instruments was reduced to $0.75 million when the company switched from "stand-up" batch production to the more usual mass production technique wherein girls remain at their work stations.

"We don't believe in handcrafting generally," says Selby. "We avoid having to hire highly skilled people to do complex assemblies. We divide the job into simpler parts. But at the same time, we don't like 'stand-up' runs, where each girl does just one operation at a time, either. They're inefficient."

Delivery Starts Fast

"With the batch system," Selby explains, "the entire production run is finished before one instrument is available for delivery. With our push-along system, production lines start delivering steadily. With the batch technique, test benches may be idle until all instruments are finished. Then they're swamped with work.

"With push-along operation, mistakes are discovered immediately. In 'stand-up' systems," Selby continues, "if a lead girl makes, say four mistakes in the first oscilloscope, the entire run will have four mistakes. This won't be discovered until the batch is tested.

"Moreover, we get better quality and fewer mistakes, because the responsibility for a given operation is fixed. This is very important. The instrument is the line supervisor's baby—and the operator at a given position knows she is responsible for her own work. She does a good job."

H-P's production line is a good example of the push-along system. All benches are conveyor type, with instruments on pallets, riding freely and easily along the length of the bench. (Fig. 2.)

There is more than a mile of conveyor throughout the plant area, so very little effort is required to send an instrument chassis along to the next station.

Selby estimates that efficiency is upped some 20 per cent by the operators' being able to sit down and have the instruments come by. "If a girl has to move 100 chassis a day, and each weighs 20 pounds," Selby calculates, "that's a total of one ton. That takes energy!"

H-P manufactures 400 different types of instruments with an average run of 50. For these short runs, as much planning as possible is done at the line level.

Line supervisors spend an average of four hours a week planning production runs. The oper-

Fig. 3. An operator at H-P can assemble even very complex subassemblies easily.

Planning for Production

ators help with the breakdown of operations—and this helps build morale.

"Stand-Up" for Very Short Runs

For very short runs, H-P uses the "stand-up" technique. If only one or two instruments are to be built, the time spent in planning and breaking down the operation would not offer a sufficient return, though the efficiency might increase. Up to 20 instruments might be manufactured by "stand-up" production.

Small, complex parts, like resistor boards or decked rotary switches, are built differently. The philosophy is that of a miniature "stand-up" run. Lazy Susans (Fig. 3), with positions for up to 25 components, are filled with a batch of, say, rotary switch decks. The operator has a completed rotary switch to copy from.

She solders one component at a time, then spins the Lazy Susan from one switch to the next. Though the switch may be complex, a girl can produce it easily by doing one thing at a time and copying from the finished unit.

Move Girls, Not Parts

Since Kin Tel started moving assemblers past components (Fig. 4), the company has saved as much as 35 per cent of labor costs on each item produced. Recently this amounted to savings of $4600 on a short production run of galvanometers.

Under the old system of component assembly, operators worked on units moving by them. Learning to solder more than a few parts often took girls on the line as much as six days to reach 50 per cent efficiency, and four more to reach an efficiency of 85 or 90 per cent.

"Large, mass-producing industries can tolerate this loss of time," says Kin Tel's chief industrial engineer Ben Singleton. "Companies with short runs cannot; the entire run might be completed before the assemblers have learned the job."

Singleton, under the direction of Robert Lux, vice president for manufacturing, maintains that the "progressive operator" system is ideal for the short production run. Here's how the system works:

A lead girl attaches one part to the first assembly in a line. A second girl watches her, then takes a container of parts and installs that part on each piece of equipment in the line.

Meanwhile, the lead girl solders the next part and a third girl repeats that operation all around the line.

Learning Time Approaches Zero

In this way, the learning time for an operation is practically zero. By the time a girl has soldered the same part twice, she has become an expert in soldering that part. Using this system, Kin Tel recently produced 500 galvanometers without a single assembly error. "It is virtually impossible," claims Singleton, "for an operator to forget to place one component in each basic unit and in its correct location.

Several additional advantages soon become evident. All but very large units can be built completely in one location. They do not have to be moved from one operator position to another.

Under the "progressive operator" system, absenteeism costs no additional time, as any other operator can be assigned to a group and keep pace with the others in the group. On the conventional assembly line, substitute operators, usually paid at a higher base rate, had to fill gaps in the line.

Relief operators are not required, as girls can take breaks as soon as they have finished any cycle without stopping the line.

Production rates can easily be accelerated or decelerated by changing the number of girls at any time. This has particular value when parts shortages cause a line stoppage in the midst of a run.

And fluctuations of monthly schedules, that usually play havoc with conventional assembly setups, are easily accommodated.

Define the Product

Bendix Products Div.—Missiles joins Hewlett-Packard and Kin Tel in opposition to the use of highly skilled assemblers. Says mechanical engineer John Cunningham, "We want to avoid complex assemblies. We don't want operations which require high skill. We want to make our parts as simple as possible."

His colleagues, Grant Michael and Tom Collins, emphasize Cunningham's comments: "If you have technical people assemble the equipment, you never define your product or document it adequately.

"A technician who knows a screw is short will go to a stock room and get a longer one. But next time you build the equipment, that technician may not be there, and his correction has not been reflected back into the drawing.

"The technician may introduce his own engineering skills in a design—but they never get on paper. Furthermore, if you need a highly skilled

Fig. 4. Kin Tel moves assemblers past stationary parts, cuts learning time to zero.

man to build the equipment, you're going to need a highly skilled man to maintain it in the field."

Plan Far Ahead

Most short-run production today involves not only low volume and high unit-cost, but also, a requirement for exceptional reliability.

To cope with these demands, many companies have organized not only their production lines but many other operations as well. In efforts to improve reliability and producibility at the earliest possible time, many try to integrate the work of several departments. Though all have the common goal—reliable, lower-cost production—the approaches vary widely.

At Librascope, Inc., in Glendale, Calif., production planning is aided by an active Industrial Engineering Department. This department develops manufacturing, assembly, test and handling techniques. Members of this department work hand-in-hand with design engineers from the early stages of design.

Make The Mockup Early

To reduce the lag between design and production of complex data-processing equipment, Librascope industrial engineers start mockup planning while a unit is in the final design stages. Particularly in defense equipment, where dimensions and configurations of cabinetry are specified in advance, preliminary mockups can be made to permit development of the most efficient production techniques.

Mockups, like those shown in Figs. 5 and 6, are generally constructed of wood. They follow in exact detail the exterior and interior dimensions and configuration of the equipment. Dummy subassemblies, meters and other integral components are made of wood, and placed in the mockups to determine the most desirable arrangement from a standpoint of production and servicing.

When the mockup is complete, cabling is designed and provisions are made to install it in special channels, or with clamps, or by other methods. Color coding is established both as a production aid, and as a help in future servicing. When the cabling has been worked out, diagrams are immediately turned over to the cabling department where special harness boards are prepared in advance of production.

Unitize The Wiring

Librascope has tackled one of the most difficult process in electronic production—the wiring itself. The necessity for proper positioning of what may be thousands of separate leads has defied any attempts at automation, or even of simple mechanical aids for the assembler.

Printed circuit boards were the answer for many applications, but even with use of such boards,

Planning for Production

terminals and subassemblies must still be hand-wired together. In a typical, large Librascope computer for a defense contract, connectors for printed circuit boards are mounted in a bay and connected by thousands of insulated wires. They must follow a direct point-to-point path from one terminal to another. This requires hundreds of hours of assembly time for a single computer cabinet.

To simplify the process, Librascope industrial engineers developed a two-phase assembly program. Rather than requiring the worker to stand at a cabinet and wire the entire bay, Librascope has grouped the connectors in three panels, which are individually wired (Fig. 7), at benches where the wirer may sit and work under optimum lighting conditions. At the completion of wiring, the units are bolted into the cabinet, and inter-connections between the separate panels are completed. (Fig. 8)

Fig. 5. At Librascope, wooden mockups of equipment are used to lay out wiring prior to actual production.

Fig. 6. Worker prefabricates cable harness on wooden dummy of equipment. After harnessing is complete, cables are removed and installed in final equipment.

The two-stage assembly permits a greater number of wirers to work on the terminal bays, and reduces fatigue and errors on the part of the workers.

A recent innovation has been the adoption of solderless crimped connectors, which has effectively increased production by more than 30 per cent, and has reduced "workover" of improper connections to a minimum. At the completion of wiring, the bays are tested automatically, by specialized equipment which checks continuity and potential of all connections in the cabinet.

Integrated Cooperation

Avien, Inc. of Woodside, N.Y., uses "integrated cooperation" among manufacturing, material control, purchasing, and manufacturing-engineering personnel.

When engineering begins work on a new product, a production engineer is immediately assigned to the project.

The production engineer guides the design engineer by providing all the necessary production-capabilities information that may have a bearing on the design of the product. He points out characteristics in the initial design which can develop into serious production problems. When the unit is finally readied for production, the production engineer can bring to production a thorough knowledge of the new unit.

Keeping in close touch with the progress of engineering work, the manufacturing manager holds weekly "new unit status" meetings with representatives of all manufacturing sub-departments and with representatives of other operating departments.

Buy Long-Lead Items Early

Material control moves into the picture just prior to the final release of a new product by en-

Planning for Production

gineering. Sufficiently ahead of time, engineering releases to material control a list of long-lead-time items that will be needed for the new product. These are specially coded on red IBM cards for immediate attention.

When the design is well advanced, a meeting is called to determine test and inspection requirements. A program is set up to assemble test and inspection equipment.

Arthur Gray, manager of manufacturing engineering, warns against the temptation to cut corners at this stage. "Inadequate test equipment," he points out, "always increases the possibility of error or inaccuracy. When such inaccuracy is uncovered, it is frequently and wrongfully blamed on the product rather than the test equipment."

Gray hails Avien's integrated cooperation approach. "It pays off," he claims, "by providing a forum for interested parties to discuss all areas of the new product thoroughly." The "new unit status" meetings, he points out, act as a single, complete source of information on the status of all new products.

Manufacturing Enters After Breadboard

A variation on this approach is used by Packard Bell Electronics of Los Angeles, Calif. There, the manufacturing processes start concurrently with the construction of the engineering prototype. Basis of Packard Bell's plan is a complete engineering-manufacturing group under a program manager.

This plan has been in effect on several test equipment programs, most notable of which has been the group support equipment for the Thor missile. Under this plan, all necessary manufacturing support personnel (purchasing, expediting, etc.) are assigned directly to the project on a full time basis.

During the latter part of the breadboard phase, and prior to the prototype stage, the manufacturing section works directly with design engineers to evolve a design which not only meets performance requirements, but assures production reproducibility.

During this stage, engineering personnel are purposely transferred back and forth between manufacturing and engineering to add to their knowledge and capabilities.

An additional benefit gained by this procedure is that the manufacturing people become familiar with the equipment before they have to produce it. This extends their learning time.

To assure proper use of existing facilities, Packard Bell has formed a "make or buy" committee. Consisting of representatives from engineering, purchasing, and manufacturing, it generates a "make or buy" decision on all material for a program.

The advantages of Packard Bell's plan are manifold. According to Project Manager Max Ganstwig of the Technical Products Division, ". . . the plan not only considers the requirements of schedule, but includes the necessary controls to give reproducibility and interchangeability during a period when a large number of engineering changes may be encountered."

The idea of marrying engineering and manufacturing is not unique. In one form or another, it is practiced by many firms. At Epsco, Inc., in Cambridge, Mass., for example, engineering people

Fig. 7. (below) Worker makes point-to-point connections to terminals on connector panel for plug-in circuit boards. This is the first phase of a Librascope simplification of a wiring problem.

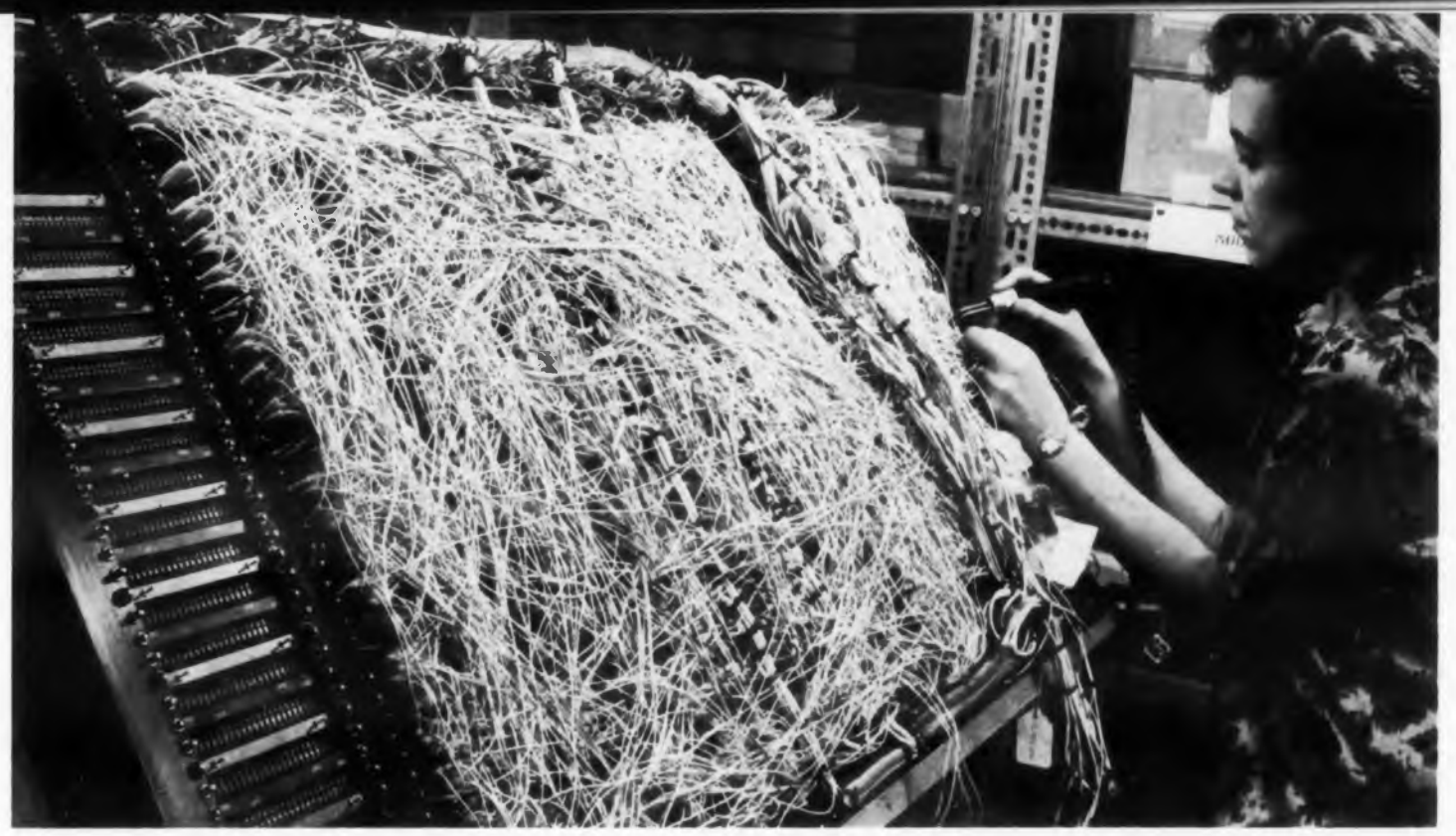


Fig. 8. Connector panels are grouped to form equipment bay. Here a worker interconnects panels—the second part of Librascope's two-phase assembly program.

move right into the pilot line production area during a pilot run of a product.

No Project Team

Lear, Inc., of Grand Rapids, Mich., is rather unique in not having project teams at all. Engineers are organized on a specialty basis rather than a project basis. Circuit designers do all the circuit design. Packaging specialists do all the packaging. Circuit designers do no packaging; hence, they make no packaging errors.

"Advantages of organization on a specialty basis are strong ones," say Mel Frontjes, head of the electrical engineering department. "Specialists carry ideas from one application to another. What they learn on Project A, they can apply on Project B."

Frontjes points to an additional advantage in that it's not necessary to repeat talent in different project groups. He admits though, that the specialty type of organization may not be practical for very large companies.

Only ME's Design the Package

At Bendix Products Div.—Missiles, in Mishawaka, Ind., only a mechanical engineer designs packages, except for critical ones like rf circuits. An electronics designer will double-check his package and finally, the two men will work together to prepare it for production.

Before packaging, a mechanical engineer may spend two or three days talking with the electronics man. He'll learn the circuit peculiarities to guard against. The electronics engineer may tell him, for example, to keep certain temperature-sensitive components away from heat sources—or to watch out for noise and leakage across printed circuit tracks.

The Bendix man will construct a "bull" model, a breadboard which looks like the final package should look. Then the experimental shop will make the engineering prototype—to drawings rather than sketches.

Aim for Prototype Like Final Product

At Stavid Engineering Inc., the aim of design is to make an engineering prototype that will closely resemble the final production product. At this Plainfield, N. J., firm, people with production know-how are included in all the project design teams.

To design reliability into a product, rather than attempt to improve reliability after the design is completed, quality control, reliability, and component personnel contribute their specialized knowledge early in the design phase.

Project engineer Edward Kasner contends that this parallel planning is far superior to the traditional series plan in which design engineering is followed by production engineering.

Says Kasner, "The glorified breadboard model, ceremoniously referred to as the 'preproduction prototype' is invariably unfit for production. To improve producibility, it is turned over to a product engineering group (looked upon as production people by the design group, and as design engineers by the production group).

"This process," continues Kasner, "wastes time. It requires consultation between design and product engineers, about seemingly minor changes, at the crucial time when the product should already be crossing the bridge to production."

Assemble by Hand or Machine

Kasner goes on to challenge a popular notion. "Mechanical assembly in *itself*," he says, "does not necessarily promote production efficiency. In the instances where mechanized assembly is used to economic advantage, the equipments were shrewdly engineered so the assembly operations could be most efficiently performed by the machinery intended for the task."

Warming up to his subject, Kasner continues: "Production-cost analyses, and time and motion studies have shown that the simple, repetitive motions performed by assembly machines can also be performed, optimally, by human operators.

"Psychological production aids such as air and color conditioning, proper illumination, music, coffee breaks, etc., do much to minimize operator boredom and fatigue. In many industries where these aids have been used, especially when supplemented by incentive-pay systems, industrial engineers have shown that the substitution of complex, expensive mechanization for human operators is not necessarily justified.

"The ideal electronic equipment design should be equally amenable to manufacture by either mechanized or manual means.

"With a mechanized-assembly capability inherent in its design, the military electronic product can be manufactured economically in small quantities by manual assembly methods and in large quantities by mechanized-assembly methods." ■ ■

Ideas and Tools

Speed Short-Run Production

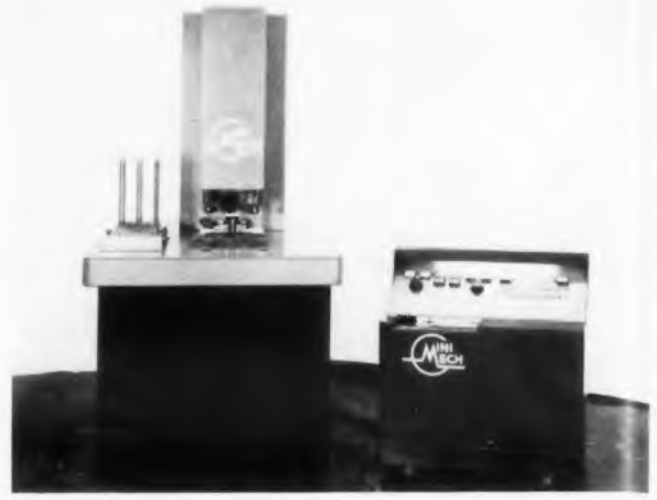


Fig. 3. Melpar's Mini-Mech selects components, positions boards, inserts components, and solders them in place. Unit at the right is the punched-card programmer.

Fig. 1. Operators at Librascope guide circuit boards through Dynasert machine for automatic component insertion.

Fig. 2. Dnyasert machines cut leads, bend them to fit holes in the circuit board, insert components, and crimp the leads.

CHARACTERISTIC of the short run is the fact that it can rarely justify the purchase of costly, single-purpose, mass-production machinery. But the short run can be mechanized—and to great advantage.

Before considering machinery for fabricating parts or assembling components, the design engineer should study his design. Many errors can creep into a design that can make it unproducible.

- First of all, he should design so his parts can be manufactured on standard machines—if at all possible.
- He should design for tools that exist, and should know the capabilities and limitations of available machines. He should know, for example, when to use a drill fixture, when to use a punch.
- He should be careful, for example, not to put a mounting hole where a machine can't get at it. He should not have too narrow a flange on a chassis. Bending brakes just can't handle narrow flanges reliably.
- He should pay particular attention to tolerances especially around sheet-metal bends—and should remember that tolerance errors add up.
- He should investigate the possibility of using production tooling on engineering models.
- He should take advantage of contract expendable tools—patterns, castings, jigs, punching templates, holding fixtures, etc.
- He should determine the extent of tooling he'll go to on the basis of his contemplated quantity.
- He should learn to adapt available equipment to his needs.
- He should not overlook processes which are usually considered for high production only. Die-casting, for example, is usually considered only for very large production lots. Yet, for close-toler-

Fig. 4. The component inserting tool and anvil of Mini-Mech, shown in the stapling position.

ance complex parts, it is often cheaper to die-cast as few as 50 pieces than to machine them.

How To Mechanize

Having assured himself that his design is producible and that the bugs are out, an engineer can begin to determine what machinery he can use for making parts or assembling components. At this point, he can become aware of a very important fact:

The key to mechanization of the short run is in the use of versatile machines—machines that can handle a variety of components or a variety of sizes—machines that can do more than one job—and machines that can be changed over quickly from one operation to another.

Fortunately, many commercial machines embody a high degree of flexibility.

Machines Can Assemble Parts

Perhaps the most useful machine for electronics work is one that can install components. Many such machines are in use. Engineers at Librascope, Inc. of Glendale, Calif., have speeded computer construction by using many automatic and semi-automatic assembly techniques.

They use precision drilled boards throughout assembly. Where eyelets are used, five semi-automated machines install as many as 60,000 per shift.

Dynasert machines insert components in these boards (Figs. 1 and 2), with one operator loading and tending three machines. The components are automatically aligned and sorted by these machines, wire leads are clipped to length, bent to fit the circuit board's holes, then crimped into place. The crimped leads hold the component

firmly until they are dip-soldered to the printed circuit.

For larger boards, a Librascope-developed cycling feed automatically moves the boards into position for multiple insertion of diodes. For special test or prototype runs, manual insertion is used, but even here, special semi-automated lead-forming machines preform component leads at high speed.

The machines cut the leads to size, shape them, and bend them to any required angle. Parts are hopper-fed into the machines, and are automatically aligned and sorted before forming.

Assemble, Then Solder

For component assembly, few systems are more versatile than the Mini-Mech System developed by Melpar, Inc. of Falls Church, Va., for the Navy Bureau of Ships. This equipment, shown in Figs. 3 and 4, is now commercially available, either as a complete unit, or in part.

Mini-Mech, programmed manually or by punched card can select components automatically from a supply of 24 types, and can install them in their proper places on automatically positioned, foil-clad circuit boards.

It handles only axial-lead components, and only up to about the size of a one-watt resistor. This takes care of about 90 per cent of all circuit requirements. Mini-Mech bends component leads into shape, simultaneously cleans them, then solders them (either through plain holes or eyelets) to the printed circuit foil, and provides an excellent heat sink during soldering. And the soldering is far more reliable than one could expect from a human with a soldering iron.

On the subject of soldering, A. Arnold Lawson, Melpar's project engineer who headed the design team responsible for Mini-Mech, poses this rhetorical question: "What is the mathematical probability of obtaining a reliable hand-soldered connection?"

Calculating quickly, Lawson estimates, "The mathematical probability of obtaining a reliable hand-soldered connection is almost as good as picking a winner at a dog track."

Lawson doesn't reveal how well he does at dog tracks, but he lists 10 possible causes for failure in soldered connections.

1. Temperature—too low or too high.
2. Timing—too short or too long.
3. Poor contact of iron to junction.
4. Improperly made junction.

...in any environment, silicones protect

Fluid Short-Stop Deflects Moisture

Employed in many airborne guidance, tracking, computing, and telemetering units, "Vitramon" Capacitors are porcelain-bodied to resist adverse conditions such as heat and humidity. But Vitramon engineers realized that only a small amount of condensation on the porcelain could cause leakage paths and lead-to-lead shorts. They solved the problem by dipping each capacitor in Dow Corning silicone fluid. The micro-thin coating is moisture-repellent . . . durable. The silicone surface "beads" water, preventing condensed moisture from forming a conductive film.

CIRCLE 601 ON READER-SERVICE CARD

This Resin Is As Good As Its Bond

The Osborne Electronic Corporation makes, among other things, specialty transformers for airborne electronic systems. Look hard and you'll see an Osborne unit in the Jupiter Ground Support Equipment control box on the facing page. At the center of each Osborne transformer is a coil bobbin which must have maximum mechanical and electrical strength in minimum thickness to allow maximum copper content in the core window area. Normal tolerance is ±.015. In addition, they must withstand temperatures from —65 C to over 200 C, be free of voids or pinholes. Osborne engineers have found the most economical way of producing top quality silicone-glass laminate coil bobbins of special sizes and shapes for their custom transformers is by winding glass tape on a mandrel, then saturating it with Dow Corning solventless resin applied by paint brush. Dow Corning resin cures with heat; no pressure needed. It provides the high physical strength to resist heavy wire winding pressure.

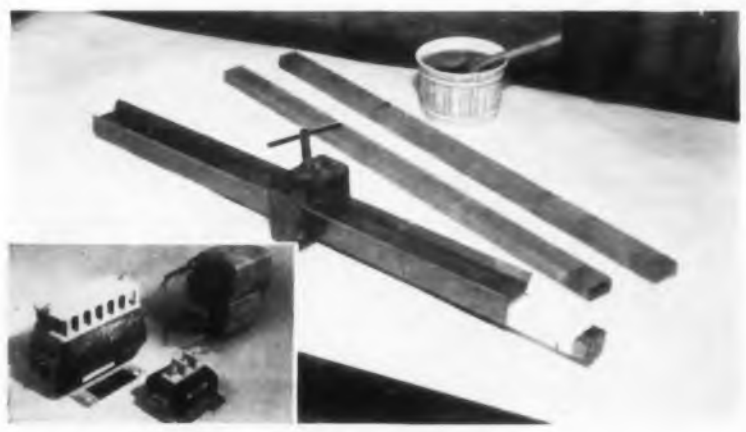
CIRCLE 602 ON READER-SERVICE CARD

Silastic® Insulates Beyond The Call

This giant Klystron focusing coil, a product of Varian Associates, is destined for a vital role in space-age electronics. Designed for 5000 hours minimum life, it operates at 1650 watts input and is cooled by liquid heat-exchange. *Inlet* coolant temperature is 125° C!

Where does Silastic, the Dow Corning silicone rubber, fit in? It's over, under, and around every layer of the coil. A paste form of Silastic is coated on each successive winding and over the copper cooling coils as well. Dielectric strength, resiliency, and resistance to heat and moisture are essential. The coil must withstand water immersion tests, vibration tests, a shock test of 10 G's for 15 cycles of 11 micro-seconds each, and environmental testing which includes severe thermal cycling.

CIRCLE 603 ON READER-SERVICE CARD



CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

Fig. 5. Operator positions material by following a template on this Wiedemann turret punch press.

5. Improper fluxing.
6. Improper solder.
7. Improper heat capacity of the iron.
8. Disturbance of joint before solder has set.
9. Improper heat sinking.
10. Improper degree of cleanliness.

In view of these, he advises close supervision of all personnel with soldering irons in their hands. He recommends, as far more reliable, mechanization of soldering. He points out that Mini-Mech offers complete control of all the variables which are the general causes of failure. In controls the time, temperature, pressure, and quantity of solder which will be used in a connection.

Flexible Fabricators

After assembly machines, the most useful equipment for electronics manufacturing consists of tools for punching chassis and circuit boards. Here too, one can find versatility in commercial machines. One very versatile machine is Wiedemann's RA-41P turret punch press, shown in Fig. 5. Equipped with as many as 20 turret stations, it can quickly punch a wide variety of hole sizes and shapes. Individual punches and dies are easily replaced to increase the number of hole sizes and shapes available.

This machine combines the versatility, accuracy,

Fig. 6. General Electric's automatic positioning control combines with the power of this Wiedemann press to provide great production speed and flexibility.

Fig. 7. This Wales-Strippit Fabricator, with an auxiliary Duplicator, follows a template to provide a wide variety of precisely positioned holes.

and high speed of a pantograph for rapid hole location, with rapid punch and die selection.

Where quantities can justify the cost, the new, high-speed, tape-controlled Wiedematic press (Fig. 6), can prove enormously useful. Controlled by a modified General Electric Mark III automatic positioning control, this machine handles all press functions automatically—tool selection, material positioning, and piercing.

Tape control provides great advantages. From the viewpoint of inventory, it allows fewer pieces to be carried in stock since setting-up is merely a tape-out-of-the-file away.

From the viewpoint of engineering, it simplifies the preparation of information for the shop. With

Fig. 8. Complex, short-run jobs like these are handled quickly by the Wales-Strippit Fabricator-Duplicator.

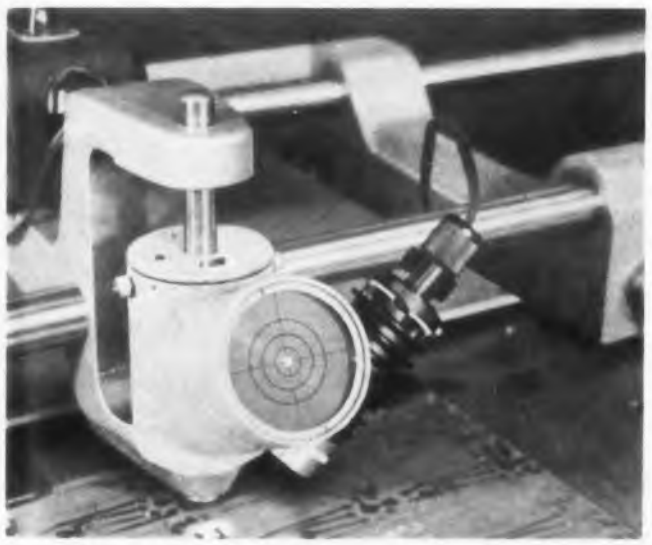


Fig. 9. The Dupl-O-Scope locates the position of holes optically. It can help the Fabricator prepare a template for use with the Duplicator.

tape-controlled machines, shop people no longer need conventional drawings.

Punch Chassis or PC Cards

Wales-Strippit, Inc. of Akron, N.Y., manufactures a "Fabricator" (Fig. 7), which punches, notches, or nibbles sheet material, and can dimple flush-head fasteners. It is just as useful in punching the metal chassis shown in Fig. 8 as in punching printed circuit cards.

With an accessory "Duplicator," the machine

Ideas and Tools

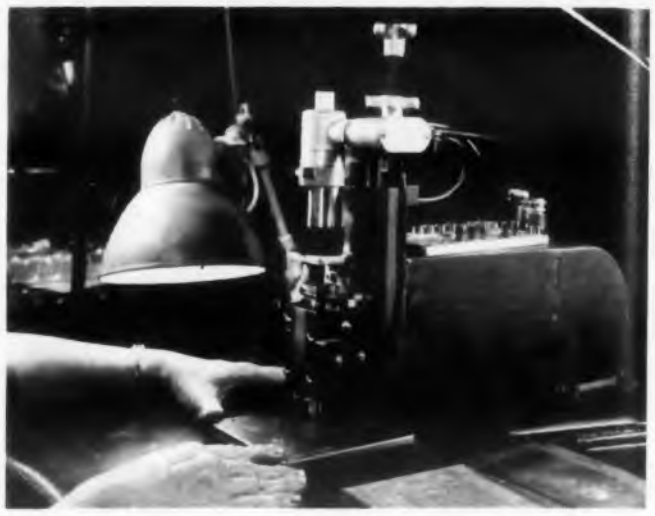


Fig. 10. Librascope-developed drill can drill as many as six circuit boards at a time. A "finger" follows a drilling path etched on the template, to position the boards.

uses a pantograph principle to follow the position of a stylus in template pilot holes.

Another accessory, the Dupl-O-Scope of Fig. 9, locates holes optically, from a drawing, layout, or sample part. On printed circuits, holes can be centered from the OD of round circuit connection points, even where the hole points on a sample are off-center.

Upside-Down Drill Follows "Finger"

For automatic assembly on printed circuit boards, the holes for mounting component leads

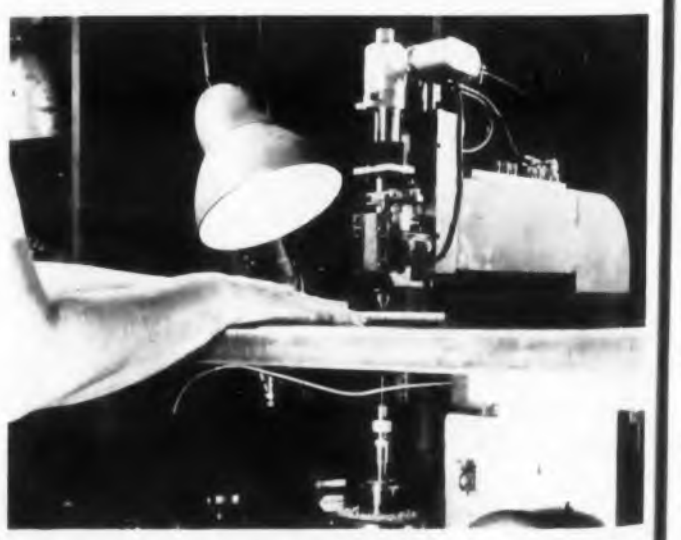


Fig. 11. When the "finger" drops into an indentation, the drill rises from below.

Fig. 12. The new Hermes Engravograph can be used for marking or for deeper cutting applications.

Fig. 13. Hinchman's Unex Jet Molder uses interchangeable injection cylinders and dies.

must be positioned precisely. To meet this requirement, Librascope has developed a ganged-drill.

Using this machine, shown in Figs. 10 and 11, an operator gangs as many as six circuit boards by placing them in a special positioning fixture. The fixture, a rigid metal plate backed by a reinforced plastic, has a surface plate with a drilling path etched into the metal. Positioning indentations correspond to the holes to be drilled.

As the positioning finger drops into an indentation along the contact path, the operator touches a toe switch and a special carbide drill, located below the table, makes the holes.

The drill itself is completely automatic, rising at a controlled rate and spinning at a pre-set

Fig. 14. Raytheon's Weldpower Control applied to solidly packed circuit "sticks."

speed. It cannot rotate until the exact position for a hole is located by the operator.

Two-Job Engraver

Another versatile machine is the model ITX Engravograph manufactured by New Hermes Engraving Machine Corp. of New York City. This engraver, shown in Fig. 12, does two kinds of jobs. As a marking tool, it makes signs and nameplates, engraves names and numbers on parts, instrument panels, legend plates, dials and knobs. As a production tool, it handles many surface-cutting applications.

Flexible Plastic Molder

For short-run plastic molding and encapsulation, Hinchman Manufacturing Co., Inc. of West Concord, Mass., makes a Unex Jet Thermoplastic Molder. Shown in Fig. 13, this machine uses interchangeable injection cylinders and a variety of standard dies to make components of different materials, shapes or colors within minutes.

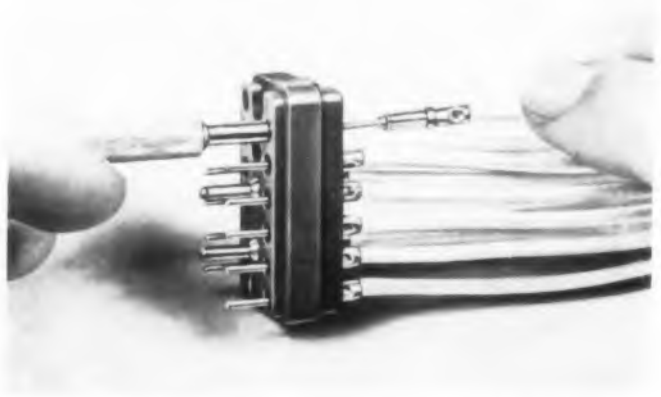


Fig. 17. Burndy's Hyfen connectors allow individual or gang connect or disconnect. The simple extraction tool is used for individual disconnect.

Don't Overlook Welding

Within the past two years, welding has become more and more popular as a means of joining components. A proper weld can provide a far better joint than solder, and can remove the possibility of undetected cold solder joints.

Furthermore, in miniaturization applications, the bulge of a solder joint may occupy too large a volume. A weld, of course, takes up no additional space. In some low-noise applications, the noise contributed by the solder joint is objectionable. And since a weld is made in milliseconds, it is not necessary to heat-sink temperature sensitive components.

Welding lends itself beautifully to some of the new packaging techniques using conventional components. Fig. 14 shows Raytheon's Weldpower Controls used in Raytheon's Welded Module construction.

Fig. 16. These "micro markers" flag the four fine terminal leads on this toroid. These markers are unaffected by coil-generated heat.

Raytheon's Commercial Equipment Division in Waltham, Mass., manufactures a variety of types of welding equipment for ultra-small and rather large applications. Flexibility is inherent in the design of the equipment.

For example, Raytheon can provide a welding system for a pilot run. This equipment includes a welding head, a simple fixture for manual feeding, and a power supply.

When the customer's requirements grow, Raytheon can supply equipment to automate the welder for high-volume production runs. The automated equipment provides completely automatic feeding, wire-cutting, welding, and ejection.

It uses part of the customer's original pilot-run equipment so that a customer can salvage more than 70 per cent of the cost of his pilot-run equipment when he switches to automatic equipment.

Fig. 15. All leads of this wiring harness are permanently marked with self-sticking markers made by W. H. Brady.

Identify Parts

Positive identification of wires in mass-produced equipment and assemblies is important. In short-run production, it's often vital. Good identification, as in Fig. 15, can save hours and dollars in circuit checkout and hook-up time and can prevent costly errors due to improper connections.

One-of-a-kind assemblies can be marked almost as quickly and economically as their mass-produced counterparts. Particularly useful are the self-sticking wire markers like the Perma-Code series manufactured by the W. H. Brady Co. of Milwaukee, Wis.

These adhesive-backed markers are supplied on self-dispensing cards, ready for rapid application. Until recently, most markers were a bit too large for very small assemblies. But Brady's new "micro markers" can be used on even very small subminiature assemblies, as shown in Fig. 16.

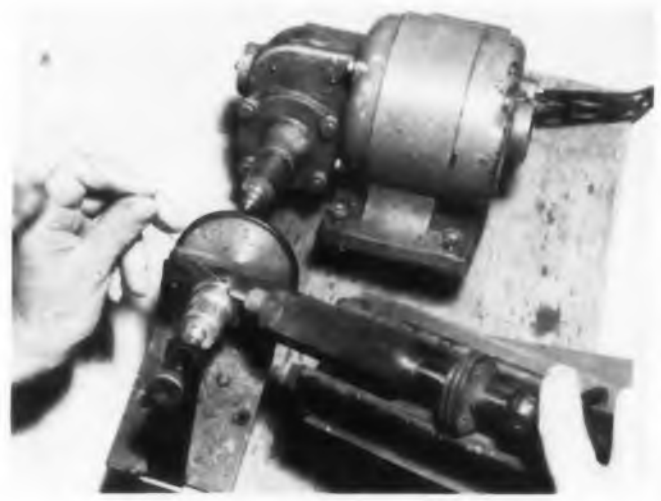


Fig. 18. A simple hermetic-seal rig developed by Newark Controls.

Watch the Connections

In short runs, just as in long runs, the reliability of equipment depends largely on the reliability of the connections. For short-run work, compression connectors of the Hyfen type can be particularly useful.

As shown in Fig. 17, these connectors, manufactured by Burndy Corp. of Norwalk, Conn., allow removal of individual wires with a simple extraction tool. This feature can be a boon to the man who has to check that hard-to-get line that always terminates in the center of a connector.

Use What's Commercially Available

For short runs, a good rule is: "Don't make what you can buy." Too often, an engineer gets into a bind trying to fabricate customized components. The engineer usually has the fixed idea that "nobody's going to make the stuff in the kind of small quantities I need."

But many manufacturers do provide short-run services. Even cable, which usually comes in 5000 foot lengths can be purchased in small runs. Alpha Wire Corp. of New York City for example, uses special techniques to provide "customized cable" runs as short as 50 feet.

Adapt What's Available

Often, when the purchase of specialized equipment is not justified, equipment on hand can be modified easily to fulfill a short-run requirement. For example, Newark Controls Company of Bloomfield, N.J., uses the simple rig shown in Fig. 18 to hermetically seal covers on gas density switches.

The cover fits snugly over the switch and is held in place by a nest and spring-activated clamp. The component is turned by a foot-pedal-operated, motor-driven shaft. A soldering iron heats the piece sufficiently in four revolutions so that solder can be hand fed during the fifth revolution.

Even unskilled operators can distribute the solder smoothly and evenly with this little fixture and the cost is negligible.

Ideas Wanted

Designing for short-run production is challenging. The problems are many. Many of the techniques developed over the years for mass production simply cannot be applied to the short run.

But many can! They are waiting to be used—usually with modifications. But the modifications require thought and planning—lots of planning. With proper thought and planning and with the use of available mechanical aids, short-run production can be profitable.

The stimulation provided by the challenges of short-run production has even prompted some engineers to claim "The short run can be fun." ■ ■

DESIGN FORUM

Low-pass linear phase electronic filter with a frequency range from 10 cps to 80 kc is designed to give a constant time delay and optimum transient response.

Electronic Filter Provides Linear Phase

PRACTICAL solutions to design problems have produced an electronic filter with constant time delay and optimum transient response. By cascading three amplifiers having staggered dampings and natural frequencies, a low-pass filter with a terminal slope of 36 db per octave has been obtained. The instrument's output is not distorted by random signals.

Designed by Ralph Morrison of the Dynamics Instrumentation Co., 1118 Mission St., South Pasadena, Calif., the Model 2200 covers the frequency range from 10 cps to 80 kc in tenth decade steps. Output has less than one mv rms noise and hum; drift is less than 10 mv per hour when the filter is operated from a regulated power line.

Since often the engineer wants to place the cut-off frequency of a low-pass filter as high as possible and still attenuate disturbing signals that are near the cut-off, the obvious solution is to extend the frequency response and increase the attenuation rate above the cut-off point.

This is possible within limits, notes Morrison, but there are undesirable side effects. One result of this kind of maximally flat filter is a poor transient response; another is time distortion. Both of these can be compensated for if square waves or sine waves are being processed. This is rarely the case, in practice. In fact, the square or sine wave response of a filter is usually only of academic interest.

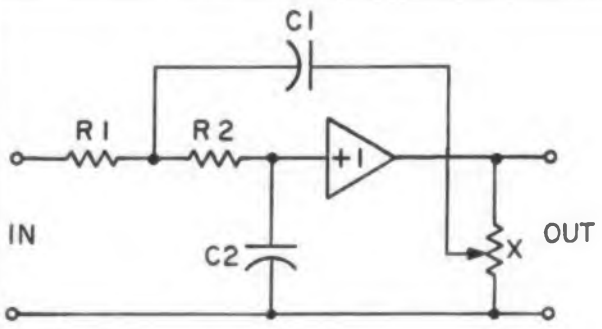


Fig. 1. Unity-gain dc amplifier with feedback network. Transfer characteristics are defined by passive elements rather than vacuum-tube characteristics. By interchanging R's and C's, filter can be made high-pass.

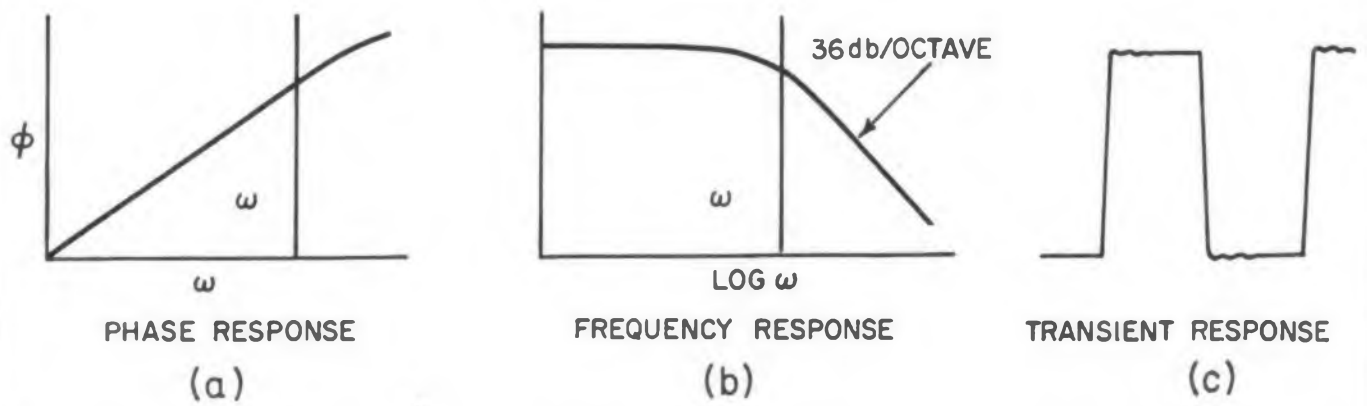


Fig. 2. Phase response of cascaded system is shown in (a); frequency response in (b). At cut-off, frequency response curve is rounded, but this is said to be desirable. Rise time, in the transient response curve (c), is only 0.4 sec.

Design

Each of the three cascaded amplifiers can be described as a single-degree-of-freedom system, with natural frequencies and dampings and only two energy storage elements like capacitors and inductors.

Requirements for the amplifiers include zero output for a zero input dc signal, freedom from drift and noise. Using feedback introduces the desired transfer characteristics — determined by passive elements and not by vacuum tube characteristics. The feedback circuit shown in Fig. 1 transforms a dc amplifier with high input and low output impedance into a single-degree-of-freedom system.

The transfer function of the system can be written

$$E_o/E_{in} = \omega_n^2/(S+S_1)\ (S+S_2)$$

where $S_1 = k\omega_n + j\omega_n\sqrt{1-k^2}$, and

$S_2 = k\omega_n - j\omega_n\sqrt{1-k^2}$.

When three amplifiers similar to the one in Fig. 1 are cascaded — and where S_1 and S_2 are $6.4 \pm j4.0$; S_3 and S_4 are $3.9 \pm j11.7$; and S_5 and S_6 are 20.4 and 5.37, respectively — the net result is a low-pass filter with a phase response like that in Fig. 2a. Frequency response and transient response for the same filter are shown in Fig. 2b and c.

Note that while the transient response is good the frequency response is rounded in the region of cut-off. Morrison contends that far from being undesirable, a low-pass filter with this characteristic is ideal for handling random signals.

Other Considerations

A single switch on the filter provides for high-pass operation. This is accomplished by interchanging the R's and C's of Fig. 1. The circuitry was arranged so the crossover frequency for any low-pass-high-pass setting occurs at the three db point. For both modes of operation the terminal slope is 36 db per octave.

Input impedance is more than 100 K for all frequencies. Output impedance is low: maximum output voltage is ±20 v with maximum output current of ±20 ma. The low output impedance is to ensure that the filter transfer characteristics are relatively independent of loading, which is difficult to obtain with a passive filter

To eliminate any troublesome ground tie between filter channels in a multichannel system, the Model 2200 is built so the shield and B_o (input-output common) are free from any cabinet connection. The power transformer is doubly-shielded to prevent common-mode power line signals from generating reactive ground currents.

For further information about this well-designed linear-phase electronic filter, turn to the Reader-Service Card and circle **101.**

Intercoupling Circuit for Precision Amplifiers

Whether engaged on major project assignments or minor development work, George Hall enjoys the challenge of simplifying circuitry. He feels that a circuit devoid of reactive components, such as described, is ideal for medical and hi-fi applications.

George H. Hall
Research Engineer
Arthur D. Little, Inc.
Cambridge, Mass.

Dc amplifiers, when compared with ac amplifiers and chopper-rectifier combinations, offer superior performance in terms of higher signal-to-noise ratio and zero phase shift over a wide band width. Drift, the serious drawback, is minimized drastically by the novel interstage coupling principle described.

SERIOUS PROBLEMS associated with dc amplifiers are drift and the necessity to operate succeeding stages at higher and higher potentials. Using a tube and small bias battery arrangement[1] as an interstage coupling device results in size, weight and cost reductions when compared with conventional direct coupling techniques. In addition, the elimination of excessively high potentials by this coupling approach reduces the shock hazard and improves amplifier stability.

Conventional DC Amplifiers

Comparing ac amplifiers, with chopper input and rectifier output, against dc amplification, dc amplifiers have no chopper noise, higher signal-to-noise ratio, and zero phase shift from dc up to frequencies where interelectrode capacity of tubes become effective. Furthermore, ac amplifiers are limited by being unable to go down to dc, and by having a narrower bandwidth than dc amplifiers. Therefore, dc amplifiers are especially desirable for use in instrumentation work requiring precision.

However, a serious problem in dc amplifier circuits is drift and the fact that the output of any given stage is at a higher dc level than desired for input to the next stage. The usual methods of combatting this second problem are direct coupling, resistive divider coupling, or voltage regulator tube coupling. These methods are generally unsatisfactory.

When the control grid of a stage is maintained at the same dc potential as the plate of the preceding stage, the plate supply voltage must be succeedingly higher for each stage so that the necessary grid potentials may be maintained. This results in high-voltage supplies which are expensive, unstable, and dangerous. In addition to the plate-supply problem, the filament supply is complicated by the restrictions in maximum cathode-filament voltage specified by the tube manufacturer, and by the generation of hum and noise when circuits are operated at levels far removed from ground potential.

Battery coupling is expensive, bulky, and introduces phase shift. Coupling with voltage regulator tubes results in additional noise and therefore is undesirable at low signal levels. Sometimes a voltage divider is used in the coupling circuit, but this method proportionately attenuates both the dc level and the signal level.

The novel interstage coupling principle described permits dropping the potential level from the previous stage without appreciably distorting or diminishing the magnitude of the signal. The resulting amplifier is characterized by high gain, low drift, and low noise-to-signal ratio. Phase distortion is eliminated, because no reactive components are used in the amplifier circuit.

A simple circuit illustrating the technique is shown in Fig. 1. V_2 is the coupling tube. Between its grid and cathode is a bias battery so that the grid is held negative by the small voltage e_{gk} supplied by this source. (A mercury cell is very satisfactory in all respects.) As the signal from the previous stage V_1 varies, the plate voltage of the coupling tube changes. The plate-to-cathode voltage, however, remains substantially constant and equal to μe_{gk}. As a result, signal variations are transmitted to the cathode resistor and appear almost without loss at a dc level determined by the no-signal plate current times R_k, and the value of the negative bias supply.

Thus there is basically a fixed voltage drop across the top leg of the output divider composed of V_2 and R_k. This is equivalent to inserting a large battery or a gas tube of constant voltage drop equal to μe_{gk}. In this instance, the volt-

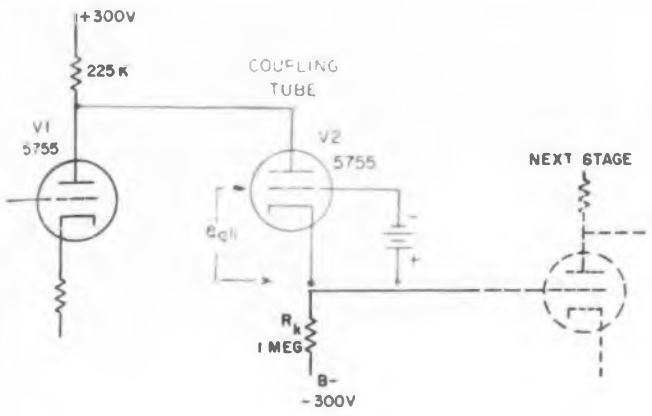


Fig. 1. Basic circuit illustrating the use of a tube (V2) plus bias battery as an interstage coupling element.

age gain of the tube is used to decrease the size of the battery required for this task. Alternatively,[2] may be considered a "high-vacuum neon lamp" whose running voltage is adjusted by the selection of the grid-to-cathode battery.

The application of the technique to a difference amplifier is shown in Fig. 2a. The characteristics of this coupling circuit may be shown as an equivalent circuit similar to voltage divider type circuit, but the two resistance elements are a resistor and the cathode-plate electron path of a vacuum tube.[2] The circuit constants are arranged so that the vacuum tube operates at a point on its characteristics where the dc plate-to-cathode resistance is high and the dynamic resistance, i.e., incremental change in voltage corresponding to a similar change in plate current, is relatively low. [Tube R_p (dc) is high—Dynamic r_p (ac) is low.] This coupling device is shown schematically with a plot of equivalent static resistance vs. dynamic resistances. (Fig. 2b)

At the operating point on the 5755 tube characteristics, the dc resistance is:

$$R_p = \frac{E_p}{I_p} = \frac{200}{1.\times 10^{-4}} = 2 \text{ meg}$$

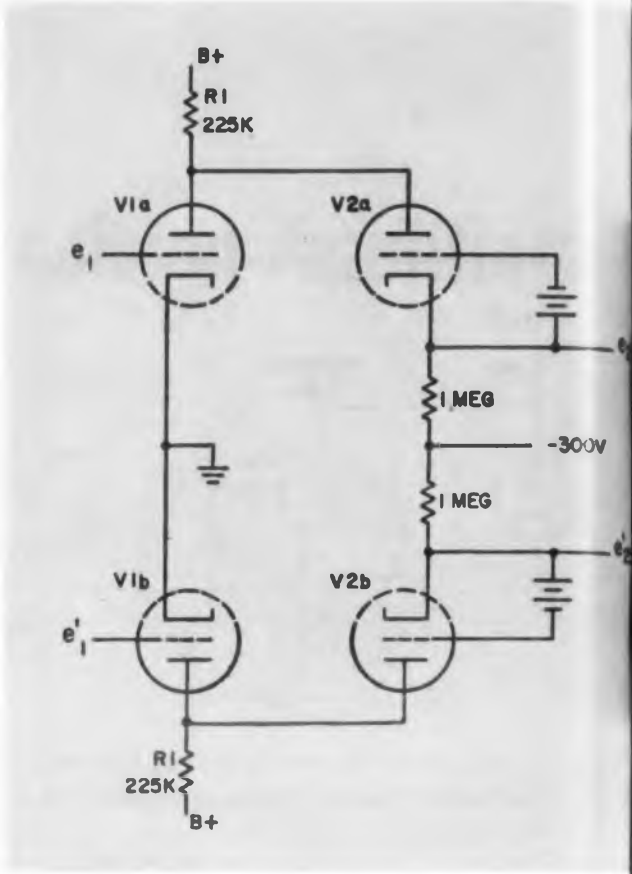


Fig. 2a. Interstage coupling principle applied to difference amplifier.

For dynamic tube resistance:

$$ep/ip = \frac{50}{4.\times 10^{-4}} = 0.0625,$$

or 93.75 per cent efficient for the transfer of the signal voltage.

The series resistor R_k is large (1 meg), and the voltage across it is applied to the grid of the succeeding stage. With this arrangement, the dc voltage across it is considerably less than the dc level across the tube as the other element of this divider. However, since the resistance of this resistor is much greater than the dynamic ac resistance of the vacuum tube, substantially all of the signal voltage appears across this resistor and is thus applied to the grid of the succeeding stage. This coupling circuit has very useful characteristics since it generates negligible noise and signal distortion, and the phase shift over a wide operating range is virtually unmeasurable.

Typical Applications

This coupling unit is one key to simplifying dc amplifier circuitry, and it can be used in all types of conventional amplifiers, single-ended or differential.

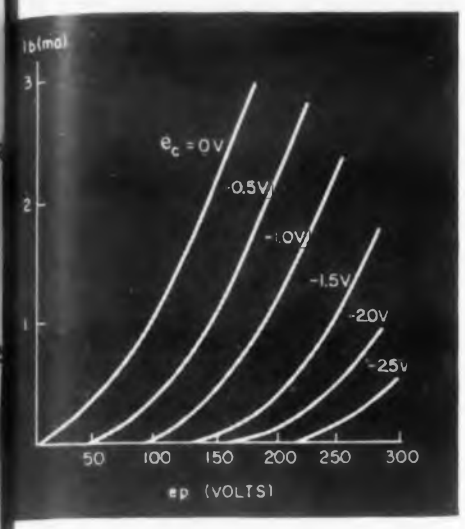


Fig. 2b. Average plate characteristic 5755 tube used for interstage coupling.

A typical circuit incorporating this interstage coupling circuit is a pneumatic sine wave generator designed for use in testing hydraulic flight control systems. The amplifier in this system has a gain of 30,000, background noise is approximately 55 db down, and the bandwidth is 100 kc. Phase distortion is so low that it cannot be measured.

The circuit is especially suitable for any application that requires extremely high-quality amplification. It is particularly well adapted for medical amplifiers used in encephalography, catheter work, heart stludies, and nerve impulse research where fidelity is of utmost importance. It will operate from dc to 0.5 mc for transient pulse measurement in biophysical work, and as an amplifier in all instruments requiring best possible fidelity. ■ ■

1. The interstage coupling circuit described is offered under license by Arthur D. Little, Inc., Cambridge, Mass.

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Thompson, North, Harris—"Fluctuations in Space-Charge Limited Currents at Moderately High Frequencies,"
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Protect Transistors Against Destructive Transients

Supply voltage transients are one of the most frequent causes of transistor power amplifier failure. Here is a simple explanation of how transients penetrate circuitry, and an easy low-cost means of avoiding their destructive effects.

Bernard B. Daien
Contributing Editor, *ELECTRONIC DESIGN*

Supply voltage transients in transistor amplifiers can be affectively minimized with relatively low-cost components. By analyzing the transient paths and providing the necessary precautions, substantial savings in "down" time, replacement costs, and maintenance can be achieved.

Built In Transient Susceptibility

The fundamental class B amplifier in Fig. 1 serves to clarify the text, and is also representative of basic servo amplifiers.

Driver transformer *T1* matches the high collector impedance of driver *TR1* to the low input impedance of the class B stage. In consequence, the inductance of one half the secondary winding appears between the base and emitter of each of the output transistors. Invariably the circuit designer thinks of this winding in terms of its dc resistance in his preoccupation with the stabilization problem (which demands a low dc resistance path between base and emitter). The effects of this inductance are therefore overlooked.

The power amplifier load impedance is made quite small since the power output of a Class B stage

$$P_{out} = \frac{2\ (supply\ voltage)^2}{collector\ to\ collector\ load\ resistance}$$

A line transient will therefore encounter very little opposition in its path to the collectors of the output stage through the primary of *T2*. If the transient has a fast rise time, the above mentioned driver transformer *T2* will appear as an extremely high impedance to the sudden increase in collector junction leakage caused by the transient. Referring to Fig. 2, the base-to-emitter return path is seen to be a very low resistance for dc but essentially a high impedance for the fast transient, as compared with the relatively low emitter to base junction impedance. As a result, the increase in collector to base leakage due to the transient flows through the base-emitter junction, is amplified by Beta, and appears as a sudden large increase in collector current. Since the increase in collector current occurs during the existence of the transient, it is apparent that the design limits for voltage, current, and power are simultaneously exceeded.

Another transient is the pulse which appears across the base-emitter junction of each output transistor through driver transformer *T1*, as *TR1* is similarly affected by the transient. Fortunately *TR1* has appreciable impedance in series with its collector, in the primary of *T1*, which usually protects it. The pulse which results may be of such amplitude and polarity as to exceed the low inverse rating of the base-emitter junction of the output transistor.

Curing The Transient Problem

In Fig. 3 are simple circuit additions which minimize the effects of destructive transients.

Resistors *R1*, placed across each half of the secondary of *T1*, limit the maximum impedance of the base to emitter path to the value of *R1*. Suggested values for *R1* are 100 ohms, with lower values preferable. Drive power must be increased to allow for the shunting effect of *R1*, but this is a small price to pay for the improved transient

Fig. 1. The fundamental Class B or servo amplifier.

Fig. 2. Collector junction leakage paths.

Fig. 3. The protected amplifier incorporates Zener diodes *Z1* for transient limiting and *Z2* as power supply regulator.

immunity afforded, and is certainly lighter, smaller, and less expensive than an LC filter in the power input lead.

Zener diodes, *Z1*, are placed across the collector to emitter of each output transistor. These Zeners are rated at 1 w and twice the voltage of the dc supply (to allow for the normal peak signal swing plus supply voltage.) The Zener simply affords protection against overvoltage; it does not protect against that portion of fast rise time transients below the Zener breakdown voltage. *R1* is therefore desirable despite the Zeners. Without *R1*, repetitive fast transients may result in sufficient heating to set off runaway.

Zener diode *Z2*, and its associated resistor *R2*, limit transients appearing at the collector of the driver transistor. This limits the pulse through *T1* to a reasonable value, protecting the base to emitter junctions of the output transistors.

Reducing Immunity Cost

By selecting the voltage rating of *Z2* somewhat lower than the minimum supply voltage anticipated, *Z2* functions as a regulator and decoupling filter for the driver and preamplifier stages. Unlike a capacitor, the Zener impedance remains small at low frequencies, hence prevents low-frequency feedback through the power supply more effectively than a capacitor. The regulated voltage so obtained may be used as a stabilized source for obtaining bias for the driver and preamplifier. The resulting reduction in operating point shift, due to changing line voltage, permits the use of less degeneration, enabling greater stage gains to be realized. The cost of *Z2* may therefore be recovered by eliminating the need for a decoupling section normally used.

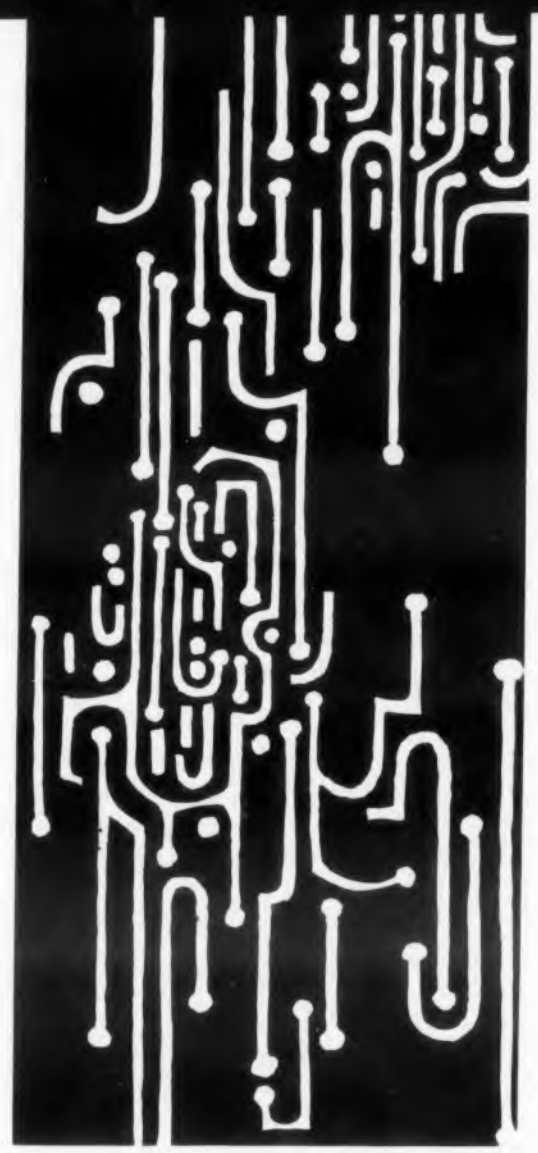
The cost of *Z1* is recovered by using output transistors with a lower collector voltage rating, since the Zener affords positive overvoltage protection, eliminating the need for a "safety factor."

Practical Example

A 28-v servo amplifier, immunized in accordance with these principles, was repetitively pulsed with 300 v transients of 1 msec duration. The transients had extremely fast rise times. Despite this there was no observable deterioration of the amplifier or of the transistors which were tested before and after the pulsing. It is suggested that for extremely severe transient conditions, *Z1* be made as large as necessary to handle the peak current; 200 mw units proved unsatisfactory in this test.

The same amplifier without modification repeatedly suffered destruction of one or both of the output transistors after only a few pulses under the same test conditions. ■ ■

The author gratefully acknowledges the assistance offered by the AVION DIVISION, A.C.F. INDUSTRIES in the preparation of the necessary art work.



How Large Should a Module Be?

W. Van Alan Clark, Jr.
The Sippican Corp.
Marion, Mass.

W. Van Alan Clark, Jr., president of The Sippican Corp., describes himself as a backslid economist. A product of Williams and MIT, he joined the MIT faculty in 1946, becoming, in 1954, Associate Professor and Assistant Dean of MIT's School of Industrial Management.

He views the electronics industry as an ideal industry for the practical education of an economist since "it provides a maximum risk and a minimum profit potential."

In this article, he shows how an economist would solve the problem of module size.

WHAT'S the best size for an expendable module? The module may be a true chuckaway or a chuckaway which is actually "swapped" at the field level. It may be repairable at the depot level or separable at the depot level into yet smaller chuckaway modules.

Determining module size is complicated by the fact that the decision involves a number of cost elements which are hard to think about with intuition alone.

There are the costs which occur when the system is built. There are those which are required to fill the supply and maintenance pipelines to obtain full operation of the system. There are further costs which are in the future (which means that we must discount them to their present value). There are uncertain costs, whose value we must find by multiplying their probability by their cost when they do occur.

There are variables in repair cost which depend on the amount and kind of training that repair personnel must have at various repair points. And there are ultimate salvage values (negative costs) at the end of the useful life of a system.

Different sized modules can affect the value of a system by affecting its weight and size, its performance, and certainly, its reliability. These costs are very real but are usually hard to estimate, let alone document.

Make an Economic Model

One way to look at this problem is to construct an economic model—an expression of the way the costs of the system may be expected to behave—and to optimize this expression.

Engineers are accustomed to optimizing equations to find the best part of a curve. Where the equation is known, they will differentiate it with respect to variable to be optimized and set the differential equal to zero. Then they will solve

for the best value of the variable.

Similarly, economists, who often don't have formal equations to deal with, explore margins to find the slope of the total cost curve. Often, they work with a cost curve and a value curve. By finding the effect of marginal changes in cost or value (by determining the slope of these curves), they learn something about the slope of the total cost curve and thus determine in which direction the optimal total profit point lies.

Economics of Module Size

Applying these thoughts to the field of module size, one finds an expression of cost. Expressing it verbally the cost of a system is the sum of the following costs:

- The cost of constructing it.
- The cost of filling the supply and maintenance pipeline.
- The likelihood of system failures times the cost of these failures when they occur. This cost of failure includes down-time cost, repair cost (both labor and material), *and* in many cases, the cost of sending the system or parts of the system back for depot or factory repair.
- The cost to the performance of the system of added size and weight above the theoretical minimum (zero weight)° regardless of cost.
- Today's value of the eventual salvage value (negative cost) of the system.

To behave like reasonable economists or economically literate engineers, we should reduce all future costs in a system to their present value. To recognize time as a factor in the equation, we should divide each cost by the compound interest factor $(1 + i)^t$ to obtain its present discounted value.

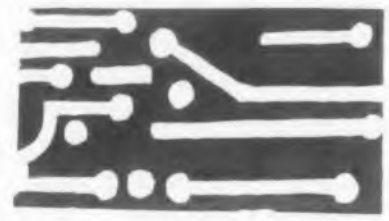
For simplicity, we can ignore the effect of time and build an equation of system cost which looks something like this:

$$\textit{Total Cost} = C_c + C_{s\text{ and }m} + pF(C_{d/F} + C_{fr/F} + C_{dr/F}) + C_{weight} > 0 - \textit{Salvage Value}$$

where c = construction
s *and* m = supply and maintenance
pF = probability of failure
d/F = downtime per failure
fr/F = field repair per failure.

If we look at this expression and think about it with respect to module size (i.e., take out the partial derivative for module size), we find that we may have no real data. But by estimating the way the module size affects the various terms, we can at least find out which terms are most signifi-

° This is no joke. The best way to do an efficient job on an operation is to get rid of it. Thus, one can often eliminate a chassis (make it equal zero pounds) and make a self-supporting circuit module.



cant and which terms dominate the equation in sheer orders of magnitude.

For any particular system, we may find these things happening:

Larger modules may make the system cheaper to build, for there may be less cabling and fewer connections. But if the system involves many unreliable components, smaller modules may be better.

The cost of putting the system in service will be greatly affected by module size. Large modules may permit a quantitative difference (in the *amount* of training needed by field service personnel), as well as an important qualitative difference (men may be more highly trained in *system* analysis with less emphasis on detailed electronic skills). It is the system which is important at the field level.

The size of modules will affect the nature of the logistic pipeline and the number of identical modules possible in the system. This, also, is a function of module size as the number of identical modules will affect the inventory required.

The probability of failure (pF) is a function of many things. Among them is the manner in which failures occur. They may be a function of hours of use, times turned on and off, or exposure to specific environments.

Module size and the manner of joining modules can certainly affect the failure rate. Murphy's Law, which holds that what might come apart probably will, has not yet been abrogated. Thus, a totally "hard" system is likely to have fewer failures than one with many connectors and much cabling.

Failure probability is also affected by the amount of maintenance required in use. It is fairly certain that the reliability of many systems is reduced by their being worked on.†

The cost of a failure, once it occurs, is the sum of at least three costs.

1. The first, the cost of unscheduled downtime (or a fizzle), may be simply a by-event. Or it may be greatly affected by the number of minutes or hours involved in making the repair.

2. The repair cost is negligible when compared with the cost of on-line downtime in large elec-

† An airplane is most likely to have troubles immediately after overhaul. If you own one, make the mechanic go up with you for the first flight.

tronic systems. This tends to encourage large modules which can be exchanged after a quick diagnosis. For such major systems, large modules which are exchanged at the field level and repaired at the depot level, make logistic sense.

3. Consideration of the cost of the module eventually thrown away may reveal (in view of the total system costs) that many systems pay a very high price to save a small amount of material.

Weight and volume reduction have a high value in many systems. But they involve a cost which is hard to pin down with any precision. Increased weight, as it ripples through the design of a system, may involve an astronomical cost compared to the cost of reducing the weight in the first place.

In some cases, very high component density may impair system performance through interference. In other cases, large modules may improve performance through reduced line length.

Large modules almost certainly reduce system weight and size. They permit simpler chassis structures, less intermodular cabling, and fewer mechanical connectors or junction boxes.

Some Costs Aren't Important

Some terms are unimportant from the viewpoint of module size. Salvage value, for example, is likely to be far in the future. Discounting this event to its present value makes it an unimportant cost.

Other terms drop out entirely and are not even included in the original cost equation. Module size should not affect component cost or power consumption, for example. This is an obvious effect of differentiation; terms which do not vary in relation to the variable in question drop out.

This exercise of constructing a total system cost model may appear to be a foolish waste of time. To others, it may seem that the attempt to construct a cost model—even one arrived at inductively and with no proof—is nearly as valuable a design tool as is the construction of a physical model.

By looking at a design mock-up in physical form, we raise questions and find answers before being committed to expensive hardware. Similarly, by constructing an economic model, we raise questions and see answers in better perspective than we might by considering the various aspects of the design separately.

Most important, if we construct a total cost model which describes the costs of an apparatus over its lifetime, we quickly determine which costs are most important. We do not trap ourselves into choosing a design feature—module size—which minimizes one cost at the expense of some other cost of considerably greater magnitude. ■ ■

Solid State 10 mc Counter Uses Diode Logic

THOUGH there's nothing new about counting at a 10 mc rate, there is something quite unusual about doing it with transistors in a commercial counter-timer.

Transistorizing a counter offers the advantages of cutting size and weight and reducing power consumption. But it presents a problem. For it is no small feat to switch 10 mc pulses and run them around a chassis—even with vacuum tubes.

To dodge the switching problems found in high-frequency vacuum-tube equipment, engineers at Computer-Measurements Co., 12970 Bradley Ave., Sylmar, Calf., used digital logic for switching.

In their Universal Counter-Timer, Model 727A, all switching is accomplished at dc levels only. No pulses or high frequencies are switched through mechanical switches or switch cabling. Instead, all pulses are gated to amplifiers and to the decade counting units by means of digital logic circuitry.

For example, in the time-base gate selector shown in the logic diagram, the *AND* gates are enabled by a mechanically-switched 12 volt signal which allows the various time base signals to pass to an *OR* gate and thence to the amplifier driving the decade counters.

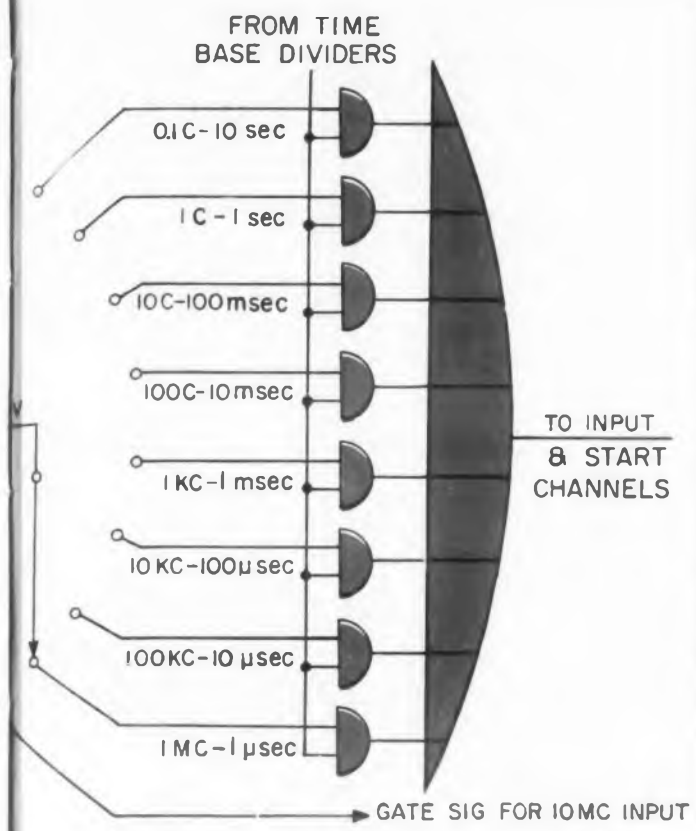
The *AND-OR* elements use IN34's in conventional diode logic configurations. Their effect on even the high frequency signals is negligible. Hence, no pulse reshapers are necessary.

For contrast, a gate selector in a typical vacuum tube counter would have pulses from time base dividers routed through a rotary switch and its associated cabling. The switch and cable capacitance would limit the frequency which could be switched.

Vacuum tubes which generate control signals must first charge the cable capacitances before they can send a signal through to the output. This requires high power from the driving circuits, and at high frequencies, the tubes must really be driven hard.

The high frequency pulses which are forced through switching networks, long lines, and cables require reshaping to restore them to useful form. CMC's transistorized counter requires no pulse shaping.

Since all switching is at dc levels, the internal circuitry is adaptable to remote



Time-base gate selector uses *AND-OR* logic to switch high frequencies. Only dc goes through mechanical switch and cabling.

operation without regard to cable length, cable type, impedance matching, and switching transients. Thus, the instrument lends itself nicely to automatic programming, and all functions are brought out at the rear for remote use.

In praising the virtues of the new counter, CMC chief engineer J. B. Olson points to low power consumption, weight, and size, and to high reliability. His comparisons are impressive.

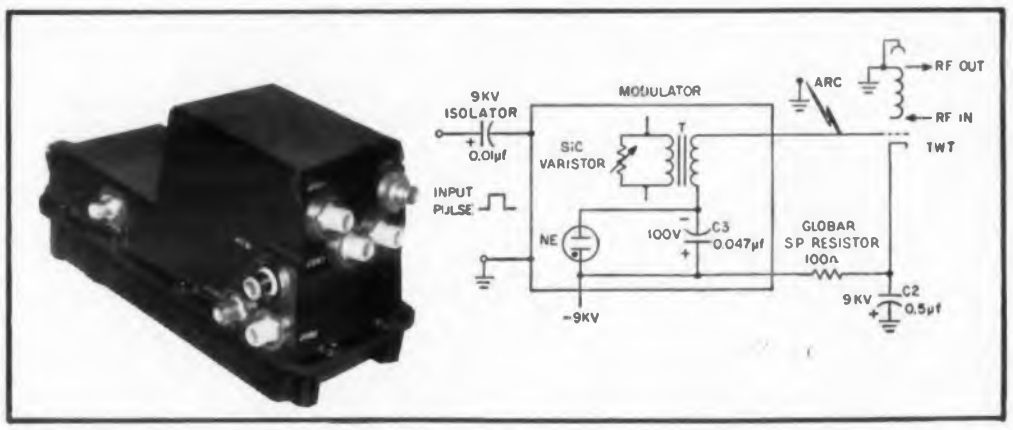
The transistorized counter consumes but 35 w. This compares with 320 w and 600 w for competitive vacuum tube versions. It weighs only 27 lb—quite a bit less than the 70 and 110 lb of vacuum tube counterparts. Its volume is less than a cubic foot as compared with almost two, and over 4 cu. ft. for competitive vacuum tube counters.

CMC has enough confidence in the unit's reliability to offer a two-year service-free warranty. Says Olson, "We don't expect to have to do any servicing on these units for a good five years—especially if we can devise a way to keep users from poking around inside."

For more information turn to the Reader-Service card and circle 103.

Electronic Products NEWS

by CARBORUNDUM
Registered Trade Mark



MEGAWATT transient handled by GLOBAR® 5 Watt SP Resistor to protect Miniaturized Pulse Generator

A tough problem was recently solved by Ramo-Woolridge, a division of Thompson Ramo Woolridge, Inc. It concerned protection against a transient discharge that caused breakdowns in a miniaturized pulse generator.

The circuitry, as shown above, involved a modulator for a 1-kw grid-controlled traveling wave tube. The grid would often arc to ground, shorting the energy stored in the condenser C2 through the modulator circuit and vaporizing the decoupling resistor R or the bias filter C3.

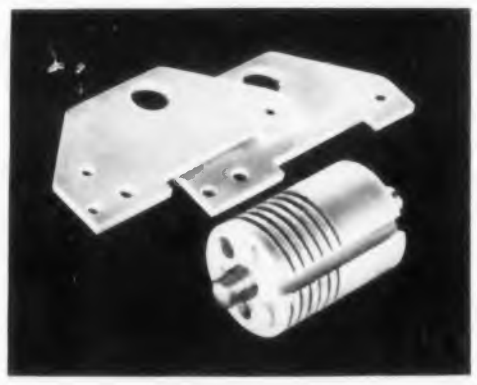
The answer was found in a GLOBAR Type SP 100Ω resistor, able to withstand the periodic 8000-v. discharge for several microseconds and to take a temperature of 1000 F. Since this resistor is non-inductive, it works well as decoupling element during normal operation, in addition to giving the protection needed when arcing occurs. 5 watt size 1¼" long, 5/16" diameter, obviates any space problem.

This example may suggest many similar applications. For more details on GLOBAR resistors, write Globar Plant, Refractories Division, Dept. EDR119, Carborundum Company, Niagara Falls, N. Y.

CIRCLE 712 ON READER-SERVICE CARD

CERAMIC DRUM AND END PLATES for radio tuner GROUND TO .001 ACCURACY

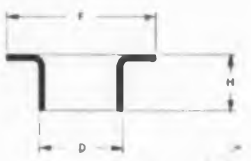
The drum coil and end plates shown in the photo are parts of a tuner for the Transport Radio Command and Ground Radio Command. The plate holes are ground to size with an accuracy of ±.001 and the hole spacing is held to a tolerance of ±.002. The drum with its stainless steel bearing sleeves is a direct ceramic-to-metal assembly. The bearings must withstand a vertical load of 60 lbs. Three of the end holes are tapped. The slot, the pitch and the depth of the spiral winding groove are ground to tolerances of ±.001.



This is an example of the accurate specifications that can be met with equipment at Carborundum's Latrobe Plant, which specializes in ceramic, ceramic-to-metal and glass-to-metal assemblies. Facilities are available for small or large production runs. For more information, write Latrobe Plant, Refractories Division, Dept. EDC119, Carborundum Company, Latrobe, Pa.

CIRCLE 714 ON READER-SERVICE CARD

Vacuum-tight, matched expansion GLASS-TO-METAL WINDOWS



Part No.	F	D	H
95.6006	11/16	.490	.175
95.6009	3/8	.281	.187
95.6010	7/8	.490	.078
95.6011	3/8	.250	1/8
95.6013	.220	.150	.150

Windows of the type shown above have a variety of applications where truly reliable vacuum-tightness or gas-tightness over a considerable temperature range is desired.

The advantage of these windows is that the frame and glass are united to form a chemically bonded, hermetically sealed unit. Use of KOVAR® alloy and borosilicate hard glass, which have practically identical expansion characteristics, eliminates stress and strain.

Large quantities of these windows are manufactured by Carborundum's Latrobe Plant. Bulletin 5133, giving complete information, is obtainable by writing to Latrobe Plant, Refractories Division, Dept. EDS119. Carborundum Company, Latrobe, Pa.

CIRCLE 713 ON READER-SERVICE CARD

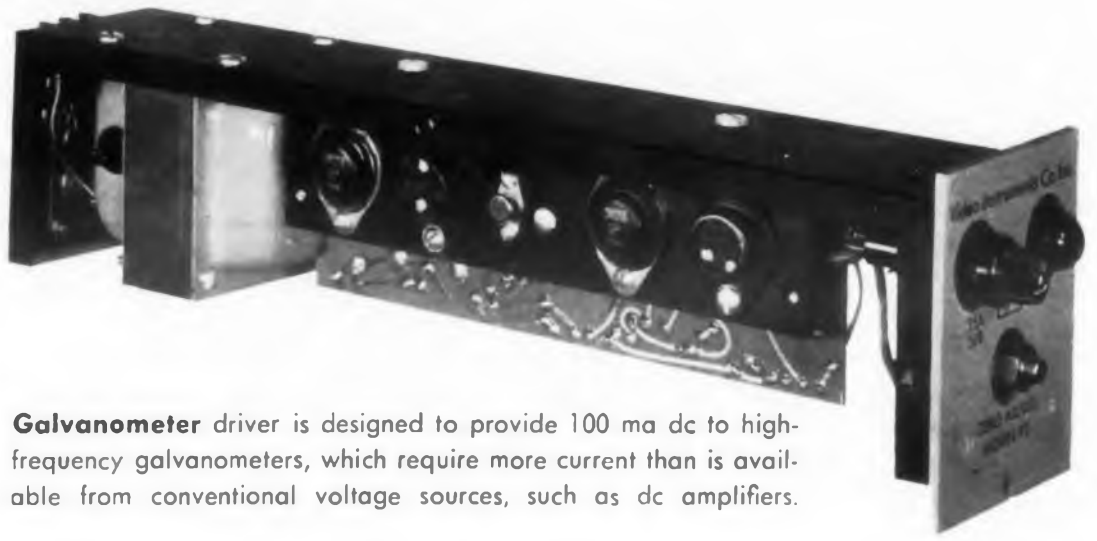
NEW BOOKLET AVAILABLE ON KOVAR® ALLOY

KOVAR is an iron-nickel-cobalt alloy used for making hermetic ceramic- or glass-to-metal seals. It has applications in many types of electronic equipment. This booklet is a complete catalog of specifications and applications. For your copy write Latrobe Plant, Refractories Division, Dept. EDK 129, Carborundum Co., Latrobe, Pa.

CIRCLE 715 ON READER-SERVICE CARD

CIRCLE 712 THROUGH 715 ON READER-SERVICE CARD

High-Current Amplifier Drives Hi-Fi Galvanometers



Galvanometer driver is designed to provide 100 ma dc to high-frequency galvanometers, which require more current than is available from conventional voltage sources, such as dc amplifiers.

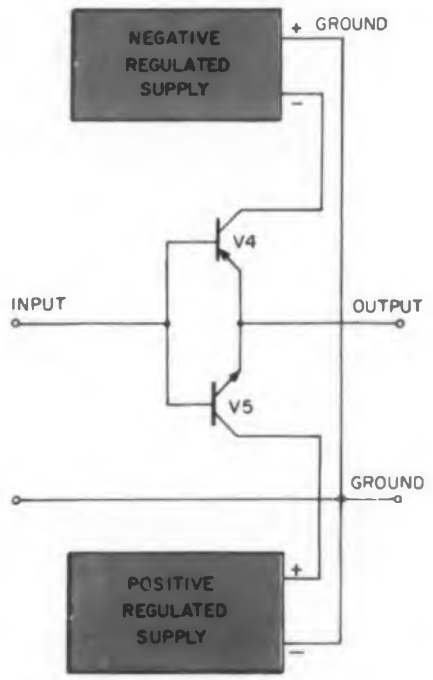


Fig. 1. Basic dc amplifier circuit has low input impedance, only 1 per cent accuracy.

DELIVERING 100 ma at an output impedance of less than one ohm, a new dc amplifier fills a gap in the supply of voltage units for high-frequency galvanometers.

The recent availability of galvanometers with high-frequency response and their concomitant higher-current demand has created a need for an improved voltage supply. The new unit, priced at $150, provides current that typical high-gain, dc amplifiers, telemetering receivers, demodulators, oscillators or detectors cannot.

Manufactured by Video Instruments, 3002 Pennsylvania Ave., Santa Monica, Calif., the Model 92 accepts maximum input signals ±15 v, has an input impedance of 100 K. Voltages up to 300 vdc between input and case ground are rejected by 120 db. Voltages of 60 cps up to 20 v rms are rejected by 80 db.

An interesting circuit design is used in the Model 92. It improves on the convential basic circuit.

In the basic circuit in Fig. 1, transistors V_4 and V_5 are complementary pnp-npn power transistors used as emitter-followers. These are used to couple the free

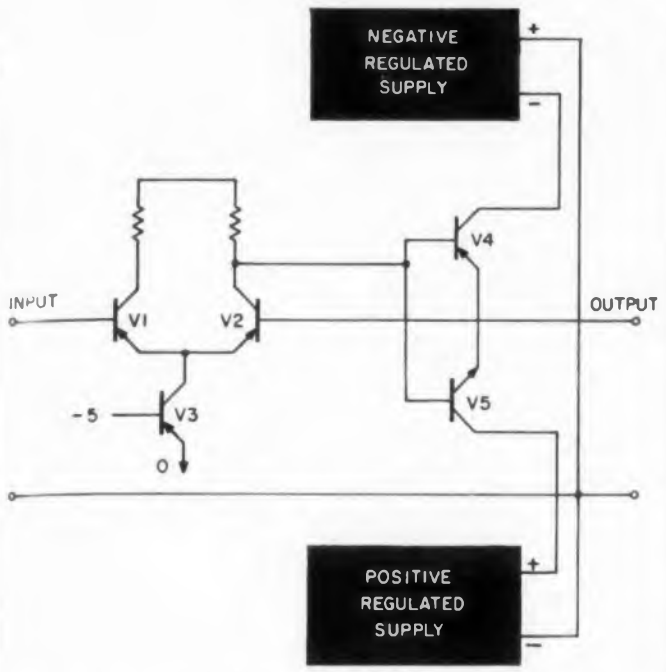


Fig. 2. Improved circuit has added transistor network to get 100 K input impedance and 0.2 per cent accuracy.

end of the regulated supplies to the output. Depending on the polarity of the input signal, either V_4 or V_5 conducts. Its emitter, connected to the output, will follow the input-signal voltage.

Simple. But there are two disadvantages. A low input impedance results, because the power to drive the transistor is supplied by the input. And because of the base emitter voltage drop, the output voltage will follow the input with an accuracy of only about 1 per cent.

Improved Design

To improve the accuracy to 0.2 per cent and to get a high (100 K) input impedance, the input signal is applied to one side of a differential amplifier (see Fig. 2). The other differential input is tied to the output of the transistors. These are driven by the output of the differential amplifier. In this way any difference between the input and output signals is sensed by the differential amplifier and used to correct the output.

V_1 and V_2 have a voltage gain of 200; this provides 46 db over-all feedback, and the output voltage is now an accurate reproduction of the input to within 0.2 per cent.

The Model 92 has a built-in regulated power supply, uses 8 w of 115 v, 50 to 400 cps power. To protect the galvanometer, amplifier output is limited to ±11 v.

For further information on this solid-state galvanometer driver amplifier, turn to the Reader's-Service Card and circle 102.

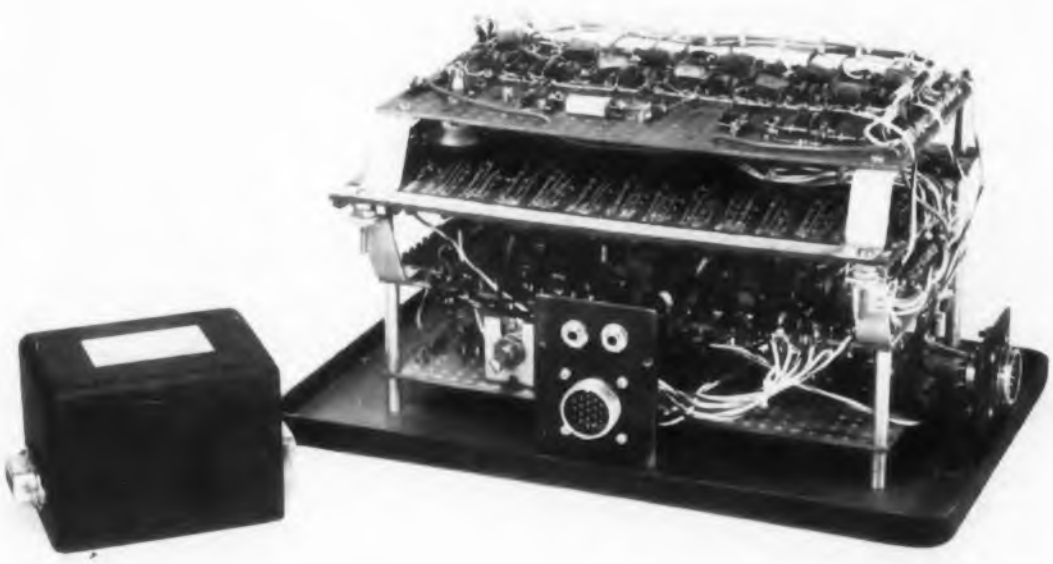
Replace both mechanical commutators and signal conditioners with

Low Level Solid State Multiplexer

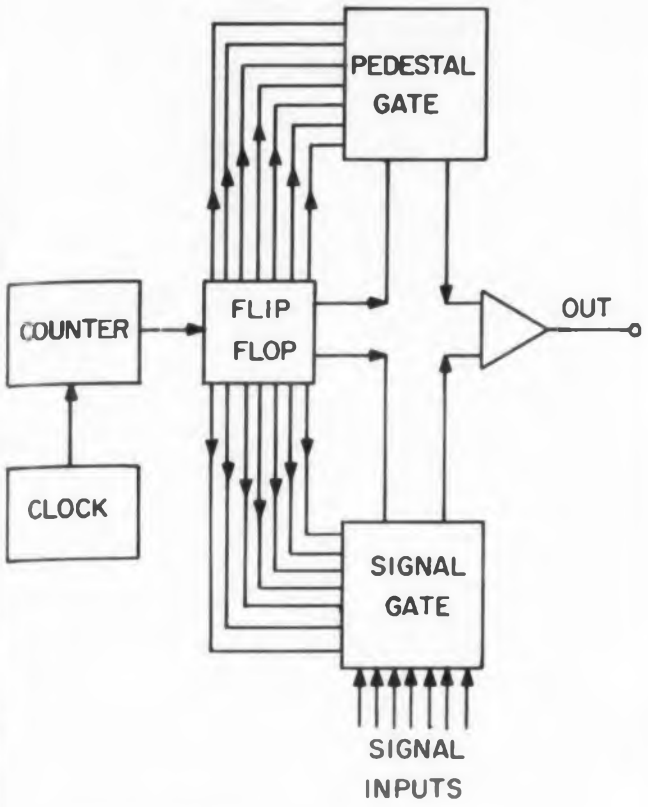
LOW LEVEL (5 mv full scale) transducer signals as well as high level (to 5 v) signals can be multiplexed for PAM, PDM or PCM telemetering with a new solid state commutator and signal conditioner package. No external signal conditioners or amplifiers are needed for use with standard thermocouples, strain gages, resistance bridges, pressure, acceleration or displacement transducers.

Now in production at Servomechanisms, Inc., 12500 Aviation Blvd., Hawthorne, Calif., the signal conditioner-and-multiplexer provides strain gages and resistance bridges with excitation voltage from its own supply. Need for special power supplies is eliminated.

Telemetering engineers are not bound to the use of any particular type of transducer: the commutator provides for individual scaling of the 30 input channels. Any full scale signal from 5 mv to 5 v can be handled and converted to 0 to 5 v dc pulse amplitude modulation, pulse duration modulation or pulse code modulation signals.



Low level solid state commutator and signal conditioner give one per cent accuracy on 30 channels. At left is the production unit; next to it is the original breadboard.



Block diagram of the unit shown in the above photo. Counting clock and counter as one module, unit consists of five separate components.

Since both thermocouples and strain gages, for example, put out a 10-30 mv full scale signal and have 10-20 μv threshold level resolutions, one of the problems has been for the mechanical commutator and signal conditioner to provide comparable accuracy and resolution. The new unit has a sense resolution of 10 to 20 μv.

Consisting of five main modules as shown in the block diagram, the solid state multiplexer has an overall gain of 1000. Output impedance is 500 ohms, input on low level (0-5 mv input) 2 K, high level up to 500 K. Speed of commutation can be 25 kc. With some 30 channels in operation output noise on any given channel is held to 20 mv—according to Servomechanisms engineers this includes crosstalk. Usable information band is 90 per cent of the total on time.

Rated environment for the solid state device is zero to 71 C, 50 g acceleration and 38 to 2000 cps ±20 g vibration. Under all conditions of this environment and with all 30 channels in operation accuracy is said to be ±1 per cent of full scale. The new unit weighs 2 lb, measures 3-1/2 by 2-3/4 by 2-1/2 in.

For further information on this solid state commutator circle Reader-Service number **104**.

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

Tape Recorder's Dimensions Are 5 x 4 x 2 in. Complete

This two-channel recorder measures 5 x 4 x 2 in. complete, including all electronics. Its total weight is 2 lb. All applicable parts of MIL-E-4158A for ground uses are met, but it can also be furnished for special flight and other applications. Power requirements are 2.5 w dc. The unit includes electronics for record and reproduce and a timing reference source. It operates at any tape speed to 48 ips, bi-directional, with end-of-tape sensing. Frequency response is up to 160 kc, ±3 db at 48 ips.

Precision Instrument Co., Dept. ED, 1011 Commercial St., San Carlos, Calif.

CIRCLE 60 ON READER-SERVICE CARD

Miniature Rotary Switch Weighs Less Than 3 Oz.

Weighing less than 3 oz and measuring 1.5 in. long and 1.375 in. in diam, the Ledex BD2E rotary switch can be used for stepping, counting, programming, circuit selecting and homing. It can be either self-stepped or externally impulsed. The switch is actuated by a rotary solenoid and remotely controlled. Up to four 12-position circuit wafers, with 2, 3, 4, 6, or 12-electrical position selective control, are available. Wire sizes to accommodate 3 to 300 v dc, 1000 v rms Hi-pot, are obtainable.

G. H. Leland, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

CIRCLE 61 ON READER-SERVICE CARD

Leads Emerge From One End Of Tantalum Capacitors

The type TES tantalum electrolytic capacitors have both leads emerging from one end. Since a seal is required on only one end, there is a savings in overall length. The units are similar in performance to the axial-type TEF capacitors which meet all the requirements of MIL-C-3965 B. Containing a non-corrosive, wet electrolyte, the capacitors operate in a temperature range of −55 to +85 C. The larger of two case sizes measure 1 in. in length and 0.375 in. in diam. For several hundred hours, the units will stand 105 C at 80% of rated voltage and 125 C at 67% of rated voltage.

Transistor Electronics, Inc., Dept. ED, West Road, Bennington, Vt.

CIRCLE 62 ON READER-SERVICE CARD

Electro-Magnetic Brake Measures 0.405 in. Overall

With an overall length of 0.405 in. and an output torque of 16 oz.-in. min at 24 v dc, this electro-magnetic brake can be used in airborne and other miniaturized control applications. Made to meet or exceed applicable Mil specs, the unit has no slip rings, brushes, rotating coils, or other moving electrical parts. It comes in a size 8 frame and weighs 0.7 oz. Maximum drag torque is 0.05 oz-in., and its life is a minimum of one million cycles at 60 cps. The unit consumes 2 w at 24 v dc and operates in a temperature range of 55 to 125 C.

Dynamic Instrument Corp., Dept. ED, 59 New York Ave., Westbury, L. I., N. Y.

CIRCLE 63 ON READER-SERVICE CARD

Wirewound Resistor Rated At 1 Meg Measures 3/16 x 3/8 in.

The type 1274 wirewound resistor, measuring 3/16 in. in diam and 3/8 in. in length, is made with a maximum resistance of 1 meg. The maximum wattage rating is 0.25 w. Resistance tolerances as close as 0.01% can be had as well as temperature coefficients as low as ±3 ppm per C. The unit meets all charactertistics of MIL-R-93, Amendment 3, except physical size.

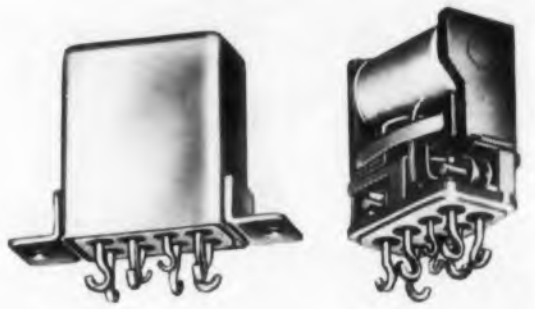
The Daven Co., Dept. ED, Livingston, N. J.

CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

Can Type Relays

Rated for 10 amp dc operation



Type FC-215 miniature hermetically sealed can-type relays are rated for 10 amp dc operation. They withstand 30 g vibration and 50 g shock. Designed for operation at ambient temperatures to +125 C, they meet or surpass MIL-R-575C and MIL-R-25018 requirements. The standard operating coils are rated at 26.5 v dc nominal with a coil resistance of 400 ohms. Other dc coil resistances are available. The relay weighs 3 oz and the enclosure size excluding mounting and terminal provisions is 5/8 x 1-1/32 x 1-1/4 in. Hook type, long, and short wire lead terminals can be furnished. The headers have 0.2 in. grid spacing.

Struthers-Dunn, Dept. ED, Pitman, N.J.

CIRCLE 67 ON READER-SERVICE CARD

Gyro Wheel Supply

Amplifier type

Type WS-213 gyro wheel supply is designed to drive three-phase gyros from a single-phase line. The unit contains a transistorized amplifier. One, two, or three gyros can be excited from the same wheel supply unit. The input is 115 v, 400 cps, single phase and the output is 10 v, 400 cps, three-phase. The initial balance at a specified load is 3% and the regulation is about 5%. The temperature range is −55 to +71 C. The supply is furnished in a hermetically sealed enclosure and meets applicable Mil specs for shock and vibration.

Harrel Inc., Dept. ED, 1788 First Ave., New York 28, N.Y.

CIRCLE 68 ON READER-SERVICE CARD

Synchros

Transmitters, differentials, control transformers

These 60-cps synchro transmitters, differentials, and control transformers are designed for use in industrial servo systems. For operation in corrosive atmospheres, they have stainless steel housing, shaft, and ball bearing construction, plus laminations of corrosion resistant nickel steel. They may be used in servo systems for remote and automatic control of weighing operations and valve positions, and to regulate instrument dials and position potentiometers.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 69 ON READER-SERVICE CARD

High-Mu Triodes

Ceramic-metal construction

Made for uhf service in portable field equipment, missile-guidance systems, and satellite-communication applications, types 7552 and 7554 high-mu triodes are of ceramic-metal construction. They can operate at plate-seal temperatures to 225 C and withstand conditions of nuclear radiation. They have good thermal stability and need 12 min warm-up time to reach 90% of dc operating plate current. The 7552 is made for class A rf amplifier use up to 1000 mc and the 7554 is for class C operation as an oscillator, rf-amplifier, and frequency-multiplier up to 3000 mc. Both types can be operated at altitudes to 100,000 ft without pressurization and have a maximum plate-dissipation rating of 2.5 w.

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

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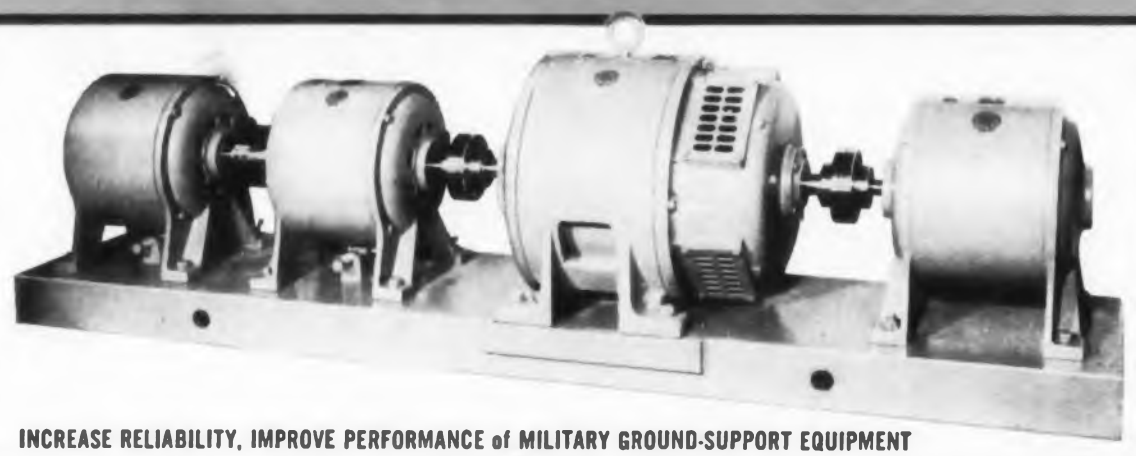

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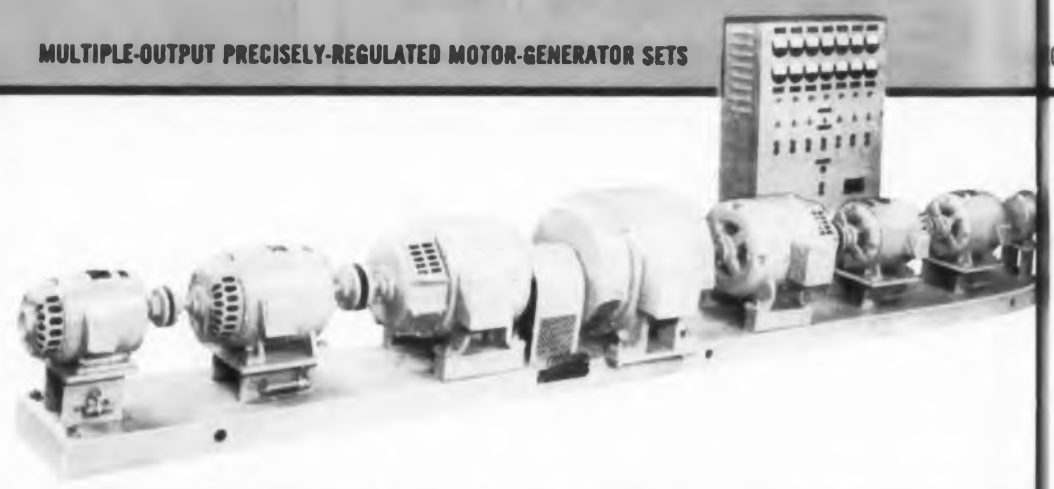

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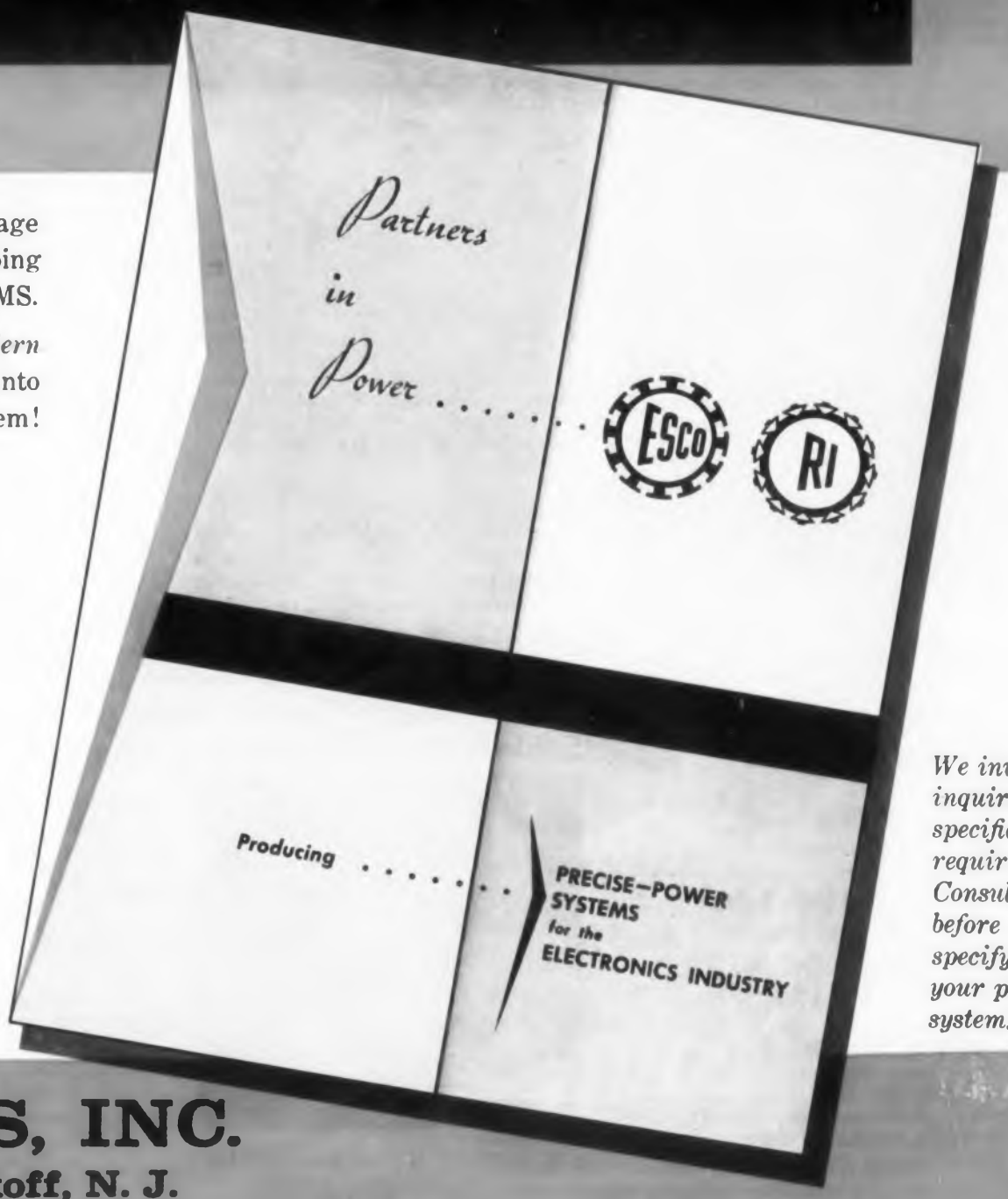

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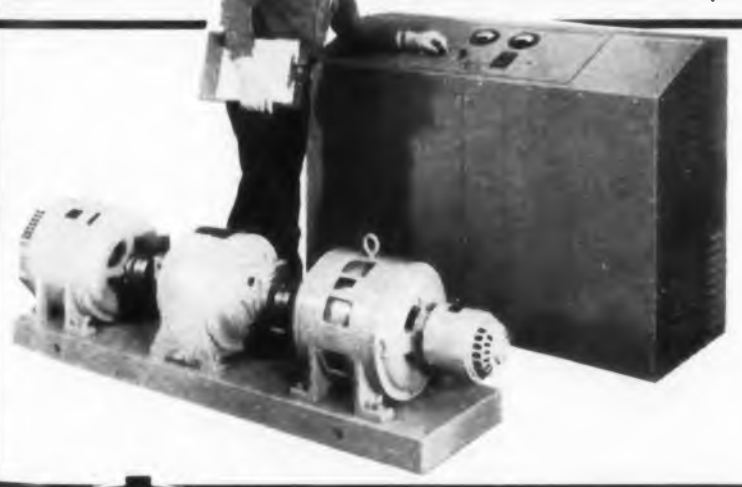

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CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS

DC Amplifier

Bandwidth is from dc to 10 kc

Model 92 galvanometer driver-amplifier has a bandwidth from dc to 10 kc, 0.2% linearity, and provides ±10 v at 100 ma. Typical voltage sources are high gain dc amplifiers, telemetering receivers, demodulators, detectors, oscillators, and transducer-demodulator combinations. The unit has an integral, regulated power supply. Circuitry is isolated from the case.

Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

CIRCLE 74 ON READER-SERVICE CARD

Coaxial Connectors

For use up to 10,000 mc

Type QDS weatherproof, quick-disconnect type connectors are for use with medium size coaxial cables. They have a nominal characteristic impedance of 50 ohms, a piv of 1000 v, and may be used at frequencies up to 10,000 mc. They employ three-ball positive-locking coupling, and metal-to-metal cable clamping construction. Teflon insulation is used. For use with armored cables, armor clamps can be incorporated or standard clamping hardware can be furnished. They are made to conform to MIL-C-18867, MIL-Q-5923C, and MIL-Q-9858.

Gremar Manufacturing Co., Inc., Dept. ED, Wakefield, Mass.

CIRCLE 75 ON READER-SERVICE CARD

TV Tube

Operates in altitudes to 60,000 ft

Designed for TV cameras in military and industrial use, type 7198 shock and vibration resistant image orthicon withstands operating conditions in altitudes to 60,000 ft. It operates at temperatures to 71 C and at relative humidities to 95%. The resolution capability of the tube is better than 600 lines and the response covers the range of 3200 to

◀ CIRCLE 547, 548, 549 ON READER-SERVICE CARD

6950 A. Made to have a low target capacitance, the tube has negligible microphonics due to the movement of the target and mesh with respect to each other. It is capable of reproducing motion in low-light-intensity scenes with a minimum of smearing. When used with low-noise amplifiers, it produces signal information with illumination on the photocathode as low as 0.00001 ft-c.

Radio Corp. of America., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 76 ON READER-SERVICE CARD

Solid State Relay

For teletypewriters

Made for installation in any teletypewriter, model 550 solid state relay provides automatic control of the printer drive motor. The relay energizes the motor at the first signal pulse, sustains operation throughout the transmission, and shuts down the motor after completion of the message. The delay period between the last received pulse and automatic shut-down is factory adjusted to 180 sec. The unit is a self-contained, plug-in module, housed in a drawn-steel case measuring 3-1/4 x 2-5/8 x 4-1/4 in.

Trepac Corp. of America, Dept. ED, 30 W. Hamilton Ave., Englewood, N.J.

CIRCLE 77 ON READER-SERVICE CARD

Digital Computer

Easily programmed

Type DE-60 digital computer is easily programmed and can be used by nontechnical personnel. The keyboard provides manual input through the automatic program control to the arithmetical center which computes, compares, iterates, branches, holds, or transfers information. It operates from 115 v 60 cps power and draws 150 w. Completely transistorized, it requires no special cooling system.

Clary Corp., Dept. ED, San Gabriel, Calif.

CIRCLE 78 ON READER-SERVICE CARD
CIRCLE 79 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Pressure Switch

Range is 10 to 3000 psig

Having a range of 10 to 3000 psig, type P36-1001 pressure switch combines a transducer, a solid state carrier oscillator, a ring demodulator, and a switching transistor. The dc input voltage is converted to ac for excitation of a variable-reluctance magnetic circuit. The absence of mechanical contacts permits no chatter or shift in the electrical output due to vibration. The maximum working pressure is 200% of nominal switch pressure, the accuracy is ±1.5% of setting, and the switch pressure adjustment is ±16% of nominal switch pressure.

Wiancko Engineering Co., Dept. ED, 255 N. Halstead, Pasadena, Calif.

CIRCLE 81 ON READER-SERVICE CARD

Electric Motor

Rated at 1/750 to 1/85 hp

Type S/L-1085 electric motor has ratings of 1/750 to 1/85 hp. The unit-bearing rotor turns on a stationary shaft at 3400 rpm without a load and from 2600 to 3200 rpm with recommended loads. The motor does not need lubrication and can operate over the temperature range of −10 to +250 F. Its uses include cooling electronic data processing machines, driving exhaust fans, and operating liquid circulating pumps in machines. It can be fitted with circulating blowers 2 to 3 in. in diam, plastic fans measuring 4 to 6 in., or gear blowers.

Howard Industries, Inc., Dept. ED, 1760 State St., Racine, Wis.

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CONNECTICUT: The Bond Radio Supply, Inc., 439 W. Main St., Waterbury

DISTRICT OF COLUMBIA: Silberne Industrial Sales Corp., 3400 Georgia Ave., N.W.

ILLINOIS: Merquip Co., 5904 W. Roosevelt Rd., Chicago; Newark Electric Co., 223 W. Madison St., Chicago

INDIANA: Brown Electronics, Inc., 1032 Broadway, Fort Wayne; Graham Electronics Supply, Inc., 122 S. Senate Ave., Indianapolis

MARYLAND: Radio Electric Service Co., 5 N. Howard St., Baltimore

MASSACHUSETTS: The Greene-Shaw Co., Inc., 341-347 Watertown St., Newton

NEW YORK: Hudson Radio & Television Corp., 37 W. 65th St., NYC.; Sun Radio & Electronics Co., Inc., 650 Sixth Ave., NYC

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PENNSYLVANIA: D & H Distributing Co., 2535 N. 7th St., Harrisburg; Herbach & Rademan, Inc., 1204 Arch St., Philadelphia

WASHINGTON: Seattle Radio Supply Co., 2115 2nd Ave., Seattle

WISCONSIN: Radio Parts Co., Inc., 1314 N. 7th St., Milwaukee

CIRCLE 84 ON READER-SERVICE CARD

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

Automatic MINIATURIZED silicon power rectifiers

SMALL TO FIT YOUR SPACE REQUIREMENTS

JEDEC TYPE NO.	MAXIMUM RATINGS: PEAK INV. VOLTAGE (V)	MAXIMUM RATINGS: MAX. AVG. RECTIFIED CURRENT (mA)* @ 25° C.	MAXIMUM RATINGS: MAX. AVG. RECTIFIED CURRENT (mA)* @ 150° C.	ELECTRICAL CHARACTERISTICS: MINIMUM SATURATION VOLTAGE @ 100° C. (VOLTS)	ELECTRICAL CHARACTERISTICS: MAXIMUM REVERSE CURRENT @ PIV (uA) @ 25° C.	ELECTRICAL CHARACTERISTICS: MAXIMUM REVERSE CURRENT @ PIV (uA) @ 100° C.	ELECTRICAL CHARACTERISTICS: MAXIMUM VOLTAGE DROP @ 400 ma DC @ 25° C. VOLTS DC
1N645	225	400	150	275	0.2	15	1.0
1N646	300	400	150	360	0.2	15	1.0
1N647	400	400	150	480	0.2	20	1.0
1N648	500	400	150	600	0.2	20	1.0
1N649	600	400	150	720	0.2	25	1.0

*Resistive or inductive load

We've shrunk the size, but not the quality. All the outstanding characteristics and reliability you expect of products from General Instrument Corporation are present in these miniaturized units. Data sheets on these and other Automatic silicon rectifiers are available upon request

Semiconductor Division
GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronics Supply Co., Burbank • Milwaukee: Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp., Sun Radio & Electronics Co. • Philadelphia: Herbach & Rademan, Inc. • San Diego: Shanks & Wright, Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics

CIRCLE 85 ON READER-SERVICE CARD

NEW PRODUCTS

Heavy-Duty Hand Winder

Winding speeds are 300, 400, 800, and 1800 rpm

Models 510-AM heavy-duty winder has winding speeds of 300, 400, 800, and 1800 rpm at full 1/2 hp torque rating. For laboratory and production use, it winds wire gages as heavy as No. 10 AWG on spools to 8 in. in diam. It also winds extremely fine wires. The maximum coil OD is 12 in., loading distance between headstock and tailstock is 12 in., and the output end of the spindle is a 3/4-in. keyed slot. The unit is furnished with a 1/2 hp, 5000 rpm, 115 v, 60 cps motor with rheostat foot pedal, instant re-setting automatic counter, and a positive stopping magnetic brake. Also available, model 510 has a dial counter instead of an automatic reset counter.

George Stevens Manufacturing Co., Inc., Dept. ED, Pulaski Road at Peterson, Chicago 46, Ill.

CIRCLE 86 ON READER-SERVICE CARD

Silicone Impregnating Varnish

Curing temperature is 150 C

Type SR-220 silicone impregnating varnish cures at 150 C. Made for use in the production of transformers and electronics equipment, it can also be used over existing insulation systems. It has a high dielectric strength and long heat life. It also offers tank stability and excellent shelf life.

General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N. Y.

CIRCLE 87 ON READER-SERVICE CARD

Black Glass

For enclosure of semiconductor devices

Impervious to light, code 9361 black glass is for enclosure of silicon semiconductor devices. Offered in the form of beads and cases for sealing to 0.017 Dumet lead wires, the glass filters out virtually all wavelengths of the ultraviolet,

visible, and near infrared spectrum. It has a thermal coefficient of expansion of 92 x 10^{-7} per deg C. Softening point is about 675 C, annealing point about 495 C, and strain point about 445 C. The beads have an OD of 0.053 ±0.002 in. and an ID of 0.023 ±0.002 in. The cases have an OD of 0.095 ±0.002 in. and an ID of 0.06 ±0.002 in.

Corning Glass Works, Dept. ED, Corning, N. Y.

CIRCLE 88 ON READER-SERVICE CARD

Capacitors

Have drawn rectangular cases

Type 271P capacitors are designed to operate over the temperature range of −55 to +85 C, and type 272P capacitors will withstand operation at temperatures to 125 C without voltage derating. Both types have drawn-rectangular cases, use a dual insulation consisting of synthetic polyester film and high grade capacitor tissue, and use a synthetic polymer impregnant. They meet the requirements of MIL-C-25A and MIL-C-25B, but are more compact than the specified size.

Sprague Electric Co., Dept. ED, N. Adams, Mass.

CIRCLE 89 ON READER-SERVICE CARD

Polyester Film Capacitors

Temperature range is −55 to +85 C

Type 158P Filmite E capacitors operate over the temperature range of −55 to +85 C with no derating and have a dielectric of polyester film. They are protected against moisture by a polyester-film tape. The end seals are of a plastic resin which bonds with the film and the tinned leads providing a secure seal. They have good resistance to vibration and shock. Made for both military and industrial applications, they are suitable for potting and encapsulating in subassemblies and filters, digital computers, and in control apparatus.

Sprague Electric Co., Dept. ED, N. Adams, Mass.

CIRCLE 90 ON READER-SERVICE CARD

CIRCLE 91 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Potentiometers

For airborne use

Series MFG rotary Metlfilm servo potentiometers are for use in missiles and other airborne systems where extremes in temperature, acceleration, vibration, and shock must be met. The capsule contact design protects the sealed resistance element from environmental deterioration and provides for accuracy over a wide temperature range. The pressure contact eliminates the problem of sliding friction.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

CIRCLE 92 ON READER-SERVICE CARD

Servo Potentiometers

Multiturn type

This line of multiturn servo potentiometers consists of four miniature types and one medium size type which have wirewound construction on insulated copper mandrels. The three, five, and ten-turn types provide close mechanical tolerances and high electrical accuracy. A miniature ten-turn model is designed for ganging up to ten cups per shaft. All models are suitable for military use.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

CIRCLE 93 ON READER-SERVICE CARD

DC Power Supply

Provides 200 to 325 v dc

This dc power supply provides a continuously variable output of 200 to 235 v dc for load currents of 0 to 100 ma. Input is 105 to 125 v, 60 cps. Regulation is better than 1%. Ripple is less than 10 mv. An isolated ac voltage of 6.3 v at 3 amp is available at the output terminal connections.

Associated Specialties Co., Dept. ED, 1751 Main St., Orefield, Pa.

CIRCLE 94 ON READER-SERVICE CARD

◀ CIRCLE 95 ON READER-SERVICE CARD

Carbon Resistors

Are 1/8 and 1/4 w

These Hot-Coat plastic-compound, deposited-carbon, 1% resistors, 1/8 w type CEL and 1/4 w type CEH, are protected by a thick nonreactive coating. They are designed to meet the requirements of MIL-R-10509B.

Clarostat Manufacturing Co., Dept. ED, Dover, N. H.

CIRCLE 96 ON READER-SERVICE CARD

Rectifier Transformers

Miniature

Series I and H miniature rectifier transformers are useful in constructing compact low voltage power supplies which supply the collector voltage of transistors. They operate from an input of 115 v ac, 60 or 400 cps. Requirements of MIL-T-27, class R, grade 4, conditions 02 are met. They can be supplied either in a channel frame construction, hermetically sealed, or encapsulated.

Ferrotran Electronics Co., Inc., Dept. ED, 693 Broadway, New York 12, N. Y.

CIRCLE 97 ON READER-SERVICE CARD

Terminal Blocks

Pressure contact type

Made for heavy duty use, type 9-85 pressure contact terminal blocks are of one-piece construction, molded of general purpose phenolic or in plastics as per MIL-M-14E. The top and bottom are closed with molded plastic. Available in lengths from 2 to 12 terminals, they are rated at 85 amp, and 8000 v, breakdown voltage. A vise-like grip on each wire of through-connected pairs eliminates soldering and offers protection from accidental shocks.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N. Y.

CIRCLE 98 ON READER-SERVICE CARD

CIRCLE 99 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Diode

Monitors rf outputs

Type MA-437 (1N2771) point-contact silicon diode monitors power outputs of rf generating devices from 140 to 750 mc. Rectified current through the diode is monitored in a standard holder at three frequencies: 140, 375, and 750 mc, at input levels —2.8, 0, and 3.6 dbm. Within this power range, power monitoring error is less than 1 db. At any specific test frequency, the power error is less than 0.5 db. Cartridge construction is used. The output is coupled directly to a dc microammeter. Requirements of MIL-E-1 are met. Applications are in communications and TV transmitters.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 105 ON READER-SERVICE CARD

Decommutation System

Uses phase-lock loop technique

Designed to operate on both PAM and PDM telemetry signals, type 90 decommutator uses the phase-lock loop technique to maintain synchronization with changes in commutation speeds of ±20% and over several segments of complete signal drop out. Three operational-amplifier type integrators operate sequentially on data pulses to reduce crosstalk to less than ±0.1% and to average out the effects of noise on the recovered pulses. Translators have outputs of ±15 v and deliver 10 ma to a 1500-ohm load. Output impedance is less than 1 ohm from dc to 1000 cps. Translators have standard accuracies of 0.07%. Automatic zero level compensation reduces zero shifts of ±10% to less than ±0.1%. Automatic gain compensation readjusts ±10% full scale shifts to less than ±0.1%.

Telecomputing Corp., Data Instruments Div., Dept. ED, 12838 Saticoy St., N. Hollywood, Calif.

CIRCLE 106 ON READER-SERVICE CARD

◀ CIRCLE 107 ON READER-SERVICE CARD

Relay

Miniature, spdt type

This spdt miniature relay is available with resistances of 50 ohms and 5 K. At 50 ohms the required pull-in is 18 ma, and at 5 K, 2.3 ma. The fixed contacts are made of nickel silver and the movable contacts are silver palladium. The unit weighs 0.37 oz and measures 0.402 x 0.687 x 0.812 in. The relay is for use in multichannel radio control equipment and in computers.

W. S. Deans Co., Radio Control Research and Development, Dept. ED, 8539 Albia St., Downey, Calif.

CIRCLE 108 ON READER-SERVICE CARD

Spectrum Analyzer

Ranges are 0 to 70 mc and 0 to 5 mc

Type SPA-4 spectrum analyzer has independent frequency dispersion ranges of 0 to 70 mc and 0 to 5 mc. Negligible internal frequency modulation permits narrow band analysis free of fm. A variable if bandwidth from 1 to 80 kc for analyzing wide or narrow pulsed rf signals is provided. The sensitivity is 100 dbm. The unit includes linear and power amplitude scales, a precisely calibrated log, a tuning head with a 10 to 44-mc frequency range, and a self-contained marker oscillator.

Panoramic Radio Products, Inc., Dept. ED, 514 S Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 109 ON READER-SERVICE CARD

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers •

ESC EXTRA

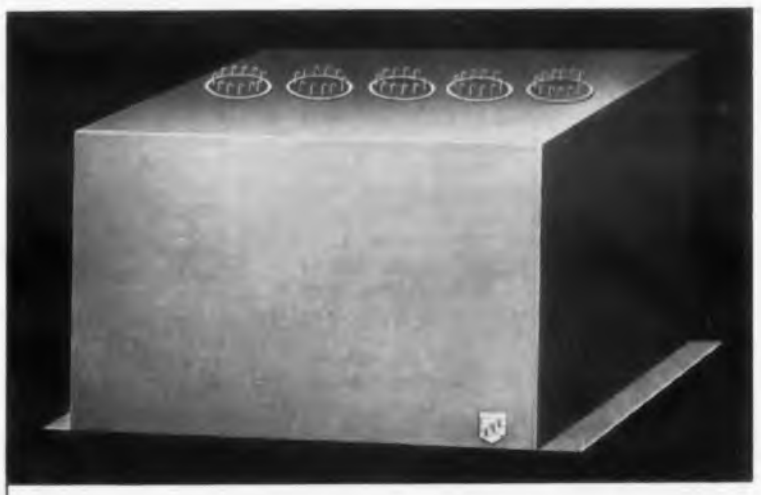
Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

ESC DEVELOPS DELAY LINE WITH 170 to 1 DELAY TIME/RISE TIME RATIO

Model 61-34 Perfected For Specialized Communications Application

PALISADES PARK, N. J.—An entirely new Lumped-Constant Delay Line, with a proven 170 to 1 delay time/rise time ratio, has been announced by the ESC Corporation, Palisades Park, N. J. The new delay line, known as Model 61-34, was specifically designed for a specialized communications application calling for the exceptionally high delay time/rise time ratio.

ESC, the world's leading manufacturer of custom built and stock delay lines, is already widely recognized in the electronics industry for its exceptional engineering advances. In October, 1958, ESC broke through an existing design barrier and produced a delay line with a 145 to 1 delay time/rise time ratio. It had been thought, prior to the announcement of the Model 61-34, that ESC had reached the ultimate in this type of delay line.



SPECIFICATIONS OF NEW DELAY LINE MODEL 61-34

Delay time/rise time ratio: 170/1
Delay: 200 usec.
Rise time: 1.16 usec.
Attenuation: less than 2 db
Frequency response: 3 db = 325 KC
50 taps with an accuracy of ±0.2 usec. at each tap.

Complete technical data on the new unit can be obtained by writing to **ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.**

CIRCLE 110 ON READER-SERVICE CARD

NEW PRODUCTS

Ferrite Shutter Switch

Has no moving parts

Model W574-1A-1 ferrite shutter switch is for use in monopulse and doppler radar systems, surveillance, and fire control systems. It has no moving parts and can be used as a shutter or switch element. The frequency range is 13.5 kmc ±15 mc, isolation is 25 db min, and the insertion loss is 0.3 db max. The input vswr transmit is 1.1:1 max at center frequency and the input vswr reject is 30:1. Rise time is 100 μsec max, control coil power is 2 w max, and the ambient temperature range is −85 to +105 C. The unit weighs 5 oz and measures 2-3/8 x 1-5/16 x 1 in.

Kearfott Co., Inc., Microwave Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 111 ON READER-SERVICE CARD

Tape Handlers

For 35, 80, and 100 ft of tape

These three continuous-loop transports handle magnetic tape in lengths up to 35, 80, and 100 ft. Designed for detailed analysis programs, such as those with analog computers and wave analyzers, the loop mechanisms have an isolated tape path under the multitrack record and playback heads for precise low-flutter performance. Tape widths up to 2 in. can be changed. The units have up to nine tape speeds, dual tension sensors, slide mounting, and integral power supplies. Series 3190 transport has a full view door with safety interlock. An adapter for series 3170 transports is also available.

Minneapolis-Honeywell Regulator Co., Dept. ED, 10721 Hanna St., Beltsville, Md.

CIRCLE 112 ON READER-SERVICE CARD

ENGINEERING REPORT ON OTHER BENDIX COMPONENT PACKAGES

CAM COMPENSATOR

Efficient compensating device for servo system error.

The type CP-20-A1 is a simple, entirely mechanical means of correcting an output data shaft in relation to either servo loop errors, sensing errors, or known environmental factors affecting the system. Eliminates need for adjusting remotely placed or inaccessible units. Ask for full details.

CLUTCHED SYNCHRO

Transmits corrective signal, or establishes new reference.

The type CP-4-A1 is an integrated unit containing a high-precision pygmy Autosyn* synchro and an electro-magnetic clutch. Has general systemic application where it is desired to transmit a corrective signal, or to establish a new reference as a result of a temporary condition. Removal of electro-magnetic clutch excitation instantly re-establishes Autosyn, or signal source, at zero. Three unit-mounted resistors provide for proper output voltage as well as correct phase relationship of output voltage to excitation voltage. Write for further information.

*REG. U. S. PAT. OFF.

Manufacturers of
GYROS • ROTATING COMPONENTS
RADAR DEVICES
PACKAGED COMPONENTS
INSTRUMENTATION

Eclipse-Pioneer Division

Bendix AVIATION CORPORATION

Teterboro, N. J.

CIRCLE 126 ON READER-SERVICE CARD

Delay Line

Delay time is 1 μsec

Having a delay time of 1 μsec and a rise time of 0.2 μsec, type 10C5-5/14 delay line comes in a 0.4 x 1.5 in. case. A lumped constant unit, it is suitable for printed circuit and transistor applications. The characteristic impedance is 1400 ohms, the attenuation is 3%, and the temperature coefficient is 0.03% per deg C. The temperature range is −55 to +105 C. The unit is molded in a hermetically sealed brass tube with the leads brought out through glass-to-metal end seals. Mil specs are met.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

CIRCLE 127 ON READER-SERVICE CARD

Flowmeter

For aircraft use

Consisting of a flowmeter transmitter and a flow-rate indicator, this flowmeter system measures the fuel flow rate in aircraft by mass rather than by volume. Flow rates to 1200 pph can be measured. Its power requirements are 115 v 400 cps. It operates within the temperature range of −65 to +250 F and has a life of 500 hr continuous operation. The unit measures 3 in. long and 2 in. in diam and weighs about 2 lb. Indication may be by an illuminated pointer or an integrally-lighted dial scale; unlighted indicators are also available.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 128 ON READER-SERVICE CARD

Quadruple Exhaust Blower

Produces 250 cfm

For electronic cabinet cooling applications, model 4EB300 quadruple exhaust blower produces 250 cfm of air. Designed for rack mounting, it has vertical and diagonal exhausts with ventilators on the front and rear of the cabinet. Panel height is 5-1/4 in. The filter is easily changed without removing the unit from the cabinet. The motor meets CC-M-636A specifications.

McLean Engineering Labs., Inc., Dept. ED, P.O. Box 228, Princeton, N.J.

CIRCLE 129 ON READER-SERVICE CARD

ENGINEERING REPORT ON BENDIX COMPONENTS

ONE-MINUTE SYNCHRO SYSTEM ACCURACY

Electrical two-speed Autosyn* synchro features—

- **ACCURACY UNAFFECTED BY THERMAL AND MECHANICAL STRESS**
- **HIGH SIGNAL-TO-NULL RATIO**
- **ELIMINATION OF GEAR ERROR FOUND IN MECHANICAL TWO-SPEED SYSTEM**
- **ADAPTABILITY TO GYRO PICKOFF**

Developed to meet need for accurate data transmission with maximum system simplicity. Produces two electrical outputs from single shaft, thereby eliminating inaccuracies of two-speed gear system as well as installation and maintenance costs of additional unit.

The synchro contains two separate sets of windings. One set produces the normal signal pattern of one cycle of output voltage, while the other produces eleven cycles, for each rotation of the synchro shaft. Increase in accuracy is very close to the 11-to-1 theoretical maximum, resulting in a system error of ±1 minute when used back-to-back with similar units.

*REG. U. S. PAT. OFF.

ADDITIONAL CHARACTERISTICS:

Input voltage (to rotor)	26 volts, 400 cycles, single phase
Input current	200 ma max.
Input power	2.5 watts max.
Signal-to-null ratio	350:1
Sensitivity (mv/degree)	3500

For more detailed information on specific applications, write—

Eclipse-Pioneer Division
Teterboro, N. J.

Bendix AVIATION CORPORATION

District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 130 ON READER-SERVICE CARD

NEW PRODUCTS

Nonreactive Resistance Standards

Accuracy is 0.01%

These nonreactive resistance standards have an accuracy of 0.01% from dc to 50 kc. Model AC440 covers the range of 11,111 ohms in 0.1-ohm increments. Other models have from one to five dials, increments as small as 0.01 ohms, and resistance values up to 100,000 ohms. The method of reactance compensation used permits a choice of minimum inductance error, minimum resistance error, or the best compromise. The effect of shielding capacity is eliminated.

British Industries Corp., Dept. ED, Port Washington, N.Y.

CIRCLE 132 ON READER-SERVICE CARD

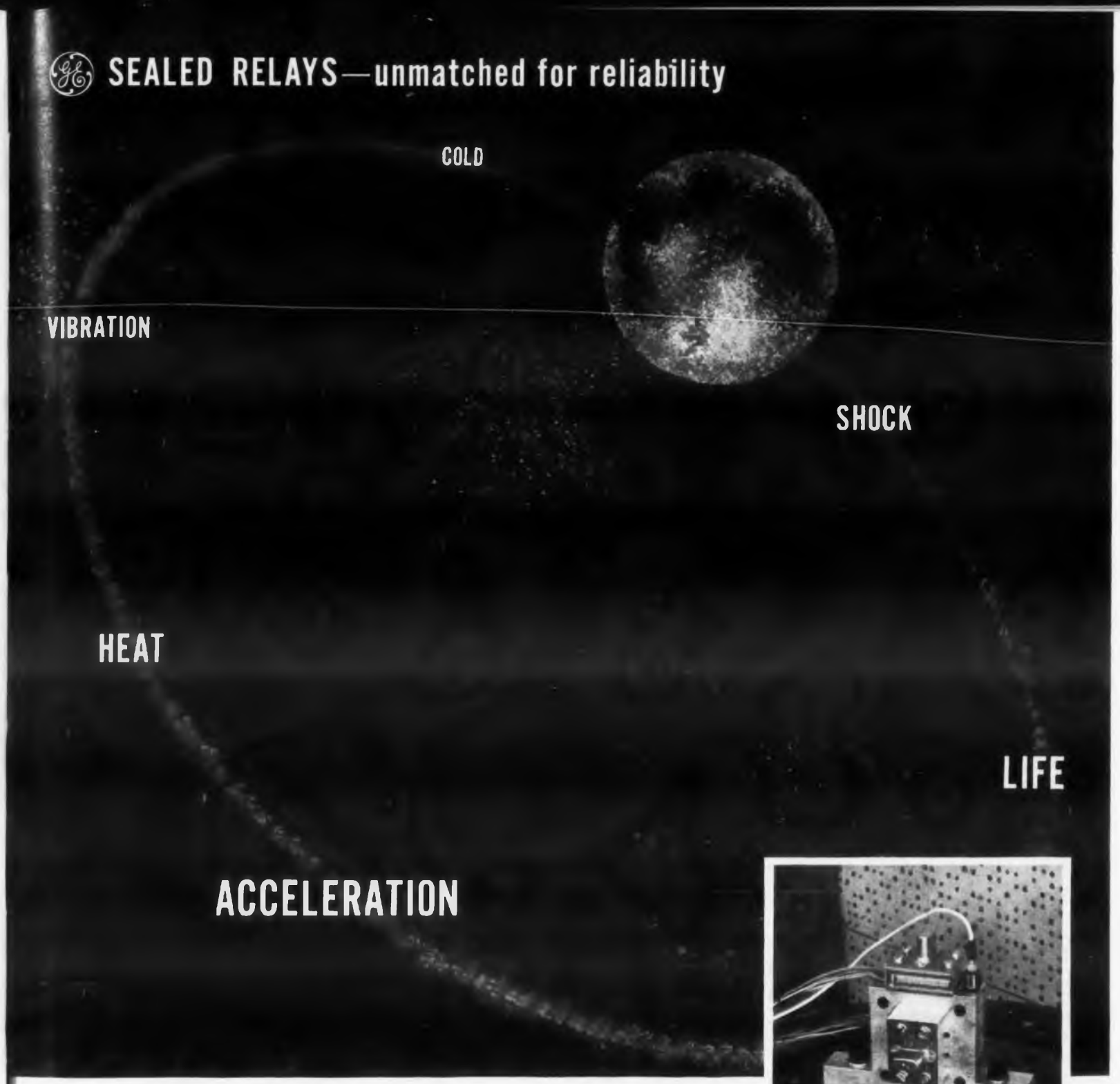
Amplifier

Differential transformer type

Model 401C differential transformer-amplifier provides an output suitable for viewing on cathode ray oscilloscopes or for direct drive of pen or light beam galvanometer recorder. The instrument has an internal excitation supply, self-checking features which eliminate drift errors, and five calibrated sensitivity ranges which cover all usual scientific and industrial requirements. The frequency response is flat from 0 to 200 cps and useful to 500 cps. The accuracy is 2% with a maximum resolution of 0.000005 in. of core displacement.

Daytronic Corp., Dept. ED, 225 S. Jefferson St., Dayton 2, Ohio.

CIRCLE 133 ON READER-SERVICE CARD



To the moon and back without leaving our lab

Rapid acceleration, vibration, violent shock, extreme temperatures—these are the environmental conditions found on a trip to the moon . . . and in General Electric's relay-testing laboratory as well. Here, exhaustive tests—simulating operating and atmospheric conditions—are conducted to continually verify the reliability of G-E sealed relays.

Even in standard production testing, General Electric goes well beyond requirements to assure reliability. Each lot of G-E relays is subjected to 27 tests and measurements before being released for shipment. For example, every relay built is subjected to a 15-cycle dynamic contact-resistance check—the prime indicator of cleanliness.

For one demanding application, General Electric and the customer scheduled 109 tests for each unit. A 5% lot sample was subjected to destructive tests including monitored six-hour vibration and load-life tests. A single relay failure meant rejection of the entire lot. During this contract, 23 consecutive lots (over 4000 relays) were processed without a lot-sample failure!

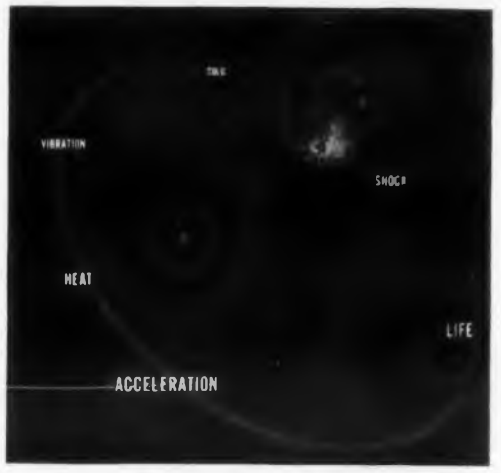
But testing is only part of G.E.'s reliability story. Design leadership (such as produced the Unimite, the world's smallest 1-amp relay) and advanced manufacturing techniques (including new inert-arc welding to eliminate contact-contaminating solder and flux) consistently produce superior relays.

Obviously, all relays don't require the same testing—but whatever your needs—General Electric has the know-how and facilities to meet them. See your G-E Sales Engineer, or mail the coupon at right. General Electric Co., Specialty Control Dept., Waynesboro, Va.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 135 ON READER-SERVICE CARD



There's a G-E sealed relay for every circuit need—every reliability requirement

G-E miniature, sub-miniature, micro-miniature and Unimite relays combine small size with unusual reliability under severe temperature, shock, and vibration conditions to make them ideal for electronic jobs, both military and commercial. G.E.'s complete line of sealed relays includes these basic types:

MINIATURE: Long-life type; rated 5 amps at 28 volts d-c; in 2- or 4-pole double throw and 6-pole normally-open forms. Ideal for ground use.

SUB-MINIATURE: 2 amps at 28 volts d-c, 115 volts a-c, double-pole double-throw. Excellent thermal life.

MICRO-MINIATURE: Crystal-can type, double-pole and new welded 4-pole units. Rated 2 amps, 28 v d-c or 115 v a-c. Grid-space terminals available.

UNIMITE: The world's smallest 1-amp sealed relay; single-pole type. Isolated contact chamber, high speed 1.5 millisecond operation.

General Electric Co.
Section A792-11
Schenectady 5, N. Y.

Please send me a free copy of the 1959-60 Sealed Relay Catalog.

Name_____

Address_____

City_____

State_____

GENERAL ELECTRIC

NEW PRODUCTS

Control Transformers

Come in frequencies of 50 to 2600 cps

For control applications, these miniature epoxy-molded power transformers are available in va ranges to 25 va and in frequencies from 50 to 2600 cps. They can be supplied to meet MIL-T-27 grades 2 and 5. Nickel-plated brass screw stud terminals are furnished. Mounting may be strap, insert, or stud type.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 136 ON READER-SERVICE CARD

Drive Unit

Worm gear type

For use with rotary components such as resolvers, syncros, potentiometers, and capacitors, type PDW-1 worm gear drive unit has a 180:1 ratio which allows direct dial readings of 1 min of arc. Compact in design, the unit has a plexiglass hairline indicator and large size engraved dials. The spring loaded gears are made of stainless steel or aluminum. Spring loaded ball bearings help to eliminate backlash. All parts are mounted in a machined, one-piece aluminum housing. Units can be supplied with the input shaft projecting from the back of the housing to allow driving from the rear and dial readout on the front.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

CIRCLE 137 ON READER-SERVICE CARD

Insulation Papers

Melting point is 1900 F

Made of synthetic mica, the Crystal M insulation papers have a melting point of above 1900 F when heated in a closed system, and convert to a higher melting ceramic body when heated in an open system. The material has an index of refraction of 1.5, a bulk density of 2.7 g per cc, and is insoluble in water and organic solvents. It may be manufactured in calipers from 2 to 10 mils, but is now available at 5 mils only. It can also be made in blocks weighing from 10 to 20 lb per cu ft, and compression-molded shapes. Metal fibers, powders, and other conductive materials such as graphite can be included in the paper to produce controlled resistivity. It can be used on wires and cables as high temperature insulation and can be laminated to other materials.

Minnesota Mining and Manufacturing Co., Dept. ED, St. Paul 6, Minn.

CIRCLE 138 ON READER-SERVICE CARD

Millivolt Potentiometer

Range is −11 to +101 mv

Type 8690 millivolt potentiometer has a range of −11 to +101 mv, eliminating the need to reverse input leads. It can be used in routine in-place checking of thermocouples, recorders, and controllers as well as for tests involving temperature measurements and calibration studies. The measured values are read directly in digits and a scale interpolation is obtained from a central reading window. The limit of error is ±0.05% of reading +20 μv without reference junction compensation, and ±0.05% of reading +40 μv with reference junction compensation. Completely self-contained, it has a manually-operated reference junction temperate compensator. It has a nine-position function switch.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 139 ON READER-SERVICE CARD

◀ CIRCLE 140 ON READER-SERVICE CARD

NEW PRODUCTS

AC Amplifier

For airborne and telemetering use

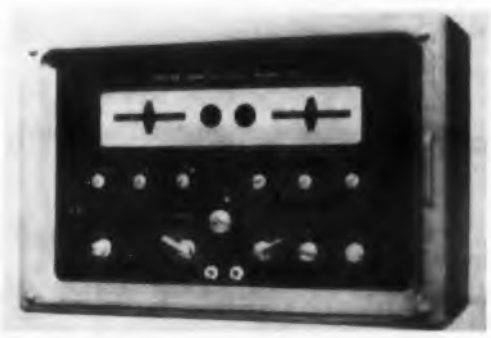
Model WC-222 ac amplifier is for use in telemetering instrumentation, for amplifying the output of capacitive generator type transducers, and in missile nose cone instrumentation. The input signal range is 0 to 660 mv. A variable gain up to 20 db is available. The output impedance is about 5000 ohms. Frequency response can be altered to meet specific requirements. Both limited and unlimited outputs to match subcarrier oscillators and storage devices are available. Silicon transistors are used throughout. Potting and sealing offer resistance to environmental conditions and to shock and vibration. The largest dimension of the unit is 3-1/2 in. Requirements of MIL-E-8189 and MIL-T-5272 are met.

The Wurlitzer Co., Electronics and Defense Products Dept., Dept. ED, N. Tonawanda, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

Universal Bridge

Accuracy is 0.1%



Type B-221 universal bridge provides for two, three, or four terminal measurements of an impedance or transfer admittance with an accuracy of 0.1%. Measurements provided are: capacities from 0.0002 μμf to 11 μf, resistance of 10 ohms to 100 meg, and inductance from 1 mh.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

CIRCLE 143 ON READER-SERVICE CARD

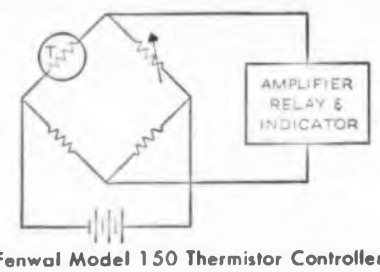
Using Thermistors

Edited by
FENWAL ELECTRONICS, INC.

STABLE THERMISTORS PERMIT HIGH CONTROL ACCURACY WITH SIMPLE CIRCUITRY

Circuit shown for the Fenwal Electronics' Model 150 Temperature Controller is typical. It has a sensitivity of 0.001°C throughout its working range!

New, extremely stable, probes permit full exploitation of thermistors' inherently high sensitivity to temperature change.



Fenwal Model 150 Thermistor Controller

Operating characteristics of the new probes are precisely predictable and repeatable over the entire control range. Furthermore, the large change in resistivity of a probe in response to a small temperature change greatly simplifies circuit design. (Resistance can change as much as 4000 ohms — or more — for a change of only 1° in temperature.) In most cases, a standard resistance bridge circuit is ample for measurement of signal output.

For full details on thermistors, send for Catalog EMC-2. Further details on Model 150 also available on request. Write FENWAL ELECTRONICS, Inc., 310 Mellen Street, Framingham, Mass. And simplify your circuit design problems with a G200 Experimental Kit of thermistors. Available from Fenwal Distributors or the Framingham plant.

Fenwal Electronics

Making Precision Thermistors
Make Your Design Ideas Come True

CIRCLE 145 ON READER-SERVICE CARD

RF CABLE CONNECTORS.—Snap-on versions of the firm's standard 50- and 75-ohm ConheX connectors are available. A spring ring or band around the slotted coupling sleeve provides the attachment means. These connectors are reduced in length and diameter.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

CIRCLE 146 ON READER-SERVICE CARD

NYLON STRAPPING.—Has 5/8 in. width and is 0.07 in. thick. It is available in either 25 or 50 ft rolls in black or natural color. It can be furnished either plain or with continuously-spaced center holes. The strapping can be used as cable clamps and hangers for wiring, switches and other components. It can be safely used in temperatures from —60 to +250 F.

Weckesser Co., Dept. ED, 5701 Northwest Highway, Chicago 46, Ill.

CIRCLE 147 ON READER-SERVICE CARD

MOTOR.—Designed to conform to specifications CC-M-636, this motor is totally enclosed, and self cooled. The motor operates from 115 v ac, 60 cps, single phase. It measures 4.25 in. in diam by 6.75 in. in length and weighs 10 lb. Designated model 33N29, the unit is rated at 1/4 hp at 3300 rpm.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado Blvd., Pasadena, Calif.

CIRCLE 148 ON READER-SERVICE CARD

GROMMET.—This one-piece solid grommet is made from Zytel 103 nylon. It can be used in the temperature range of —65 to +300 F. The grommet is inserted through the aperture and flanged over with a tool. Each size, from 3/16 to 2.5 in. in diam, fits sheet gages ranging from 0.025 to 0.25 in. in four basic lengths.

Western Sky Industries, Dept. ED, 21301 Cloud Way, Hayward, Calif.

CIRCLE 149 ON READER-SERVICE CARD

DISCRIMINATOR CHECKOUT SYSTEM.—Will operate in automatic, semi-automatic, and manual modes. In the automatic mode, up to 18 discriminators can be given an 11-point checkout in 11 sec at an accuracy of better than 0.1% linearity.

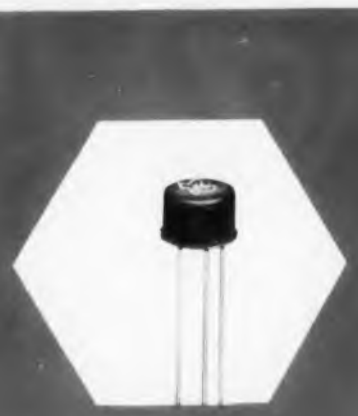
Dynatronics, Inc., Dept. ED, Box 2566, Orlando, Fla.

CIRCLE 150 ON READER-SERVICE CARD

OXIDE CERAMICS.—The Degussit line, sintered at about 1900 C, includes alumina, spinel, stabilized zirconium oxide, magnesium oxide, and kaolin bonded corundum. Type A1-23 pure alumina, sintered into tubes, rods, discs, and other configurations, is stable in oxidizing and reducing gases, in a high vacuum, and against all metals.

Materials for Electronics, Inc., Dept. ED, 152-25 138th Ave., Jamaica 34, N.Y.

CIRCLE 151 ON READER-SERVICE CARD



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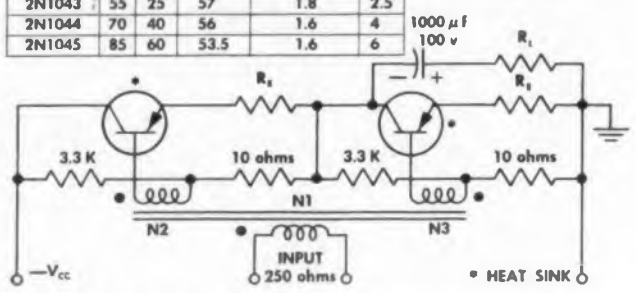
CIRCLE 153 ON READER-SERVICE CARD

Your best combination of I_{CBO}-R_{CS}-V-PLUS HIGH BETA ...TI germanium power transistors!

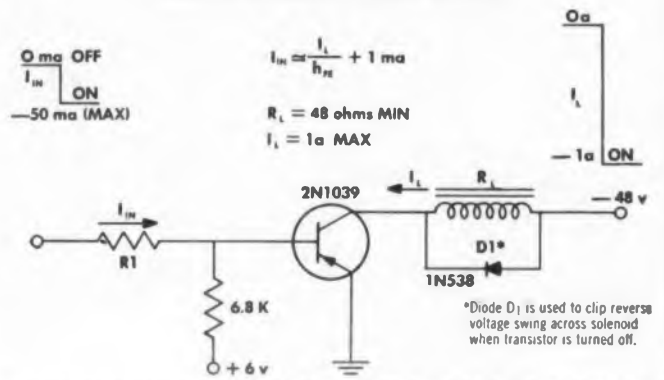
TYPICAL AUDIO AMPLIFIER 10 WATTS OUTPUT

TRANSISTOR	V_{cc} volts	R_L ohms	Efficiency %	Distortion % at P_o=10w	R_g ohms
2N1042	35	10	58	2.7	1
2N1043	55	25	57	1.8	2.5
2N1044	70	40	56	1.6	4
2N1045	85	60	53.5	1.6	6

Transformer: $N_1:N_2:N_3$ = 1:1:1
To Minimize Cross-Over Distortion the Coils Should be Bifilar Wound.



TYPICAL SOLENOID RELAY DRIVER



*Diode D_1 is used to clip reverse voltage swing across solenoid when transistor is turned off.

20-w power transistors:

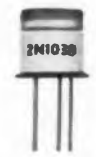
switching circuits • relay drivers • audio and pulse amplifiers

ACTUAL SIZE

TI 2N1042 series alloy-junction transistors **guarantee** 20 w dissipation at 25°C with voltage ratings of —40, —60, —80, and —100 v. You get guaranteed 20-to-60 beta spread at —3 amps and low 0.16 ohm saturation resistance at the —3 amp maximum collector rating.

1.25-w power transistors:

medium speed switching circuits • relay drivers • low-power audio and pulse amplifiers



ACTUAL SIZE

TI 2N1038 series alloy-junction transistors **guarantee** 1.25 w dissipation in moving free air at 25°C with voltage ratings of —40, —60, —80, and —100 v. **Guaranteed** 20-to-60 beta spread at —1 amp and low 0.2 ohm saturation resistance assure reliable performance.

TI GERMANIUM POWER TRANSISTOR CHARACTERISTICS AT 25 C

Type	Dissipation at 25°C Watts	Max Collector Voltage Volts	Max Collector Current Amps	h_{FE} min	h_{FE} max	Collector Reverse Current I_{CO} max	Typical Saturation Resistance R_{CS} Ohms
2N456	50	—40	—5	10 @ —5a	50	—2ma @ —40v	0.048
2N457	50	—60	—5	10 @ —5a	50	—2ma @ —60v	0.048
2N458	50	—80	—5	10 @ —5a	50	—2ma @ —80v	0.048
2N511	80	—40	—10	10 @ —10a	30	—2ma @ —20v	0.025
2N511A	80	—60	—10	10 @ —10a	30	—2ma @ —30v	0.025
2N511B	80	—80	—10	10 @ —10a	30	—2ma @ —40v	0.025
2N512	80	—40	—15	10 @ —15a	30	—2ma @ —20v	0.025
2N512A	80	—60	—15	10 @ —15a	30	—2ma @ —30v	0.025
2N512B	80	—80	—15	10 @ —15a	30	—2ma @ —40v	0.025
2N513	80	—40	—20	10 @ —20a	30	—2ma @ —20v	0.025
2N513A	80	—60	—20	10 @ —20a	30	—2ma @ —30v	0.025
2N513B	80	—80	—20	10 @ —20a	30	—2ma @ —40v	0.025
2N514	80	—40	—25	10 @ —25a	30	—2ma @ —20v	0.025
2N514A	80	—60	—25	10 @ —25a	30	—2ma @ —30v	0.025
2N514B	80	—80	—25	10 @ —25a	30	—2ma @ —40v	0.025
2N1021	50	—100	—5	10 @ —5a	30	—2ma @ —100v	0.08
2N1022	50	—120	—5	10 @ —5a	30	—2ma @ —120v	0.08
2N1038	1.25	—40	—1	20 @ —1a	60	—125μa @ —20v	0.2
2N1039	1.25	—60	—1	20 @ —1a	60	—125μa @ —30v	0.2
2N1040	1.25	—80	—1	20 @ —1a	60	—125μa @ —40v	0.2
2N1041	1.25	—100	—1	20 @ —1a	60	—125μa @ —50v	0.2
2N1042	20	—40	—3	20 @ —3a	60	—125μa @ —20v	0.16
2N1043	20	—60	—3	20 @ —3a	60	—125μa @ —30v	0.16
2N1044	20	—80	—3	20 @ —3a	60	—125μa @ —40v	0.16
2N1045	20	—100	—3	20 @ —3a	60	—125μa @ —50v	0.16
2N1046	35	—80	—3	20 @ —3a	160	—1ma @ —40v	0.9

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silicon diodes and rectifiers
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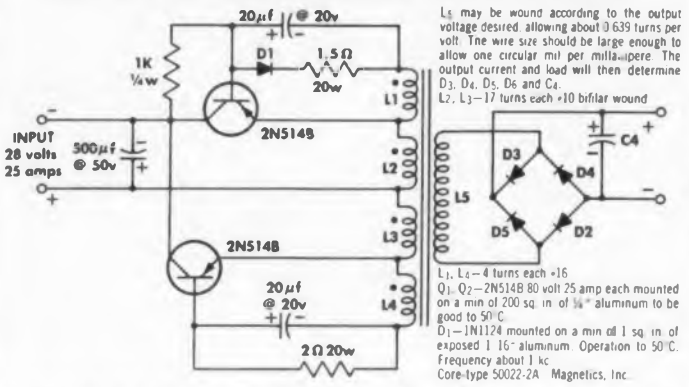
precision carbon film resistors
***sensistor* silicon resistors**

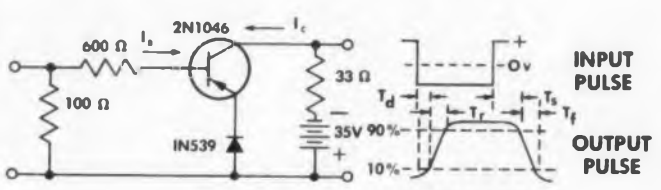
TEXAS

DC-TO-DC POWER CONVERTER 630-WATT OUTPUT AT 90% EFFICIENCY



L_5 may be wound according to the output voltage desired, allowing about 0.639 turns per volt. The wire size should be large enough to allow one circular mil per milliampere. The output current and load will then determine D_3, D_4, D_5, D_6 and C_4.
L_2, L_3—17 turns each #10 bifilar wound
L_1, L_4—4 turns each #16
Q_1, Q_2—2N514B 80 volt 25 amp each mounted on a min of 200 sq. in. of ⅛" aluminum to be good to 50°C.
D_1—1N1124 mounted on a min of 1 sq. in. of exposed 1/16" aluminum. Operation to 50°C.
Frequency about 1 kc
Core-type 50022-2A Magnetics, Inc.

TYPICAL SWITCHING CHARACTERISTICS



TYPICAL SWITCHING TIMES			TEST CURRENTS	
T_d	Delay Time	0.3 μsec	I_{B1}	(Turn-on Current) = — 30mA
T_r	Rise Time	0.7 μsec	I_{B2}	(Turn-off Current) = + 30ma
T_s	Storage Time	1.2 μsec	I_C	(Collector Current) = — 1A
T_f	Fall Time	0.5 μsec		

ACTUAL SIZE

10 to 25-amp switchers:

high current switching applications

TI 2N511 series alloy-junction transistors **guarantee** collector currents of **—10, —15, —20, and —25 amps** in —40, —60 and —80 v ratings. All units provide low 0.025 ohm saturation resistance and typical switching times at 25°C of 12.5 μsecs (t_{on}) and 8.0 μsecs (t_{off}).

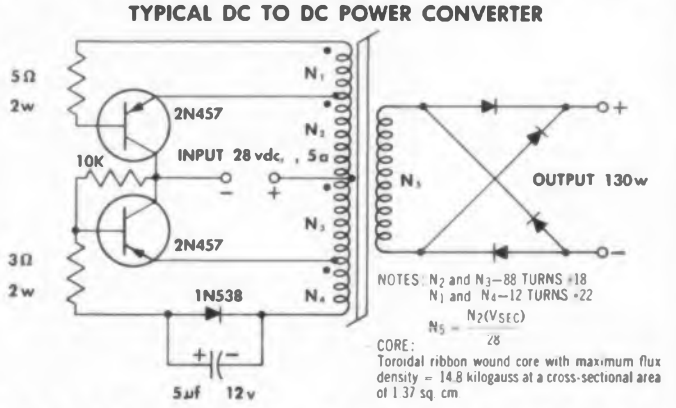
ACTUAL SIZE

high power/high frequency switchers:

computer core drivers • deflection circuits • light weight converter applications

TI 2N1046 alloy diffused transistors combine high power, high frequency and high voltage performance in a single package. **Guaranteed** 35-w dissipation, collector breakdown voltage to —80 v, and low 0.75 ohm saturation resistance with **12 mc** typical alpha cutoff insure reliable operating characteristics.

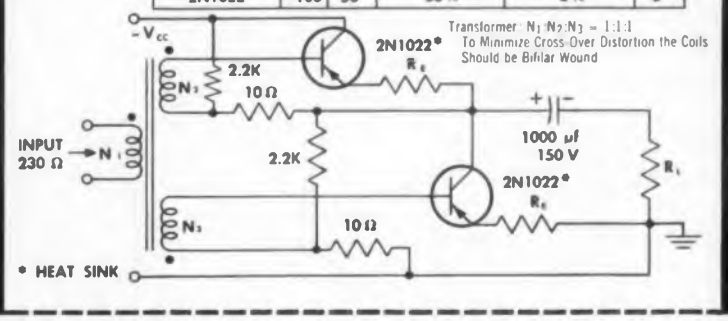
TYPICAL DC TO DC POWER CONVERTER



NOTES: N_2 and N_3—88 TURNS #18
N_1 and N_4—12 TURNS #22
$N_5 = \frac{N_2(V_{SEC})}{28}$
CORE:
Toroidal ribbon wound core with maximum flux density = 14.8 kilogauss at a cross-sectional area of 1.37 sq. cm

TYPICAL 20 WATT AMPLIFIER POWER GAIN = 23 db

TRANSISTOR	V_{CC} V	R_L Ω	EFFICIENCY	DISTORTION 20 WATTS	R_E Ω
2N1021	-80	30	66%	2%	3
2N1022	-100	50	66%	2%	5



Transformer: N_1:N_2:N_3 = 1:1:1
To Minimize Cross-Over Distortion the Coils Should be Bifilar Wound

ACTUAL SIZE

high beta power amplifiers:

audio amplifiers • current switchers • power converters

TI 2N456 series alloy-junction transistors with **guaranteed** 50-w dissipation, **—40, —60, and —80 BV_{CBO}** ratings and less than 0.048 ohm saturation resistance provide optimum performance characteristics.

ACTUAL SIZE

high voltage power converters:

audio • servo • power applications

TI 2N1021 and 2N1022 alloy-junction transistors **guarantee** maximum operating voltages of **—100 v and —120 v** respectively, low 0.08 ohm saturation resistance, and typical betas of 60 at —1 amp, 23 at —5 amps. You get **guaranteed** collector reserve current of —2 ma maximum at full rated voltage.

Check the specifications at left for the unit most suited to your particular requirements.

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CIRCLE 154 ON READER-SERVICE CARD

CIRCLE 155 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Amplifier

Comes with power supply

Model 652 servo amplifier contains its own power supply which furnishes both regulated plate voltage and regulated filament voltage to the dc amplifier section. The unit accepts several dc input or feedback signals and produces an output signal compatible with most electrohydraulic servo valves. The amplifier has a maximum gain of 100 differential ma per v when driving a 4000-ohm center-tapped load, and produces a maximum differential current of ±40 ma. It has front panel controls for gain, dither, balance, and level. Power required is 115 v 60 cps.

American Measurement & Control, Inc., Dept. ED, 240 Calvary St., Waltham 54, Mass.

CIRCLE 157 ON READER-SERVICE CARD

Frequency Converter

For ground check-out use

For use in laboratories and in ground check-out equipment, model W-1477 frequency converter changes 60 cps power to 115 to 200 v, 400 cps, three-phase power with a 750 va load capability. The standard frequency stability is 0.1%; special units having a frequency stability of 0.01% can be supplied. The maximum distortion at any load does not exceed 5% and the phase balance is 120 ±2 deg. Regulation of standard units with variation of input line from 110 to 120 v and variation of load from 0 to 750 va is less than 2%. The unit operates loads that vary from 0.85 lead to 0.9 lag PF. It withstands transient voltages of 80 v dc without damage. Operating life is in excess of 25,000 hr. Designed to fit a 19-in. relay rack, the unit has over-all dimensions of 7 x 19 x 17 in.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

CIRCLE 158 ON READER-SERVICE CARD

Rheostat Potentiometer

Has enclosed design

The model E miniature rheostat potentiometer is now furnished in an enclosed style, consisting of a lightweight, drawn aluminum housing which is dust-tight. The three rheostat terminals are brought out to corresponding terminals on the back panel. Exclusive of the shaft, the enclosure measures 1-3/64 in. diam and 1-7/32 in. long. The unit is rated at 12.5 w at 40 C ambient temperature. It can be used in military as well as industrial applications.

Ohmite Manufacturing Co., Dept. ED, 3661 Howard St., Skokie, Ill.

CIRCLE 161 ON READER-SERVICE CARD

Zener Regulators

For low voltage regulation

Designed for low voltage regulation, these Zener regulators come in two types: type RS-6 single anode unit and type RT-6 twin anode unit. Type RS-6 has a reverse voltage breakdown voltage of 6 ±1 v and a maximum dynamic impedance of 15 ohms. The RT-6 has 20 ohms maximum dynamic impedance at the same reverse breakdown voltage. Both ratings are at 10 ma dc. Both units are encapsulated in a hermetically sealed, corrosion-resistant case and operate over the temperature range of —50 to +80 C. Their applications include voltage reference and regulation for 12 and 24-v mobile power systems, replacement of gaseous tube regulators and reference units, and biasing and coupling elements in transistor circuits.

Hoffman Electronics Corp., Semiconductor Div., Dept. ED, 930 Pitner Ave., Evanston, Ill.

CIRCLE 162 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Synthesizer

Has three ranges

Type XUB frequency synthesizer has ranges from dc to 100, 1000, and 10,000 cps with crystal-locked steps of 1, 10, and 100 cps and a maximum error of 0.5, 5, and 50 mc. The output voltage is continuously variable from 3 mv to 3 v, sinusoidal and spurious frequencies suppressed by more than 60 db. The instrument can be used in calibrating direct reading frequency meters, in investigating mechanical resonant systems, in measuring if crystals, and in engineering control.

Rohde and Schwarz, Dept. ED, P.O. Box 275, Passaic, N.J.

CIRCLE 165 ON READER-SERVICE CARD

X-Y Plotter

Operates from differential transformers

Designed to operate from differential transformers, model HR-94 plotter may be used to plot small mechanical movements or any related variables which can be converted to mechanical movements. Applications include plotting contours of miniature bearing races, plotting surface and gear tooth irregularities, stress, strain, pressure, spring, and bellows deflections. The multiplication factor is adjustable to 1000:1 with a total error of less than 0.15%. Movements of 20 μin. are detectable. Signal, reference, and rebalance circuits are 400 cps originating from a built-in tuning fork oscillator. The servo systems operate from 50 or 60 cps line frequency. Pen speed is 2 in. per sec. Standard 24 x 36 in. paper or 24 in. roll stock graph paper may be used.

Houston Instrument Corp., Dept. ED, 1717 Clay Ave., Houston 3, Tex.

CIRCLE 166 ON READER-SERVICE CARD

Paints

Electrically conductive types

These electrically conductive silver paints are used in color coding surfaces of components such as disc thermistors and in coding complex printed wiring. The paints can be brushed on the terminals of electronic control assemblies during tests to facilitate connections. Available are a silver conductive coating No. SCE22 and coatings having resistances of 20, 200, and 2000 ohms. Type RSE32, having a resistance of 2000 ohms, has abrasion, solvent, and slip resistance. The paints may be air dried or baked. Primers and thinners can also be furnished.

Micro-Circuits Co., Dept. ED, New Buffalo, Mich.

CIRCLE 189 ON READER-SERVICE CARD

DC Power Supply

Provides 4 to 35 v

This transistorized dc power supply provides from 4 to 35 v at 0 to 4 amp. The output is continuously variable by means of a knob on the front panel. Regulation is 0.1% for load and line variations with no internal adjustments. The unit operates from a 105 to 125 v, 60 cps line. It measures 3-1/2 x 10 in. and can be mounted in a 19-in. rack. Fully enclosed, it is also suitable for bench use. All parts are easily accessible.

Dynamic Controls Co., Dept. ED, 155 Massachusetts Ave., Cambridge, Mass.

CIRCLE 190 ON READER-SERVICE CARD

Digital Data Printer

Stands 50 g shock

Designed for military uses, model 2000 digital data printer withstands 50 g shock. The unit operates directly from electronically generated decimal or binary-coded decimal data sources. It operates in the temperature range of 0 to 125 F and can be stored for indefinite periods in temperatures from −65 to +160 F.

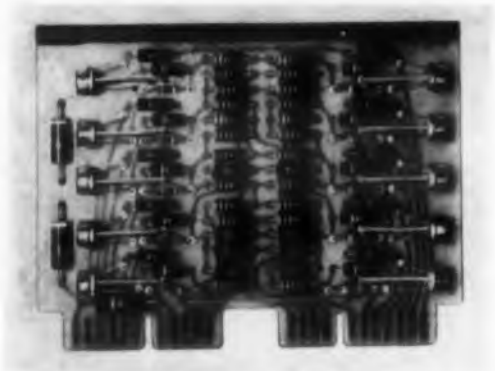
Clary Corp., Dept. ED, San Gabriel, Calif.

CIRCLE 191 ON READER-SERVICE CARD

NEW PRODUCTS

Indicator Driver

Is a BDC-to-decimal converter



Type NX-101 Nixie driver is a BDC-to-decimal converter that accepts the 8-4-2-1 binary decimal code from a decimal counter and applies the appropriate drive signals to the corresponding cathode of a Nixie tube. Each of the 10 stages consists of a npn transistor and a resistor decoder. The unit decodes signals from any flip-flop capable of sustaining an additional 3 ma in the on-transistor and having an off-collector potential of +17 v min. The power requirements are +195 v ±2% at 5.5 ma, +20 v ±5% at 9.5 ma. Input specifications are +18 v ±10%, −5% at 3 ma, and the output specifications are +20 v at 2 ma.

Computer Control Co. Inc., Dept. ED, 983 Concord St., Framingham, Mass.

CIRCLE 167 ON READER-SERVICE CARD

Silver-Zinc Battery

Has matched dual outputs

Model P43A silver-zinc battery consists of two battery sections having identical output and capacity. It is for use where standby capacity is required, or where one circuit must meet a heavy peak current demand, while the other has a steady, non-fluctuating load. Each 19-cell section provides a current of 3 amp at 26.5 v. Maximum current is 12 amp with a discharge time of 25 min at 3 amp. Capacity is 1.3 amp-hr. Internal voltage regulation insures less than 10% voltage fluctuation under maximum surge loads. Both sections are automatically activated in 0.5 sec; the signal required is 4 amp at 28 v. The unit withstands shock to 100 g, acceleration to 50 g, and vibration to 8 g along all three major axes. The temperature range is 40 to 80 F; units operating from −65 to +165 F can be provided. The battery measures 5 x 5 x 6 in. and weighs 7 lb.

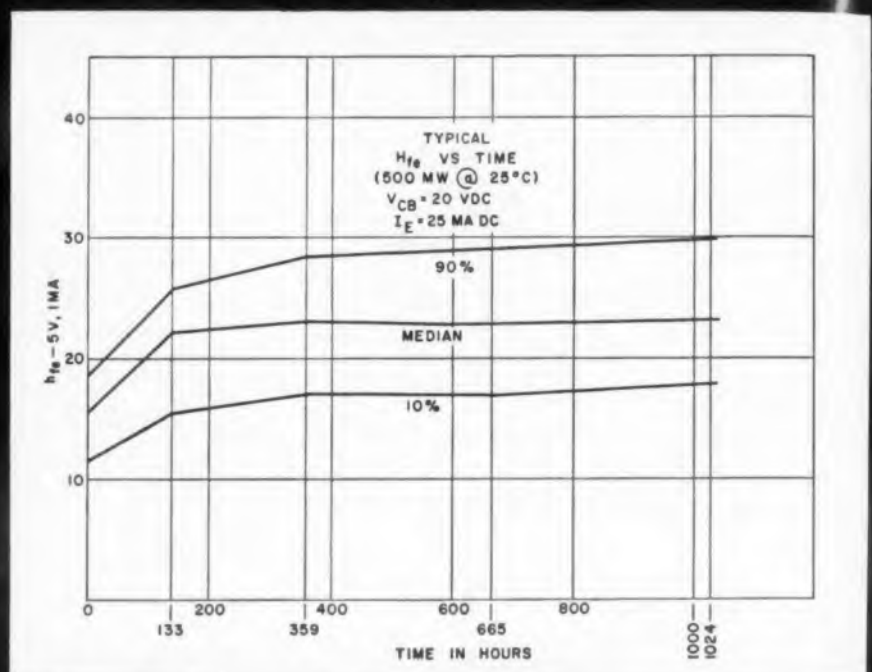
Cook Batteries, Telecomputing Corp., Dept. ED, 3850 Olive St., Denver, Colo.

CIRCLE 168 ON READER-SERVICE CARD

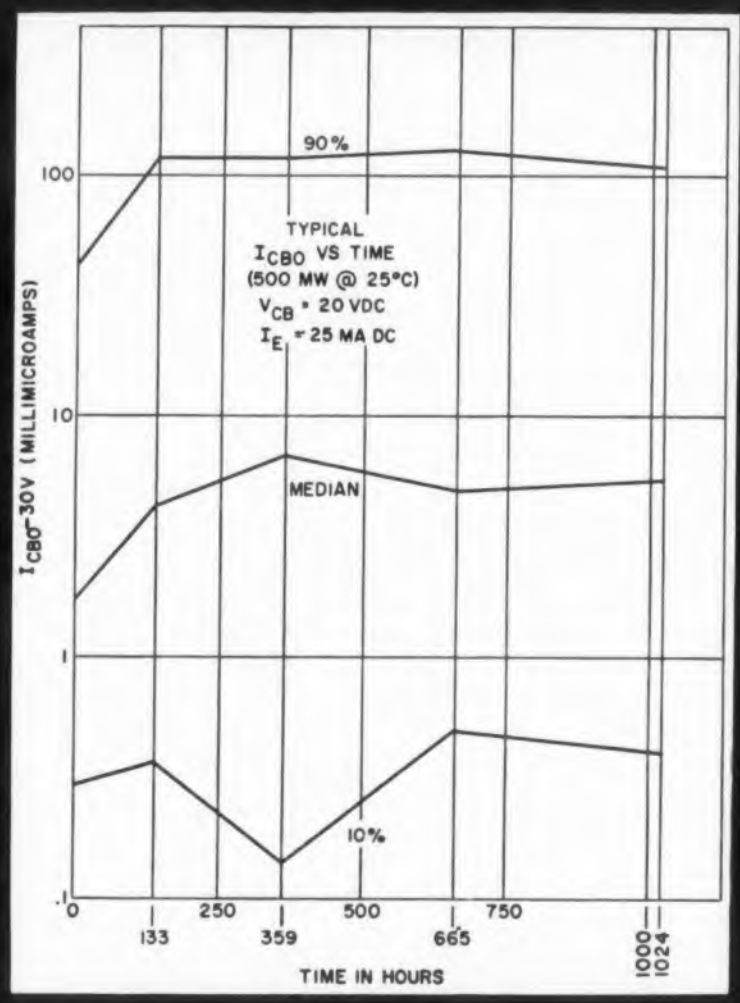
GENERAL ELECTRIC SEMICONDUCTOR NEWS

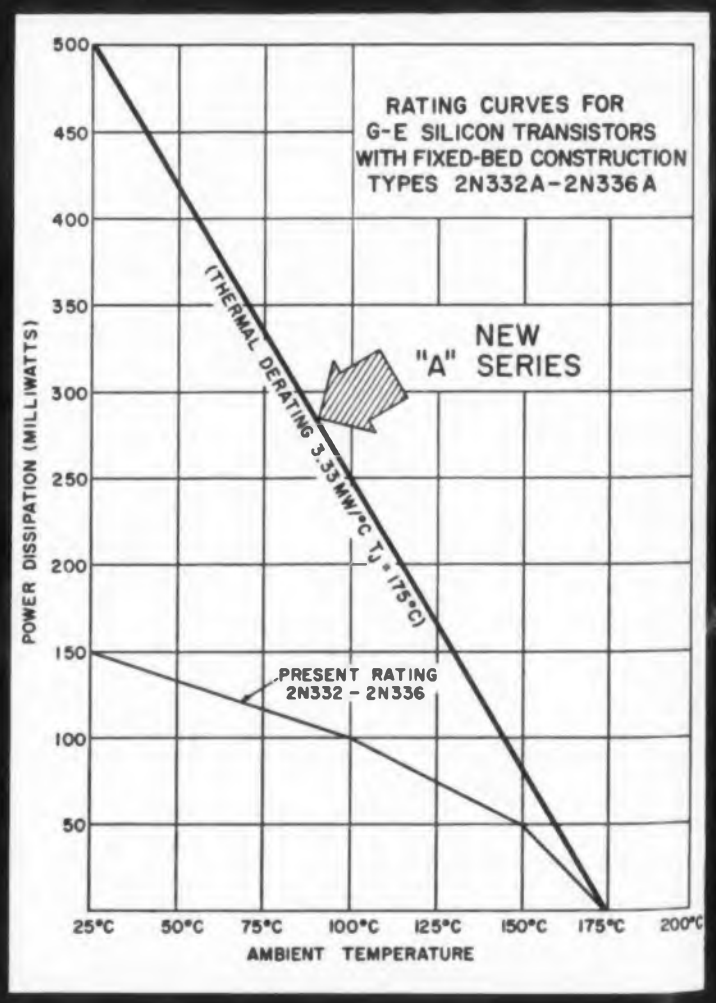
New silicon triodes dissipate

Greatly magnified photo of silicon transistor showing Fixed Bed Construction. All parts are firmly fastened, with no suspended parts except wire lead. Transistor reacts as a solid block in resisting shock and vibration. Power dissipation is inherently higher.



Power dissipation of the 2N332A-through-2N336A silicon transistors (see chart below) ranges from 500 mw at 25°C to 83 mw at 150°C without heat sink. Note also (see chart below, left) the extremely low I_{CBO} throughout 1000 hours of testing. Nearly 90% of units fall within 100 mμa. Beta spread (chart above) is stable out to 1000 hours.





500 mw without heat sink at 25°C

FIXED BED MOUNTED TRANSISTORS 2N332A-through-2N336A ALSO FEATURE:
4 VOLT V_{EB} . . . GUARANTEED 45 VOLT V_{CE} . . . .005 μa MAX. I_{CBO}
AT 25°C AND 30 VOLTS . . . PHYSICAL AND ELECTRICAL STABILITY

The 2N332A-through-2N336A line of silicon NPN triodes is a new series of amplifier and switching transistors capable of much higher performance than ever before achieved.

Collector dissipation without heat sink is 500 mw at 25°C . . . 83 mw at 150°C. Since reliability is related to junction temperature, even those designs which do not require maximum-rated power may be enhanced greatly by this device series because of the wide safety-factor potential provided.

FOUR OTHER ADVANTAGES—Collector-to-emitter voltage is guaranteed at 45 volts. Collector leakage current is a maximum of 500 mμa at 30 volts and 25°C. Collector-to-emitter leakage current is 60 μa at 150°C. Minimum cutoff frequency is 2.5 mc, typical f_{ab} is 10 to 15 mc.

FIXED BED MOUNTING—Fixed Bed Mounting is an exclusive G-E construction technique which contributes to the extreme stability obtained by this series of transistors. Storage and operating tests have resulted in a performance rate of better than 99.2% after 1000 hours.

Besides the demonstrated electrical characteristics, General Electric's silicon transistors can absorb physical punishment far beyond normal specifications. All parts are solidly fixed together and react as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club and rattled freely in an auto hubcap for 700 miles—and worked afterward.

IMMEDIATELY AVAILABLE—All types are available now from warehouse stock. Call your General Electric Semiconductor Sales Representative for complete details on the "hot" transistor line that operates the coolest. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

TYPE 2N333-THROUGH-2N335 SILICON TRANSISTORS MEET MIL-T-19500/37A SPEC.
Designing to the new MIL-T-19500/37A Spec? General Electric types 2N333, 2N334 and 2N335 can be supplied from warehouse stock to meet this specification.

SPECIFICATIONS

Absolute Maximum Ratings (25°C)

Voltages		
Collector to Base	V_{CB}	45 volts
Collector to Emitter	V_{CE}	45 volts
Emitter to Base	V_{EB}	4 volts
Current		
Collector	I_C	25 ma
Power		
Collector Dissipation RMS	P_C	500 mw @ 25°C (Free Air)
	P_C	83 mw @ 150°C (Free Air)
Temperature		
Storage	T_{STG}	−65 to 200°C
Operating Junction	T_J	−65 to 175°C

Electrical Characteristics (Typical at 25°C)

		2N332A	2N333A	2N334A	2N335A	2N336A	
D C Characteristics							
Forward Current Transfer Ratio (low current) (I_C = 1 ma, V_{CE} = 5 V)	h_{FE}	16	27	36	45	75	
Saturation Voltage (I_B = 1 ma, I_C = 5 ma)	V_{CE} (Sat)	.5	.45	.42	.4	.4	volts
Cutoff Characteristics							
Collector Current (V_{CB} = 30 V; I_E = O; T_A = 25°C)	I_{CBO}	1	1	1	1	1	mμa
Collector Emitter Current (V_{CE} = 30 V; I_B = O; T_A = 150°C)	I_{CEO}	60	60	60	60	60	μa
Low Frequency Characteristics (V_{CB} = 5 V; I_E = −1 ma; f = 1000 cps)							
Forward Current Transfer Ratio	h_{fe}	16	30	38	52	95	
Input Impedance	h_{ie}	750	1300	1700	2000	3700	ohms
Output Admittance	h_{oe}	3.5	5.0	6.0	7.0	8.0	μmhos
Output Admittance	h_{ob}	.25	.2	.18	.15	.13	μmhos
High Frequency Characteristics Common Base) (V_{CB} = 5 V; I_E = −1 ma)							
Output Capacity (f = 1 mc)	C_{ob}	7	7	7	7	7	μμf
Cutoff Frequency	f_{ab}	10	11	12	13	15	mc
Power Gain (common emitter) (V_{CE} = 20 V; I_E = −2 ma; f = 5 mc)	G_e	11	11	12	12	12	db

GENERAL ELECTRIC

CIRCLE 169 ON READER-SERVICE CARD

Bias Supply

For measuring infrared photoconductors

Made for use with photoconductors or thermistor bolometers, model 501 bias supply has voltage ranges of 0 to 50, 100, and 500 v and current ranges of 25, 100, 250, and 1000 ma. The current through the detector provides a monitor of the detector or of the cooling system. The resistance of a detector under actual conditions of use can be measured. Battery operated, the unit has a low noise figure. The battery life is 6 months under normal conditions. Accuracy is 1%. Fine control on voltage and overload protection on the microammeter are provided.

Infrared Standards Lab., Dept. ED, 10555 Magnolia Ave., Riverside, Calif.

CIRCLE 170 ON READER-SERVICE CARD

Phase Shifter

For X-band use

This X-band phase shifter provides an electronically variable mismatch for frequency control of low-power magnetrons and klystrons. It can be designed to fit a number of frequency control and antenna phasing systems applications, including magnetron frequency controllers and serrodyne phasers. Phase variation is ±45 min. phase shift, driving power requirements are 0.6 w max, and typical dc coil characteristics are 200 ohms max at −100 ma max. The power handling capacity is 2 kw peak and 2 w avg. The unit uses a longitudinal magnetic field with a ferrite rod supported in a foam dielectric.

Litton Industries, Dept. ED, 336 N. Foothill Road, Beverly Hills, Calif.

CIRCLE 171 ON READER-SERVICE CARD

NEW PRODUCTS

Shift Registers

Repetition rates are 10 to 400 kc

The SRA-10 ten-bit magnetic shift registers are available with positive or negative outputs in five models: 50 kc at 6 and 12 v, 100 kc at 6 and 12 v, and 200 kc at 12 v. All units operate from zero to rated speed. The low shift drive permits 200 bits to be driven by 100 ma with a 5-v peak drop across the series shift line. The serial input and output are permanently wired on the printed wiring board. At rated repetition rates, the power consumption is 1.2 w. Suitable for military and industrial applications, the units have a life expectancy of over 100,000 hr.

Di-An Controls, Inc., Dept. ED, 40 Leon St., Roxbury 15, Mass.

CIRCLE 173 ON READER-SERVICE CARD

Excitation Power Supply

Regulation is 0.2%

Designed for use in transducer excitation, ac meter calibration, and distortion measurement, model AP-0069 3-kc excitation power supply has a regulation of 0.2% under all conditions and a nonfundamental output of less than 0.05%. The power output capability is 5 w. Typical applications include excitation of bridge-type testing devices for production or incoming inspection, excitation of strain gage or potentiometer transducers, and use as a source in carrier data equipment.

C. A. Rypinski Co., Dept. ED, 2005 N. Oaks Ave., Pasadena, Calif.

CIRCLE 174 ON READER-SERVICE CARD

PAM/PDM Simulator

Tests decommutation systems

Model 89A transistorized PAM/PDM simulator provides simulated PAM and PDM telemetry signals and supplies pulse trains that conform to IRIG standards. The unit performs preliminary calibration and checks functional operation of decommutation equipment. In PAM operation, the frame synchronization pulse duration can be two or three sample periods. Synchronizing pulse amplitude is 10 v peak-to-peak. The PDM output signals swing from +4 to −6 v and the output signal reference is not adjustable. Accuracy of simulated analog data is within ±2% and sampling rates can be varied ±25% of standard rates. The unit operates from 115 v ac power. It mounts in a standard 19-in. rack and is 3-1/2 x 17-3/4 in.

Telecomputing Corp., Data Instruments Div., Dept. ED, 12838 Saticoy St., N. Hollywood, Calif.

CIRCLE 177 ON READER-SERVICE CARD

Harmonic Generators

Consist of two waveguides

Designed to generate energy in frequency ranges where signal sources are not readily available, these harmonic generators consist of two waveguides coupled to each other by means of a probe structure terminated in a crystal element. The input waveguide receives the excitation frequency, which is coupled to the crystal to cause harmonic generation in the output waveguide. The harmonic frequency then propagates through the output waveguide. Three models are available, providing frequencies from 53 to 90 kmc. A BNC jack is provided for monitoring crystal current or for the application of dc bias.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N.Y.

CIRCLE 178 ON READER-SERVICE CARD

NEW PRODUCTS

Pulse Generator

Rise time is less than 2.5 mμsec

Model 120B pulse generator has a rise time of less than 2.5 mμsec. Two independent outputs are available providing precise widths from 2.5 to 25 mμsec. Repetition rates from 10 cps to 10 mc may be controlled externally. A fast flexible gating input is available for complex pulse-time and pulse-amplitude selection. A 15-v trigger output may be used to initiate timing cycles or to trigger an oscilloscope.

E-H Research Labs., Inc., Dept. ED, 1922 Park Blvd., Oakland 6, Calif.

CIRCLE 181 ON READER-SERVICE CARD

Control Consoles

In aluminum, magnesium, or stainless steel

Made of aluminum, magnesium, or stainless steel, these control consoles can be adapted to individual requirements in military and commercial applications. The sloping panel can be punched or drilled to specifications and is easily removed. The counter top is made of smooth Formica or Texolite bonded on plywood. The universal panel mounting can accommodate a variety of chassis, panels, slides, and other components. The consoles have a utility drawer and full-swinging front and rear doors.

Falstrom Co., Dept. ED, Passaic, N.J.

CIRCLE 182 ON READER-SERVICE CARD

Direct-Recording Oscillograph

Has 24 channels

Type 1108 direct-recording oscillograph allows recording of up to 24 channels of hf, high-sensitivity information from dc to 5000 cps. Chart speeds are adjustable in 15 variations from 0.05 to 80 in. per sec. This dry and dustless unit produces records without processing of any kind. The light source is a high pressure mercury vapor lamp with maximum output in the ultraviolet region.

Minneapolis-Honeywell Regulator Co., Heiland Div., 5200 E. Evans Ave., Denver 22, Colo.

CIRCLE 183 ON READER-SERVICE CARD

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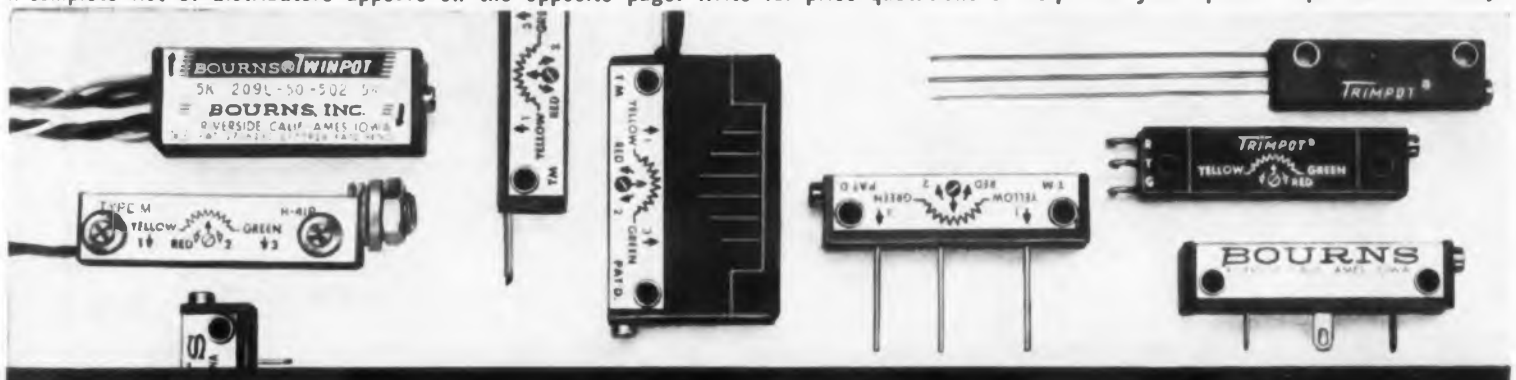
Immediate "off-the-shelf" delivery is available of the entire line of standard Trimpot potentiometers—20 basic models...4 terminal types... 3 mounting styles! More than ½ million units are stocked by franchised distributors across the nation and at Bourns plants in Riverside, California and Ames, Iowa. Wherever you are, whatever standard unit you need, there's a Trimpot source close at hand waiting to fill that rush order...no need to hold up your prototype or production projects.

This fast service is made possible by mechanized production processes. enlarged facilities, and greatly expanded engineering and production staffs. All this is part of our intent to provide the finest customer service program. It is another Bourns plus—in addition to the high quality, reliability, and performance that have won Trimpot potentiometers a place in major missile, aircraft and commercial electronic systems.

A complete list of distributors appears on the opposite page. Write for price quotations or help with your special requirements—today.



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Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration.

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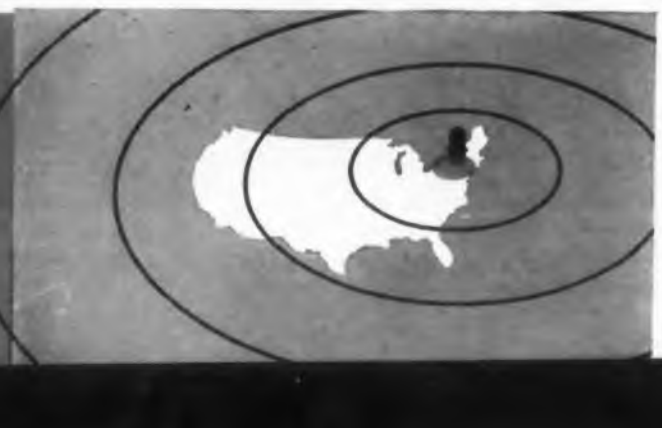
PIONEER 6-6520 TWX G-CY-NY-580

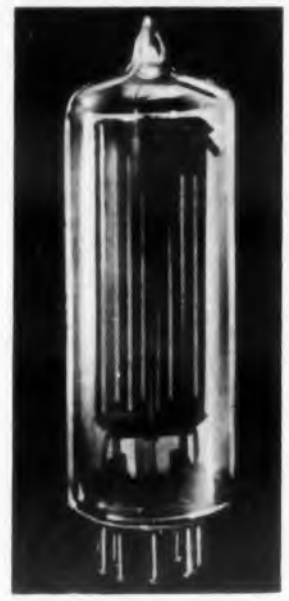
CIRCLE 185 ON READER-SERVICE CARD



NEW PRODUCTS

Photoconductive Cell

Made of cadmium sulphide



Type ORP90 cadmium sulphide photoconductive cell has an average cell current of 20 ma at 10 v dc, 4.5 ft-c, with the lamp color temperature at 1500 K. The maximum ac cell voltage is 250 v. The unit mounts in any position and can be used in the ambient temperature range of −40 to +70 C. Having a high sensitivity, the unit provides a maximum response in the red and infrared region.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

CIRCLE 186 ON READER-SERVICE CARD

Waveguide Switch

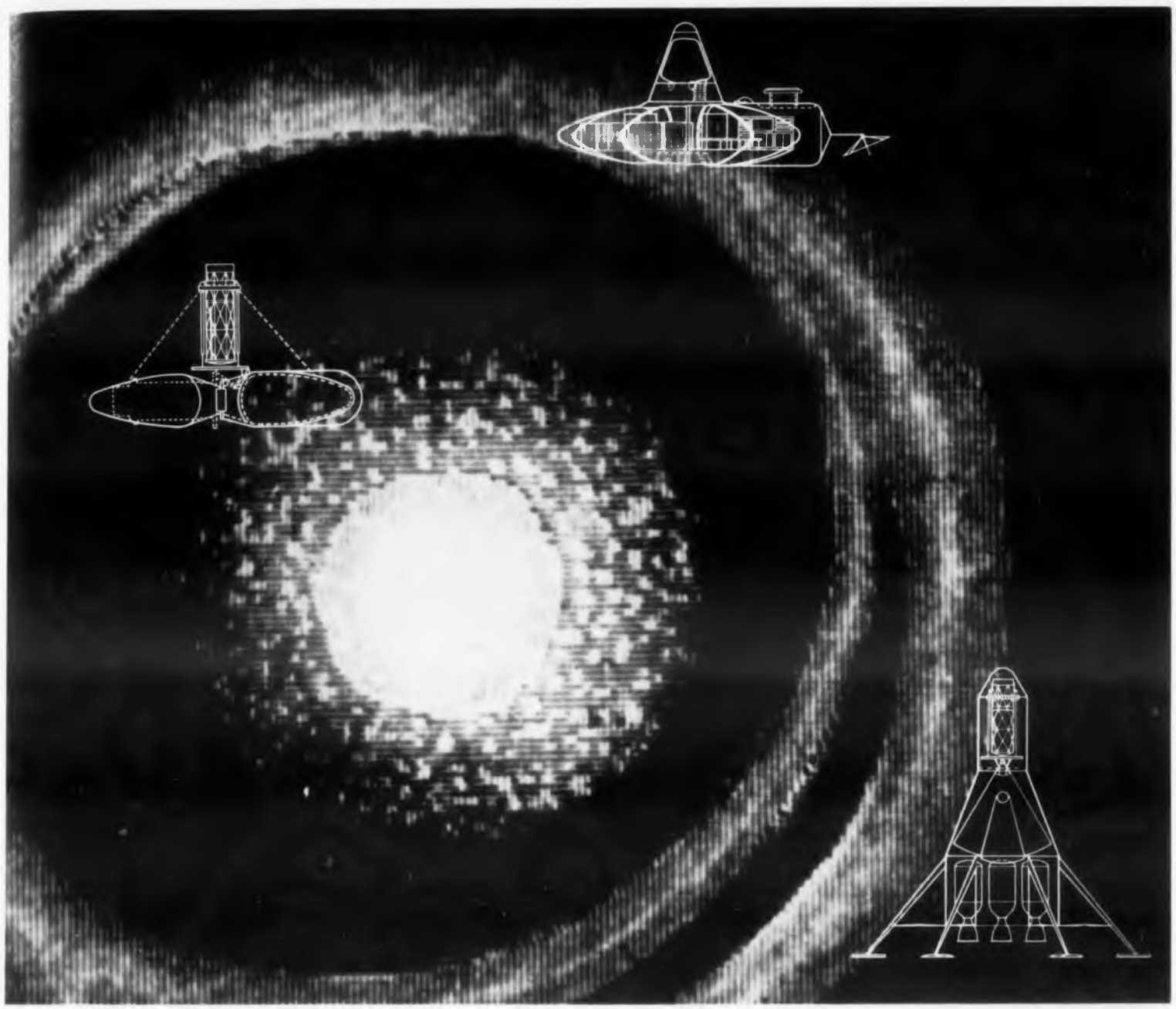
For use in the S-band

Type SP2T remote-controlled waveguide switch is for airborne, marine, and ground use in guidance and communications in the S-band from 2.6 to 3.95 kmc. It can be switched under power and has a switching time of 0.02 sec. When used as a power divider during the switching cycle, the vswr is 2.1:1. The rf characteristics include 60 db isolation and 1.15:1 max vswr. The unit weighs 4.5 lb.

Don-Lan Electronics Co., Dept. ED, Santa Monica, Calif.

CIRCLE 187 ON READER-SERVICE CARD

CIRCLE 188 ON READER-SERVICE CARD



New styles for the man-about-space

Every time a space traveler leaves home (earth), he has to wrap himself in the complete environment necessary to his physiological and psychological well-being. Styling sealed space capsules to suit man's every requirement has been a major project at Douglas for more than ten years. Forty basic human factors areas were explored in these studies. Now Douglas engineers have evolved plans for practical space ships, space stations and moon stations in which men can live and work with security thousands of miles from their home planet. We are seeking qualified engineers and scientists who can aid us in furthering these and other out-of-this-world but very down-to-earth projects.

Dr. Eugene Konecci, Head, Life Sciences Section, reviews a new concept in space cabin design with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

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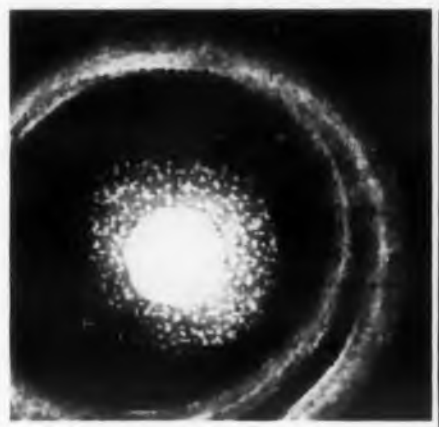

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Douglas Aircraft Company, Inc.
Santa Monica, Calif.

NEW PRODUCTS

Transistor Transformers

Miniature size

These transistor transformers are available in MIL-AG construction 1 x 1 x 1-3/8 in. or in cylindrical construction 15/16 in. in diam and 1-3/8 in. high. The use of mu metal in place of steel cans provides a hum pick-up reduction of about 20 to 30 db. The units are supplied with either high compression glass or ceramic terminals. They meet MIL-T-27A grade 4 class R and have a life rated at 10,000 hr.

Microtran Co., Inc., Dept. ED, Valley Stream, N.Y.

CIRCLE 194 ON READER-SERVICE CARD

DC Motor

Provides 16 oz-in. torque at 1000 rpm

Designed for use as a magnetron tube drive, model P7P6TFRP 28 v dc permanent magnet geared motor provides 16 oz-in. torque at 1000 rpm. It is furnished with a thermal protector for overload and stall conditions as well as a radio filter. The requirements of MIL-I-6181B are met.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado Blvd., Pasadena, Calif.

CIRCLE 195 ON READER-SERVICE CARD

Galvanometers

Compact design

Compact in design, these galvanometers are designed for operation in horizontal, vertical, or tilted positions. Model 2435 reflecting galvanome-

ter consists of an internal-magnet galvanometer system, a 10-in. folded optical system and a lamp-and-scale reading device assembled in one unit. Four interchangeable oil-damped galvanometer systems are available with periods of 4 sec or less. Model 2340 pointer galvanometer has an internal-magnet system which permits changing the sensitivities by loosening two screws on the top plate. It has a clear plastic window.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 198 ON READER-SERVICE CARD

Snap-Action Switches

For printed circuit applications

For printed circuit applications, series S30-42B switches have special terminals for easy insertion. They have positive overtravel stop and over 50 actuator variations. Gold flash contact material can be supplied for low voltage applications. The following ratings are available: 10 amp at 125 v ac, 5 amp at 250 v ac, and 1/3 hp at 125 to 250 v ac. The switch measures 1/4 x 1/2 x 1 in.

Cherry Electrical Products Corp., Dept. ED, 1650 Deerfield Road, Highland Park, Ill.

CIRCLE 200 ON READER-SERVICE CARD

Laminated Plastic

Glass-base, epoxy resin

Type GEC-111 glass-base, epoxy-resin laminated plastic meets the specifications for NEMA grade G-11 and military grade MIL-P-18177B type GEB. A sheet 1/8 in. thick retains at least 68% flexural strength after 1 hr at 300 F. The material is suitable for use as the base material for copper-clad laminated plastics. In continuous use, the maximum temperature to which it is resistant is 350 F. Water absorption after 24 hr immersion is 0.2% max. The laminated plastic is furnished in sheets having thicknesses of 0.01 to 1 in. Sheets up to 3/32 in. thick may be cold punched. As a copper-clad laminate, it is supplied with rolled copper foil, type GEC-111R, or with electrolytically deposited foil, type GEC-111E.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

CIRCLE 201 ON READER-SERVICE CARD

NEW PRODUCTS

DC Modulator

Is spdt, 60 cps

This spdt, 60 cps, dc modulator is suited for computer systems, servo mechanisms, automation, and vacuum tube voltmeters. Each unit has less than 1-mv dc offset, and less than 1 mv-drift over long service periods. Normal contact dwell time is 55%, changing less than 2% during the first 1000 hr. A magnetic driving system prevents magnetic and electrostatic interference between coil and contact. The rms noise voltage generation is kept below 1 μv. Life expectancy is from 10,000 to 25,000 hr.

Millivac Instrument, Div. of Cohu Electronics, Inc., Dept. ED, Schenectady, N.Y.

CIRCLE 204 ON READER-SERVICE CARD

Contacting Counters

Two designs available

Series 1100 and 1200 contacting counters are compact units designed for telemetering shaft rotation and position. Series 1100 counters have electrical contacts which correspond with each number on each wheel. Series 1200 counters have precision resistors mounted between the contacts to form a stepped potentiometer or voltage dividing network; resistance ratios are directly proportional to the visual indication.

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

CIRCLE 205 ON READER-SERVICE CARD

Recording System

Digital

This digital recording system may be used for any recording of data where input variables in the form of emf's in the range of 0 to 10 mv are available. It will sequentially select to 200 input variables and digitally record each with three-digit point identification by means of a motorized tape punch. The data is recorded in an eight-channel code. Cycle time per data point is 1 sec. The maximum recording cycle is 15 min. Accuracy is ±0.5% of full scale.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 206 ON READER-SERVICE CARD

NPN-PNP Power Transistors

Collector current is 3 amp max

These complementary npn-pnp power transistors have a maximum collector current of 3 amp, a minimum large-signal current gain of 30 for a collector current of 0.5 amp, and a maximum thermal resistance 3 deg per C per w. Types 2N1320 through 2N1334 plus type 2N1078 are hermetically-sealed in welded TO-10 male and TO-13 female packages and exceed the requirements of MIL-T-19500A. The use of these transistor pairs in push-pull class B circuits eliminates the need for input and output transformers. Other uses are in balanced modulators and collector-coupled multivibrators. They are available with collector-to-base voltages up to 100 v at 25 C and can be supplied with solder lugs or flying leads.

CBS Electronics, Semiconductor Operations, Dept. ED, 900 Chelmsford St., Lowell, Mass.

CIRCLE 211 ON READER-SERVICE CARD

Silicon Diodes

Recovery time is 0.8 μsec

Designed for operation from −65 to +150 C, types 1N690 through 1N693 silicon diodes have a maximum recovery time of 0.8 μsec to return to 10 K when switched from a forward current of 2-μsec pulse of 500 ma to a reverse voltage of −50 v. They switch from a 5-ma forward pulse to −40 v and recover to 100 ohms in 0.5 μsec. Forward conductance is 400 ma at 1 v and leakage is 50 μa at 150 C. These diodes meet the requirements of high current pulse circuits for high speed computer switching, pulse clamping, gating, blocking, and diode logic circuits.

Sperry Semiconductor Div., Sperry Rand Corp., Dept. ED, S. Norwalk, Conn.

CIRCLE 212 ON READER-SERVICE CARD

NEW PRODUCTS

Proximity Limit Switch

Operates from —50 to +250 F

Made to operate from —50 to +250 F, this proximity limit switch has only one moving part. Like a mechanical limit switch, it has a self-contained set of contacts that operate in response to the actuating means provided. Like proximity switch systems, it operates without physical contact with the actuating means. It operates without transistors, tubes, coils, relays, or amplifier. Protection from coolants, abrasive dust, and dirt is provided. Dimensions are 1-1/2 x 1-1/2 x 4-1/2 in.

General Equipment and Mfg. Co., Inc., Dept. ED, 116 S. Campbell, Louisville 6, Ky.

CIRCLE 215 ON READER-SERVICE CARD

Rate Gyro

Measures 1-5/8 x 3-1/2 in.

Type RG24-0103 rate gyro measures 1-5/8 in. in diam and 3-1/2 in. long, including the connector. It has a dc motor and potentiometer pickoff. Made for high altitude rocket research, it operates in the temperature range of —65 to +180 F. It withstands shock of 75 g for 6 to 12 msec on any axis, acceleration of 50 g, and vibration of 0.06 in. double amplitude at 10 to 2000 cps. Output potentiometer values can be provided to meet the usual requirements. The motor operates on 28 v dc 150 ma max running current.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 216 ON READER-SERVICE CARD

Transistor Tester

Direct readout type

Model 545-B transistor tester has direct readout of the input impedance, the hybrid parameter Beta, and the collector cut-off current with accuracies of 5%, 3%, and 2%, respectively. Voltage for the transistor under test comes from either an internal battery or an external dc source. Designed for both laboratory and production use, the instrument may be used to detect defective transistors, match and compare transistors, check tolerances, and to accumulate design information for transistor circuits. The Beta ranges are from 0 to 30, 100, and 300. Test frequency is normally 1 kc from an internal oscillator, but any frequency from 200 cps to 50 kc may be used by plugging in an external oscillator. Input impedance may be measured from 500 to 20,000 ohms. Collector cut-off current is measured from 0 to 50 ma.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 217 ON READER-SERVICE CARD

Trimmer Potentiometer

Power rating is 0.25 w

Model 235 carbon potentiometer has a power rating of 0.25 w, an operating temperature range of −85 to +257 F, and resistance values from 1 K to 30 meg. It has a 22-turn screwdriver adjustment, a self-locking shaft, and an idling wiper. Three terminal types are available: stranded insulated leads, solder lugs, and printed circuit pins. The unit measures about 5/16 x 1/4 x 1-1/4 in. and weighs 3 oz.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 218 ON READER-SERVICE CARD

*Trademark

reliable . . . long-lived . . . rechargeable!

You can read a watch in the dark with any flashlight. The difference in the one the night nurse is using is that it will probably last a lifetime.

That's because it's powered by a *sealed* nickel cadmium button cell battery that's recharged simply by plugging it into an ordinary wall socket for a few hours.

Result: A dependable flashlight that can't corrode and never needs battery replacement.

How Can You Use These Versatile Batteries?

The rechargeable *Life Lite* is only one of many interesting ways in which imaginative engineers are employing these Gulton VO batteries.

Other applications: transistorized radios, guidance canes, missiles, photoflash power packs—*wherever small size, large capacity, light weight, long life, no maintenance, complete reliability, and easy recharging are desired.*

Most Complete Line Available

"VO" cells are available in capacities of 100, 180, 250, 500 and 1750 mah; have a nominal 1.2 voltage; can be packaged in any combination to meet your voltage specs. Patented sintered plate construction provides exceptional cycling characteristics; highest capacity per unit size. Like more information? Write us for Bulletin No. VO-110.

Available from stock—
GLENNITE BATTERY DISTRIBUTORS
92-15 172nd Street, Jamaica, New York

Gulton Industries, Inc.
Alkaline Battery Division, Metuchen, New Jersey

CIRCLE 220 ON READER-SERVICE CARD

NEW PRODUCTS

Millivolt Potentiometer

Range is −10.1 to +100.1 mv

Type 8686 portable millivolt potentiometer has a range of −10.1 to +100.1 mv. As a laboratory instrument, it can be used to calibrate millivoltmeters and potentiometer indicators, recorders, and controllers. In industrial use, it can perform on-the-line checking of recorders and controllers and temperature checking. It can measure throughout the entire emf range of thermocouples without reversing the leads. The measured value appears in a central reading window as a single row of digits plus a scale interpolation. Small fluctuations of measured voltage can be followed rapidly and accurately because the final increment of potentiometer voltage is spread over the 220-division slidewire.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 221 ON READER-SERVICE CARD

Subcarrier Oscillator

Measures 1-3/8 x 7/8 x 1-1/16 in.

Type TS-50 voltage controlled subcarrier oscillator measures 1-3/8 x 7/8 x 1-1/16 in. The weight is 1-3/4 oz. The unit is transistorized, encapsulated, and has no adjustments. It operates from −55 to +125 C.

Vector Manufacturing Co., Dept. ED, Southampton, Pa.

CIRCLE 222 ON READER-SERVICE CARD

Pressure Transducers

Range is 0 to 2 through 0 to 100 psi

Made to meet the requirements of the explosion test described in MIL-E-5272A procedure 1, these absolute pressure transducers have a range of 0 to 2 through 0 to 100 psi. Resistance is 1 to 15 K, resolution is 0.2% to 0.5%, linearity is ±0.6%, and hysteresis is 0.4% to 0.5%.

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factories in Burbank, California and Palmer, Massachusetts

CIRCLE 223 ON READER-SERVICE CARD

The power rating is 0.8 w at 45 C and the operating temperature range is −55 to +120 C. Model 409 has outputs which are linear with pressure or altitude and are used for automatic flight control systems. Model 509 differential pressure version has outputs which are linear with pressure or air speed for telemetering flight test data.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 224 ON READER-SERVICE CARD

Signal Source

Covers from 1 to 11 kmc

Model 229T signal source covers the entire spectrum from 1 to 11 kmc in four segments: 1 to 2, 2 to 4, 4 to 8, and 8 to 11 kmc. The individual signal sources are all contained in a single housing. The instrument features cw operation plus internal modulation for pulse, square wave, and fm output. There are also provisions for external modulation. Each section includes a signal generator followed by a low-level traveling wave tube amplifier driving a high level traveling wave tube output stage.

Levinthal Electronic Products, Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 225 ON READER-SERVICE CARD

Gear Mechanisms

Come in sizes 8, 10, 11, 15, and 18

These standard gear heads, speed reducers, and speed increasers have a wide variety of ratios and come in sizes 8, 10, 11, 15, and 18. Designed for extreme reliability, they transmit higher torque in a comparatively shorter over-all length. All units operate from −55 to +150 C and have a maximum backlash at the output shaft of 30 min. They use either sleeve or ABEC 7 ball bearings. Mil specs are met.

Kinetic Instrument Corp., Dept. ED, 1070 Linwood St., Brooklyn 8, N.Y.

CIRCLE 226 ON READER-SERVICE CARD

NEW LITERATURE

Precision Counters 230

This two-page data sheet gives technical details, including dimensional drawings and illustrations, of precision degree and mil counters. The units have no transfer masks or shade and no interrupted gearing. Series AD-1 counts hours, degrees, mils, minutes, etc., returns to zero and repeats. Photographs, technical data, and dimensional drawings are included. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

Mica Products 231

Revised catalog and price list No. 25, which deals with compressed sheet mica products, includes these two new materials: India alkyd vinyl segment plate, and India epoxy segment plate. The latest listings are also carried on flexible mica Mylar combinations, epoxy mica molded rings, and alkyd vinyl mica molded V rings, as well as the firm's standard lines. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Definition Of Relay Terms

This standard contains definitions of the various types of relays such as electromagnetic, thermal, magnetostrictive, and electric field devices, as well as approximately 200 other terms associated with relays. Several diagrams are used in the publication to clarify definitions. The standard, No. C83.16-1959, was based, in part, on a booklet published in 1955 by the National Association of Relay Manufacturers, as well as on other sources. *Send $2.00 to the American Standards Association, Dept. PR 101, 70 E. 45th St., New York 17, N.Y.*

Voltmeter and Power Supply 232

Features, applications, circuitry, and specifications of a dc voltage standard and null meter are included in bulletin No. 15-7, two pages. The bulletin describes the model 301 high-precision instrument that can be used to measure dc voltages in the range of 1 to 501 v, full scale. Data is also given on the instrument's use as a dc voltage standard. A circuit diagram and description provides data on the instrument's operation. Detailed specifications are listed. Cohu Electronics, Kin Tel Div., 5725 Kearny Villa Rd., San Diego 12, Calif.

Resistors 233

The firm's Bobbinless precision wirewound resistor is described in brochure No. GR-30. It contains complete details and specifications on three of these resistors. By eliminating the bobbin and floating the resistive element in a special viscous fluid, the resistors gain in stability and reliability. The resistors are available in power ratings up to 1/2 w, with tolerances as low as 0.05%, and a temperature coefficient as low as 2 ppm per deg C. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

Plastic Parts 234

This four-page bulletin describes extruded shapes and precision fabricated parts made from nylon, Delrin, or Penton. It outlines the advantages, uses and limitations of the three plastic materials. Text is arranged in three columns, one for each material. The bulletin also tabulates stock sizes of extrusions available in rod, tubing and strip form. A tabular comparison of the material's properties is also included. The table covers basic mechanical, electrical, thermal and miscellaneous properties. National Vulcanized Fibre Co., 1059 Beech St., Wilmington 99, Del.

Automatic Testing Systems 235

Programmable Automatic Testing Systems are described in this four-page bulletin, No. 1100. Included are systems for missile checkout, dynamic system testing, quality control, simulation and production testing. Products covered are: an automatic multiple circuit analyzer, a universal test station, and a computer test set. The bulletin contains photographs. Consolidated Diesel Electric Corp., 880 Canal St., Stamford, Conn.

Indicator Lights 236

This four-page brochure, Form L-162, describes four series of assemblies designed to mount in a 15/32-in. clearance hole from the front of the panel. The assemblies contain two-terminal subminiature indicator lights. The series discussed are: the neon series which uses a T-2 neon glow lamp; and the incandescent series which also includes water-tight assemblies and edge lighting assemblies. All assemblies meet applicable Mil specifications. Complete lamp data, illustrations of the assemblies, features, specifications, and schematics are included. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y.

NEW LITERATURE

Mititary Components Catalog

This catalog, No. 50, 32 pages, describes U. S. military specifications covering those components which the firm makes. It includes such products as fixed power resistors, adjustable power resistors, precision resistors, rheostats, tantalum capacitors and relays covered by the latest military specifications. The catalog reduces military specifications to the "type" designation: the combination of letters and numbers by which military parts are described and ordered. "Type" designations for each military specification are explained in a graphic manner and the options permitted for each type of component are clearly outlined. The physical and electrical parameters of the style are stated and a sample "type" designation for that style is shown. Symbols and data to complete the sample "type" designation are provided on fold-out master sheets in each section. The books contain summary charts in the introduction to each section which permit a preliminary choice of size and style. It contains dimensional drawings and derating graphs. *Write on company letterhead to: Ohmite Manufacturing Co., Dept. ED, 3675 Howard St., Skokie, Ill.*

Magnetic Tape Recorder/Reproducer 239

Bulletin 1576, illustrated, describes the type 5-752 magnetic tape recorder/reproducer. A complete system in a single cabinet, the 5-752 accommodates seven different types of record and reproduces amplifiers for analog, fm or PDM modes of operation, and can be adapted to PCM (digital). Sections of the brochure describe physical and operating features. Photographs and block diagrams are included. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Electro Clutch Line 240

Detailed information on the firm's complete line of electromagnetic clutches, in six series with torque capacities from 1.8 through 13,000 lb-ft, is furnished in this 20-page bulletin. The bulletin, number R-6304-1B, provides design, specification and application material, including photographs, drawings and sketches. The clutches provide instantaneous pushbutton or automatic programming control of shaft-driven machinery in a variety of fields including radar antennas and test equipment. Clutch accessories and components are also described. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

Soldering 243

This technical guide to soldering, titled "Guide To Automatic Soldering," offers data on solder preforms—their selection and use. Also discussed are flux-filled washers for automatic soldering and the process of converting to automatic soldering. "Tips On Soldering," another brochure, deals with the subject of solving soldering problems. The "Flux Finder Guide" brochure is designed to aid the user in finding the right flux for every need. Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.

Photoelectric Equipment 244

Miniaturized electric-eye applications for counting, sorting, monitoring, assembling, and automatic weighing as applied to packaging, printing and general production is described in this 16-page bulletin. The equipment described in bulletin No. 571 ranges from direct or partial cut-off to reflector type units. It contains an expanded section dealing with specific in-plant installations. Technical and specification data includes dimensions, circuitry, speed, monitoring and relays. Photomation Inc., 96 S. Washington Ave., Bergenfield, N.J.

Telemetry Equipment 245

The various components of the firm's ground decommutations system and how they operate are described in an eight-page brochure titled "M-Series Ground Stations for PAM/PDM Decommutation." Basic, recommended systems layouts for telemetry decommutation stations are given along with accessories that may be used with them. Complete system specifications are provided. Applied Science Corp. of Princeton, a division of Electro-Mechanical Research, Inc., Box 44, Princeton, N.J.

Encapsulated Transformers 246

This four-page brochure, titled "Encapsulated Transformers," describes performance characteristics and applications of HR/Epseal and Electroseal transformer construction. Three basic design improvements, which achieve higher reliability, reduced size and weight, and improved cooling, are illustrated. Typical transformer configurations are shown in photographs. Units are designed to custom requirements from microwatt ratings to 250 kva for both commercial and MIL-T-27A, Grade 2 or 5, applications. Electro Engineering Works, 401 Preda St., San Leandro, Calif.

NEW LITERATURE

Instrument Standards

This standard, No. C39.1-1959, applies to dc and ac ammeters, voltmeters, wattmeters, varmeters, frequency meters, power-factor meters, and other instruments operating on the same principles but indicating derived quantities. It is the fifth edition of the standard. Special purpose instruments such as ultra-sensitive dc microammeters and thermovoltmeters of the vacuum-couple type are also covered, with suitable exceptions. All these instruments may be panel or switchboard mounted, or they may be portable. The standard does not cover indicating instruments provided with arrangements for curve drawing, contact making. Nor does it cover small instruments of types and sizes where the indications are only approximate. The standard contains 52 pages and includes illustrations of the various types of instruments and a tabulation of detailed requirements. *Send $2.50 to the American Standards Association, Dept. PR 103, 70 E. 45th St., New York 17, N.Y.*

Mercury-Wetted Contact Relays 249

A full line of the firm's mercury-wetted contact relays is illustrated and described in Catalog 201. Relay types are for both single- and multi-element operation, biased with permanent magnets, or adjustable to provide single-side-stable, bi-stable, or chopper characteristics. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.

Test Equipment Carts 250

Four carts for oscilloscopes and other test equipment are described in this one-page data sheet. Model numbers, applications, features, dimensions, weight, and price are given. The carts are made of 14 gage steel and finished with light grey enamel. Photographs are included. Northeastern Engineering, Inc., 25 S. Bedford St., P.O. Box 150, Manchester, N.H.

Position Indicators 251

Technical details of the series 2600 drum type latitude and longitude precision counters are given in this two-page data sheet. Dimensional drawings and illustrations are included. The counters are completely contained within a movable mask. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

Tape Wound Cores 252

Tape wound cores which can be obtained in two new core materials to precise limits are described in this eight-page, illustrated catalog. Core design data is included as well as new case sizes. Bulletin TB-105 contains diagrams, charts and tables. G-L Electronics, 2921 Admiral Wilson Blvd., Camden 5, N.J.

Moisture, Corrosion Inhibitor 253

An inhibitor that displaces and seals out water and moisture, protects metal surfaces against corrosion and lubricates is discussed in this six-page, illustrated folder. Called CRC 2-26, this liquid formula has been developed for manufacturing and maintenance use in electronic equipment. The folder includes an explanation of how CRC 2-26 works, its benefits, and details on its physical specifications. Corrosion Reaction Consultants, Inc., 116 Chestnut St., Philadelphia 6, Pa.

Microwave Meters and Filters 254

Precision frequency meters in the 500 to 18,000 mc tuning range and tunable band pass filters with tuning ranges from 960 to 9600 mc are discussed in this 12-page catalog. In addition to photos and graphs, such electrical characteristics as cavity types, frequency response, and insertion loss are covered. Frequency Standards, Div. of Harvard Industries, Inc., P. O. Box 504, Asbury Park, N.J.

Electronic Equipment 255

Detailed descriptions and illustrations of electronic equipment for research and industrial uses are covered in this 12-page, two-color book. Included are: dc power supplies, digital readout voltmeters, ac line voltage regulators, and information on custom design and prototype development engineering services offered by the firm. Davenport Manufacturing Co., 2530-32 N. Elston Ave., Chicago 47, Ill.

Semiconductor, Capacitor Catalog 256

This eight-page catalog covers the firm's line of diodes and capacitors. Basic specifications and brief descriptions are included in catalog No. U.S.S.-8-59. The catalog is divided into sections, and a page is given to ordering information on solid electrolyte tantalum capacitors. U. S. Semiconductor Products, a Division of Topp Industries, Inc., 3540 W. Osborn Road, Phoenix, Ariz.

NEW LITERATURE

Servo Systems 259

How to design, breadboard, and analyze servo systems rapidly is discussed in this six-page report. Photographs illustrate the uses of the servo system simulator. The report explains how the unit can simulate portions of a servo system, simulate complete systems, analyze components, debug prototypes, life-test systems, and perform quality control tests. Servo Corp. of America, 111 New South Road., Hicksville, N.Y.

Panel Instruments 260

Microminiature panel meters, 1/2-in. in size, are featured in this two-page bulletin. Specifications, photos, a table of standard ranges and approximate resistances, and an outline drawing describe these meters. DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N.Y.

Terminal Chart 26

Scale drawings of solder terminals wit dimensions and materials appear on th 21 x 27 in. wall chart. The solder termina kit is also included. Cambridge Ther mionic Corp., Concord Ave., Cambridge 38, Mass.

Transistor Manual

This 227-page manual, the fourth edition, contains rewritten information on transistors and their use in electronic circuits. Included in the 20 chapters are data on basic semiconductor theory, transistor construction techniques, biasing, switching characteristics, and circuits. An up-to-date listing ol all American JEDEC-registered transistor types with basic specifications and interchangeability information also appears. *Send $1 to General Electric Co., Dept. ED, Charles Bldg., Liverpool, N.Y.*

RF and IF Amplifiers 263

Catalog No. 96 provides 22 pages of information on microwave receiver front ends, rf, if, and twt amplifiers, telemetering preamplifiers, noise test sets, and beacons. Information is included on electrical characteristics, mechanical construction, and general applications. A number of new product additions are described, including an X-band low noise microwave mixer-amplifier assembly, a hybrid transistorized amplifier with a ceramic triode input, and a crash locator beacon. Pictorial material is also given. Lel, Inc., 380 Oak St., Copiague, L.I., N.Y.

Glow Lamps 264

This file folder contains specification sheets on glow lamps for the appliance, electrical and electronic industries. A 3 x 5 in. file card, which summarizes the range of glow lamps and allied devices available from the firm, tears easily from the folder cover for filing purposes. Signalite Inc., Neptune, N.J.

Telemetering System 265

This four-page, two-color bulletin describes the model TU-1A telemetering system. The system can be applied to pressure vessels, radomes, and moving and rotating equipment. It is fully described as to configuration and operational performance. Photographs are included. Telemetering Corp., P.O. Box 645, Mesa, Ariz.

Inductors 266

A line of small light-weight toroidal inductors which have high Q values is described in this two-page data sheet. A typical 1-mh inductor operating at 40 kc has a maximum Q of 240. Complete technical specifications, dimensional drawings and ordering instructions are included. Units are supplied with inductance values from 1 mh to 5 h. Designated as series 785, these inductors are fully encapsulated and hermetically sealed and meet MIL-T-27A and MIL-E-5272A specifications. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

NEW LITERATURE

Digital Systems 270

"Symbolic Logic, Boolean Algebra and the Design of Digital Systems," a 34-page illustrated booklet, discusses the binary number system and its relationship to dyadic or two-valued logic, the method of expressing the variable functions in terms of two-valued logic, and the means of implementing these functions electronically. A description of the theoretical methods for minimizing a logical function follows. Basic logical circuits are analyzed and implemented. Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif.

Power Supplies 271

Standard and special power supplies are described and illustrated in two-page data sheet 100A. A power supply requirement check list covering any supply problem is included. Burmac Electronics Co., Inc., 142 S. Long Beach Rd., Rockville Centre, N.Y.

Servo Components 272

Control and torque synchros and resolvers, and data about the firm and its personnel are featured in this illustrated brochure. Photographs, tables, and dimensional diagrams are included. Vernitron Corp., 136 Church St., New York 7, N.Y.

Silver-Zinc Batteries 273

Design details for over 20 manual and automatically activated silver-zinc primary batteries appear in this six-page brochure. Specification tables show electrical performance, environmental capabilities, physical specifications, energy-to-weight ratios, and automatic activation times. The brochure illustrates batteries featuring rectangular, and cylindrical sector case configurations. Cook Batteries, Sub. of Telecomputing Corp., 3850 Olive St., Denver 7, Colo.

Pulse Control Instruments 275

This illustrated eight-page booklet describes 24 packaged pulse-handling units. A megacycle variable scale counter and a high frequency pulse generator are included in the brochure. Burroughs Corp., Electronic Tube Div., Plainfield, N.J.

Transistor Chart 276

This revised replacement chart for transistors, two pages, lists types similar or identical to the firm's transistors. Bendix Aviation Corp., Red Bank Div., Long Branch, N.J.

Electromagnetic Clutches 277

Design, specification and application data for electromagnetic clutches are given in this 20-page bulletin. Operating characteristics, dimensions, torque ratings, speeds, and prices are covered for the six series of clutches. Photographs and drawings illustrate the units. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

Isolators 278

Microwave waveguide ferrite isolators are described in this two-page illustrated bulletin. Performance curves show vswr, isolation, and insertion loss plotted over the isolator's entire frequency range. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

Silicon Power Rectifiers 279

Specifications and a description of silicon power rectifiers, which operate from one to 15 amp, appear in data sheet 71059. The diagram gives dimensions for these 7/16-in. hex stud base diodes. Syntron Co., 283 Lexington Ave., Homer City, Pa.

Differential DC Amplifier 280

Features of the firm's wide-band low-level differential dc amplifier appear in bulletin 105801, four pages. Photos of the unit and a graph illustrating wide-bandwidth are included. Epsco, Inc., 275 Massachusetts Ave., Cambridge 39, Mass.

NEW LITERATURE

Relay Control Amplifier 285

A high-gain dc to ac relay control amplifier is described in this four-page bulletin. It gives detailed information on principles of operation, performance ratings, and applications. Illustrations and graphs are included. The amplifier recognizes the polarity of a low-level dc input signal, converts it to ac, and amplifies it to a signal with sufficient strength to actuate its master relay in accordance with that polarity. Thermo Electric Co., Inc., Saddle Brook, N.J.

Digital Magnetic Tape Recording 286

A 1500 bit per inch packing density for digital magnetic tape recording is described in this 26-page report. It includes theoretical considerations with experimental test results. Information drop-out is examined, and descriptions and diagrams for the implementation of this technique are provided. Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L.I., N.Y.

Silicon Power Diodes 287

Silicon power diodes, rated from 25 to 35 amp, are described in Bulletin XSR-310, two pages. Photographs, dimensional data, mechanical construction, and electrical characteristics are included. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Permanent Magnets 288

The magnetic and material characteristics of Hyflux Alnico V-7 permanent magnets are covered in this two-page bulletin, No. 350. Use of the magnets in lightweight ground or airborne generators, alternators and recording equipment is described. A demagnetization and energy product graph is included. The Indiana Steel Products Co., Valparaiso, Ind.

Precision Instrument Components 289

Printed on small size paper to save file space, this 416-page catalog lists over 10,000 items, including gears, shafts, collars, couplings, speed reducers, and differentials. In addition to drawings, specifications and prices, the catalog contains separate technical data, breadboard kit and tool components sections. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, N.Y.

Silicon Transistors 292

This two-page bulletin, complete with package photos, lists descriptions, important data and applications of five new silicon transistors. An itemized inventory with operating characteristics of a line of silicon transistors available from stock is also included. Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass.

Dielectric Materials 293

Properties of dielectric materials at microwave frequencies over a wide range of dielectric constants and dissipation factors are given on this colorful chart. Emerson & Cuming, Inc., Canton, Mass.

Thermal Magnetic Circuit 294

Circuit breakers designed for use with computers, data processing equipment, communications and test equipment are described in this data sheet. E-T-A Products Co., 6284 N. Cicero Ave., Chicago 46, Ill.

Miniature Toroidal Inductors 295

Designed for use with printed circuit boards or stacking on a single screw for chassis mounting, these miniature toroidal inductors are described in illustrated data sheet I 8-2. Specifications, dimensional drawings, and ordering information appear. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Transmitter Adapter 296

Features and specifications for the firm's single-sideband high frequency communications transmitter adapter are presented in this four-page brochure. Photos, graphs, and a block diagram illustrate the adapter system. Kahn Research Labs, Inc., 22 Pine St., Freeport, N.Y.

Coaxial Connectors

This 46-page reference manual is designed to simplify specifying and ordering rf coaxial cable connectors. It provides the numbers assigned by leading connector manufacturers, large users, BuShips, as well as military standards. The manual matches their equivalents with more than 2000 stock items carried by the firm. *Write on company letterhead to Gremar Manufacturing Co., Dept. ED, 7 N. Wakefield Ave., Wakefield, Mass.*

NEW LITERATURE

Spectrum Analyzers 300

This 12-page catalog gives specifications and descriptions for spectrum analyzers, special purpose instruments, accessory instruments, tracing systems, single sideband analyzers, rf-vhf-uhf and microwave analyzers, and telemetering spectrum analyzers and calibrators. Illustrations include photos of the units discussed, graphs, and diagrams. Panoramic Radio Products, Inc., 514 S. Fulton Ave., Mount Vernon, N.Y.

Silicone Rubber 301

Twelve-page illustrated bulletin CDS-170A describes room temperature vulcanizing silicone rubber compounds and silicone rubber sponge. Suggestions for handling the compounds, curing and viscosity characteristics, and data on primers for bonding applications also appear. General Electric Co., Waterford, N.Y.

Design Instruments 302

Included in this one-page brochure are photographs and specifications for a transistorized voltmeter, a transistorized signal generator, a vibration meter, a vacuum-tube voltmeter, a dc amplifier, a microsource, and an audio response plotter. Southwestern Industrial Electronics Co., P. O. Box 22187, Houston 27, Tex.

Copper-Cored Wire 303

Bulletins IND-22 and IND-23, two pages each, describe copper-cored alloy glass sealing wires. In addition to data on specific soft glasses with which the wires are compatible, a comparison of the physical and mechanical properties of solid No. 446 alloy and copper-cored No. 446 alloy also appears. Sizes, dimensional tolerances, weight, and coefficients of expansion are covered. Texas Instruments, Inc., Metals & Controls Div., 34 Forest St., Attleboro, Mass.

Transistor Dissipation Ratings 305

Eight-page booklet AN-181 has been prepared to help circuit designers determine peak-dissipation values of 39 of the firm's transistor types, which are used in pulse and switching service. A table gives the transistors' maximum permissible collector-junction temperatures, typical thermal time constants, and maximum thermal resistances. Peak dissipation is determined in terms of pulse width, duty cycle, and either ambient or case temperature. Radio Corp. of America, Semiconductor and Materials Div., Somerville, N.J.

Synthetic Mica 306

This eight-page news bulletin covering developments in the field of high temperature insulation will be published periodically. The inaugural issue features the first of a four-part series on the development of synthetic mica. Abstracts of technical papers delivered by the firm's engineers at the WESCON show and other scientific sessions are included. Mycalex Corp., 125 Clifton Blvd., Clifton, N.J.

Circular Slide-Rule

This pocket-size circular slide-rule is constructed of two durable aluminum discs and a clear plastic indicator. It performs multiplication, division, fractions, squares, square roots, cubes, cube roots, proportions, percentages, areas and circumferences. *Send $4.95 to Edmund Scientific Co., Barrington, N.J.*

Semiconductors

This semiconductor products' handbook HB-10, in loose-leaf form, covers semiconductor devices including transistors and silicon rectifiers. Intended uses, characteristics, operation, maximum ratings, terminal connections, commonly used curves plotted to easily readable scales for solving design problems, and mechanical dimensions are included. *For a subscription to this handbook send $5.00 to Radio Corp. of America, Harrison, N.J.*

Single Gate Energizes Many Output Punch Coils

WHEN PUNCHING output data from a logical unit with a device such as a Teletype perforated tape punch, command pulses from the logic unit must be synchronized with the rotation of the motor supplying mechanical power to the punch. These short pulses must also be made to energize the punch coils (in the case of the Teletype punch) for a period of 12 msec, starting at a definite point on the rotation cycle of the motor shaft.

The usual method of accomplishing this is to generate a 12-msec gate for each coil to be energized. For example, a gate is generated individually for the feed coil and each level punch coil of the perforated tape punch. The method described here uses only one gate, which is applied to all of the coil driver circuits. One coil-driver circuit is shown in Fig. 1.

A notched flywheel on the motor shaft, and a magnetic pickup are used to provide timing pulses, Fig. 2. These timing pulses trigger a 12-msec gate circuit. They also permit the logic unit to send out its command pulses for the tape levels and feed, as desired.

The 12-msec gate is applied to each of the tubes *V1* in the coil-driver circuits. The tubes V2 in the proper coil-driver circuits then receive command pulses from the logic unit, and the proper coils are activated. The circuit shown acts as an "AND" gate for firing, since both the gate and a command pulse must be present. After firing, however, only the presence of the gate is required to sustain conduction.

The 12-msec gate is applied to the grid of *V1*. This tube conducts through *R1* and the punch or feed coil to which the circuit is connected. The

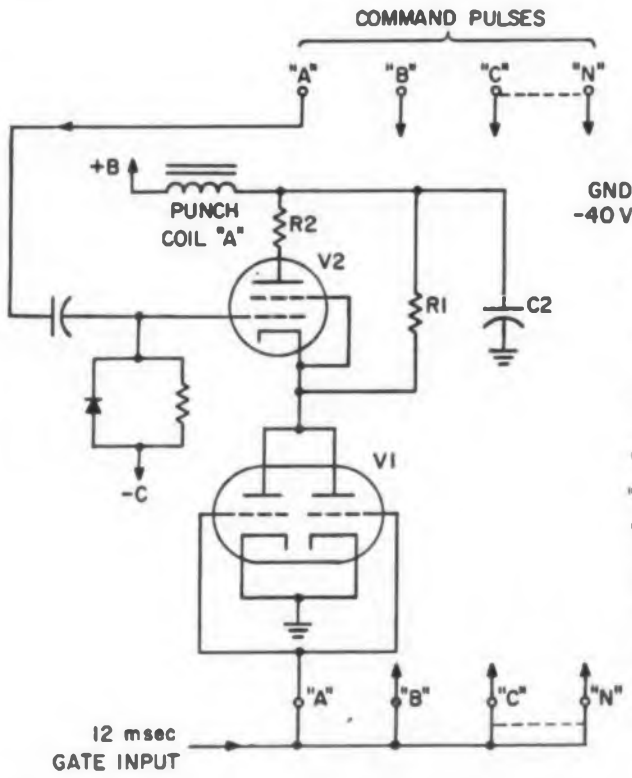


Fig. 1. One of a series of coil-driver circuits which acts as "AND" circuit for command pulse and common 12-ms gate.

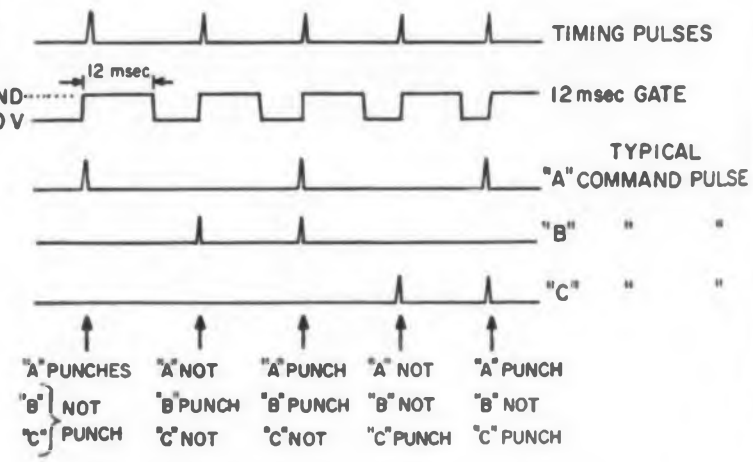


Fig. 2. Waveforms showing typical time relationships between master timing pulse, common 12-ms gate and sample command pulse.

current flow is far too low to enable the coil to pull in its armature, since the value of *R1* is very high. Essentially all of the +B voltage is dropped across *R1*, applying plate voltage to *V2*.

If this particular coil is to be energized during this cycle, the logic unit sends a command pulse to the control grid of *V2*. *V2* fires, and the circuit is then completed through *V1*, *V2*, *R2*, and the coil. The circuit now supplies sufficient current to energize the coil, which pulls in the armature.

Since *V2* is now independent of its grid, this circuit will continue to supply current until the end of the 12-ms gate. At this time, *V1* is cut off, removing the plate voltage from *V2*, and opening the circuit until the next gate is generated.

C1 absorbs the inductive kick of the coil when the circuit is suddenly opened. Without *C1*, the voltage surge from the coil would prevent *V1* and *V2* from being cut off.

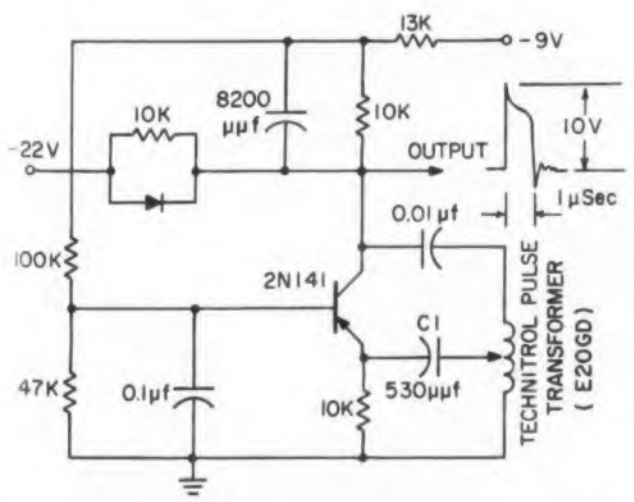
Dan M. Bowers, Project Engineer, Falls Church, Va.

Inexpensive Transistor Pulser Simplifies Computer Test

An expensive transistor pulse generator was needed for testing out computer logic to simulate timing pulses or input information. The object was to avoid tying up expensive pulse generators for this simple task.

The circuit illustrated was developed to fill this need. The compact unit can plug in a spare socket in any rack, and couple into any circuitry under test. The output is a one-μsec pulse. Repetition rate can be varied up to 50 kc by using a variable capacitor for *C1*.

Walter D. Scott, Technical Engineer, RCA, Los Angeles, Calif.



Compact pulse generator frees expensive pulse generators from routine computer test applications.

IDEAS FOR DESIGN

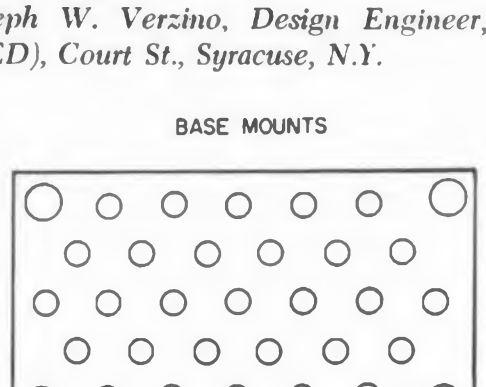
Perforated Metal Chassis Eliminates Costly Hole-Drilling

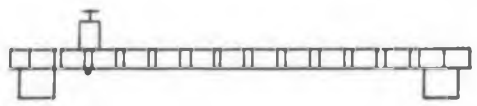
When using metal breadboard chassis, hole-drilling can be costly and time-consuming. Drilling can be eliminated completely by using perforated metal plate and stand-offs.

The plate is chosen so that the hole size is compatible with the stand-offs. A ceramic base mount can be used to get the plate up off the table. Perforated plate can also be obtained with holes that are the size of transistor sockets, so that a bank of transistors can be made without drilling a single hole.

Joseph W. Verzino, Design Engineer, G.E. (HMED), Court St., Syracuse, N.Y.

BASE MOUNTS





Perforated metal plate serves as a versatile chassis material when used with stand-offs.

Series Connection Allows Use of Germanium Transistors in HV Circuits

Series connecting transistors allow operation with higher voltage inputs than the voltage rating of the individual transistors. This extends the economy of germanium transistors into circuits normally thought to require use of their high-priced silicon brothers.

One application called for operation when the full input voltage into a transistorized power supply may be dropped by the series regulating transistor. Such a condition could occur when the output is short-circuited, and when the full input voltage at its highest input level will be impressed on the series transistors.

Under these conditions a current-limiting network will insure that no current is flowing

through the transistors. However, they will still have to support the input voltage. The application also specified that the input may contain transient spikes of short duration but high enough to exceed the voltage rating of a single transistor.

The availability of germanium transistors for higher voltage operation is limited. The rating of these transistors for voltage depends on the emitter to base bias. This in turn varies under transient conditions. (ELECTRONIC DESIGN, July 22, 1959, p 28)

To design for a proper voltage rating of the power supply while utilizing the most economical and readily available transistors, a series string is designed as shown in Fig. 1. *R1*, *R2*, and *R3* are

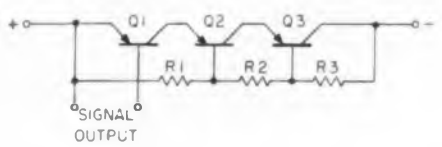


Fig. 1. Series string of transistors enables low-voltage rated transistors to accommodate high voltage input.

equal resistors forming a voltage divider across the transistors. They drop the same voltage as the transistors do.

Signal is applied to the base-emitter circuit of *Q1*. Current flowing through *Q1* biases *Q2* and *Q3* through their respective resistors *R2* and *R3*. A reduced voltage absorbed by *Q1* causes the base emitter voltage of *Q2* to increase and reduce its emitter-to-collector voltage. The same applies to *Q3*. Thus, equal voltage division is obtained

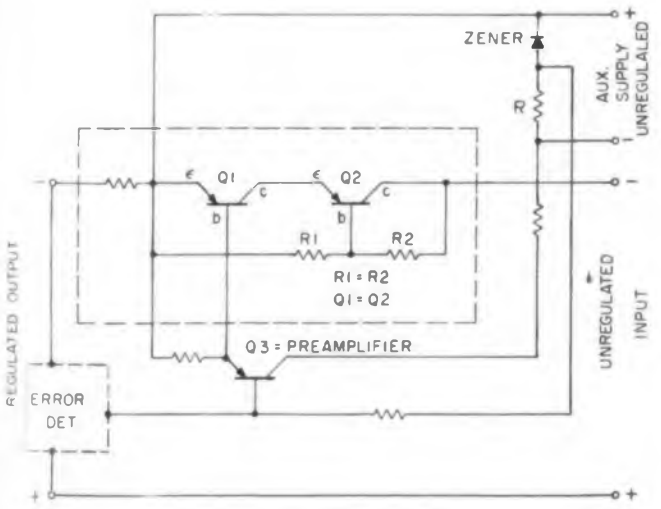


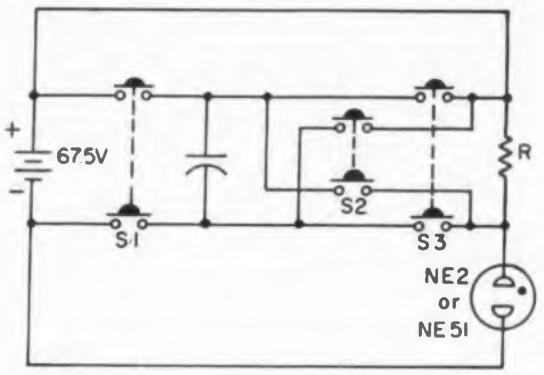
Fig. 2. A transistorized power supply designed around series connected transistors.

between *Q1*, *Q2* and *Q3*. A circuit indicating how this was incorporated into the power supplies is shown in Fig. 2.

Baruch Berman, Chief Engineer, Avion Div. CF, Paramus, N.J.

IDEAS FOR DESIGN

Capacitor and Switches Provide Inexpensive Memory for Lamp



Inexpensive memory is provided for neon lamp by 67.5-v source, capacitor and three switches.

A memory for a pilot lamp can be provided at minimum cost by use of a 67.5-v battery or dc source, a capacitor and momentary contact switches. The circuit illustrates the basic principle involved.

In this circuit, use is made of the difference between the starting and sustaining voltages of a neon lamp. The 67.5-v source is adequate to sustain the discharge in the neon lamp once it has started, but is not adequate to start the discharge

The capacitor which is charged from the 67.5-v source through switch *S1* supplies a pulse when discharged through switch *S2*. This charge adds to the 67.5-v source, and thus starts the discharge. Now the 67.5-v source is adequate to sustain the discharge and the neon lamp will remain lit, until it is extinguished.

To extinguish the lamp, the capacitor is again charged through *S1*. Discharging the capacitor through *S3* subtracts from the 67.5-v source voltage, and drives the voltage below that which is necessary to sustain the discharge. Thus the lamp is extinguished. Actual switch arrangements can be altered to suit the application.

Jack Koff, Engineer, Farrand Optical Co., New York 70, N.Y.

Measure Open-Loop Gain With the Loop Closed

In order to insure stability of a feedback amplifier, it becomes necessary to check the open-loop gain and phase response. In the case of a high-gain amplifier, this becomes quite difficult since noise alone might possibly cause saturation.

The open-loop gain phase response may be made with the loop closed and thereby eliminate

the difficulties inherent in the open-loop measurement. The method is shown in the illustrations.

By definition, β is the ratio of feed-back voltage to input voltage.

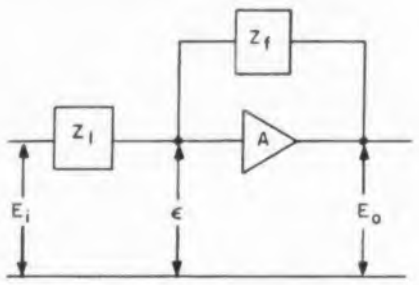


Fig. 1. Conventional feedback amplifier configuration does not permit measurement of open-loop gain.

From Fig. 1,

$$\beta = \frac{Zi}{Zf + Zi}$$

Define ε' as the voltage at the junction of the input and feedback impedances, with the input to the amplifier open and the output shorted, as in Fig. 2

$$\epsilon' = E_i \frac{Zf}{Zf + Zi}$$

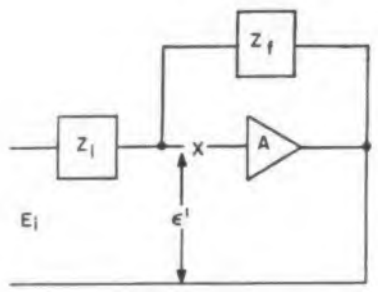


Fig. 2. Two-circuit changer permits open-loop gain measurement without danger of saturation.

By derivation,

$$\epsilon = \frac{Ei\ Zf}{Zf + (A+1)\ Zi}$$

Dividing and simplifying yields the expression

$$\frac{\epsilon'}{\epsilon} = 1 + A\ \beta$$

or

$$A\ \beta = \frac{\epsilon'}{\epsilon} - 1$$

A and β are both frequency dependent. Therefore any constant amplitude ac signal of varying frequency can be applied at E_i so that the amplifier output does not overload. The voltages ε and ε' are then measured for amplitude and phase. When one is subtracted from this ratio, the open loop response of the amplifier is obtained.

Arthur M. Goldschmidt, 531 Kings Highway, Morristown, N.J.

IDEAS FOR DESIGN

Multivibrator Design Shortcut

A common practice in designing saturating flip-flops is to first define the collector and emitter resistors (R_c and R_e) in terms of the load requirements of the circuit. Subsequent calculations of the cross-coupling networks may be simplified by determining the maximum value of R_2 in this manner.

Assume: $$V_e \simeq \frac{V_s R_e}{R_c + R_e}$$

$$V_{c\,on} \simeq V_e$$

Then: $$V_{b\,off} \simeq V_e \frac{R_2}{R_1 + R_2} + I_{co} \frac{R_1 R_2}{R_1 + R_2}$$

For proper temperature stabilization V_b off must be less than V_e when I_{co} reaches its maximum value. Therefore

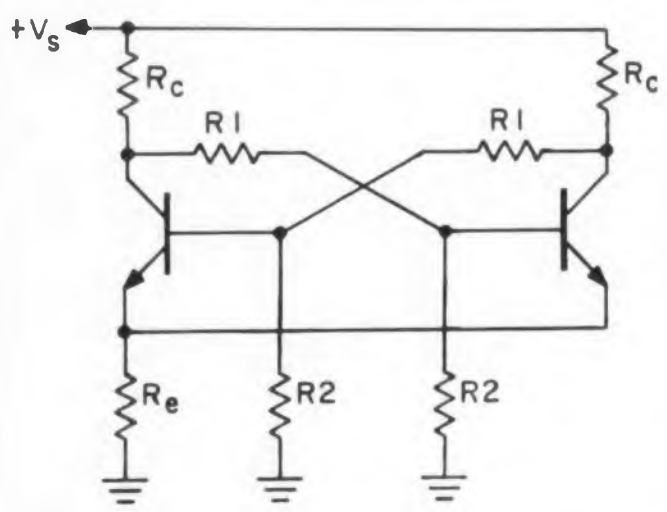
$$Ve \frac{R_2}{R_1 + R_2} + I_{co\,max} \frac{R_1 R_2}{R_1 + R_2} < V_e$$

$$V_e R_2 + I_{co\,max} R_1 R_2 < V_e R_1 + V_e R_2$$

$$V_e R_2 + I_{co\,max} R_1 R_2 < V_e R_1 + V_e R_2$$

$$I_{co\,max} R_1 R_2 < V_e R_1$$

$$R_2 < \frac{Ve}{Ico_{\,max}}$$



Cross coupling network calculations are simplified in multivibrator circuit.

This relationship quickly determines an approximate value for R_2 and the required value of R_1 may then be calculated using the minimum value of H_{fe}.

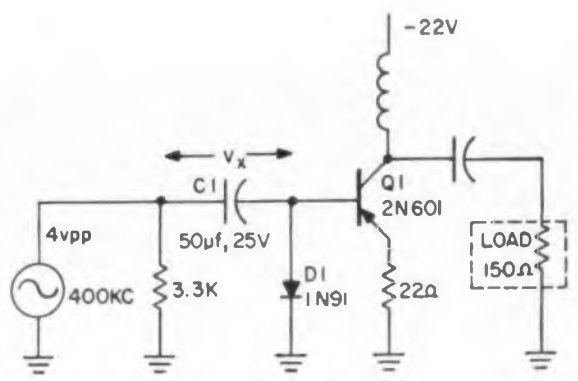
In this discussion, only dc was involved. Hence compensating capacitors were not included in the schematic.

Thomas L. Thompson, Cook Research Labs., A Division of Cook Electric Co., Chicago, Ill.

Transistor Runs Pseudo Class A In Power Driver

A medium power driver amplifier was needed to supply approximately 500 mw at 400 kc to a single-ended load. The design of a transformer-coupled push-pull stage was considered. However, it was felt that the job could be done with a single, medium-power rc coupled transistor amplifier operating pseudo "class-A". Such a circuit would be acceptable if the objectionable standby power, usually associated with class A operation, could be eliminated.

The solution chosen uses a 750-mw transistor in a signal-biased linear mode of operation. With this arrangement, collector dissipation decreases with signal level and becomes negligible under zero signal conditions. The circuit shown illustrates the method.



Eliminating standby power allows pseudo class A operation of transistor in power supply circuit.

Under zero signal conditions, *Q1* is cut off and the collector current is maintained at a small value by the reverse leakage path afforded by diode *D1* and the emitter degeneration resistor. When signal is applied, capacitor *C1* charges through *D1* to a positive voltage V_x as shown. This voltage biases the transistor into a quasilinear operating range for the particular average level of applied signal.

Performance of the amplifier is as follows:

Frequency	= 400 kc
P_{DC} (required dc power)	= 1.3 w
P_o (into 150 Ω load)	= 530 mw
P_{in} (into eff. 800 Ω R_{in})	= 4.8 mw
G_p	= 20.5 db
Efficiency	= 41%
Stand-by power	= 54 mw
Total harmonic distortion	= 11%

Donald W. Boensel, Member of Technical Staff, Space Electronics, Glendale, Calif.

IDEAS FOR DESIGN

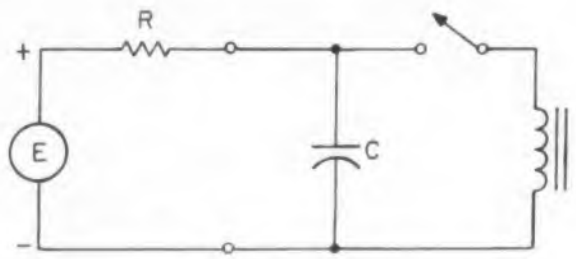
Capacitor Supplies Solenoid Pull-in Energy

A high-impedance source may be adequate to hold a solenoid once it is pulled in but not adequate for pull-in. A capacitor can often be used to advantage as shown to avoid replacing the power supply with a lower impedance source.

The energy for pull-in may be obtained by charging the capacitor across the high impedance line to full open circuit voltage. When the solenoid switch is closed, the capacitor discharges through the solenoid. This charge provides the initial burst of energy needed to operate the solenoid. As the surge decays, the normal supply takes over.

The capacitor will recharge when the switch is opened and will be ready for the next cycle. The rate of operation and the size of the capacitor are dependent upon the other circuit parameters.

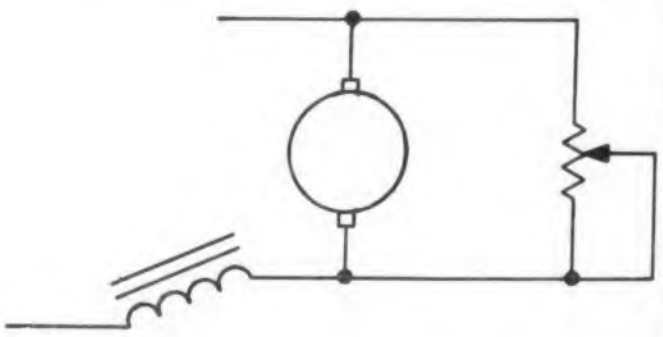
Arthur Goldschmidt, Electronics Engineer, Moorestown, N.J.



Capacitor charge enables high-impedance source to pull in solenoid.

Speed and Direction Control of A Universal Motor

A simple method for remote, 2-wire, speed and direction control can make a small universal motor much more valuable in some applications. Here is



Simple rewiring and advanced brushes provides speed and direction control for universal motor.

one method of accomplishing this modification that will fit most applications.

Advance the brushes ahead of the field-pole center by 45 degrees. If the brushes are then short-circuited, the motor will run in the reverse direction as a repulsion-induction motor. Thus, by running two leads from the brushes to the remote location, and connecting them to a variable resistor, speed control is obtained as the resistor is varied, going from full-speed in one direction to full-speed in the other.

Unless the motor is designed for this service, an ordinary motor will run hot. However, this is adequate for light or intermittent duty.

Robert A. LeMassena, Senior Engineer, Minneapolis-Honeywell, Heiland Division, Denver 22, Colo.

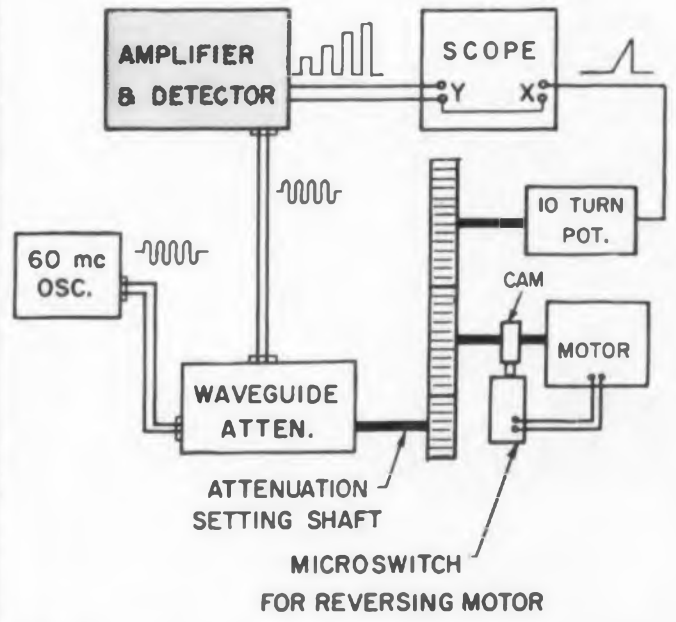
Motor Drive Helps Check Wide Range Amplifier

The motorized arrangement shown in the diagram was used to check the amplitude response of a 60 mc logarithmic amplifier over a 60 db dynamic range. Suitably modified, the arrangement can be used to check other instruments over other ranges.

The 60 mc pulsed oscillator supplies a test signal which is fed to the waveguide attenuator. The decibel output of the attenuator is proportional to the position of the shaft which drives it. This shaft is driven by a small motor which also drives a 10-turn helical potentiometer which supplies the sweep voltage for the scope.

The amplifier is assumed perfect when the top of its output pulses form a straight diagonal line.

D. Renkowitz, Engineer, Airborne Instruments Lab., Garden City, N.Y.



Simple arrangement checks response of wide-range logarithmic amplifier.

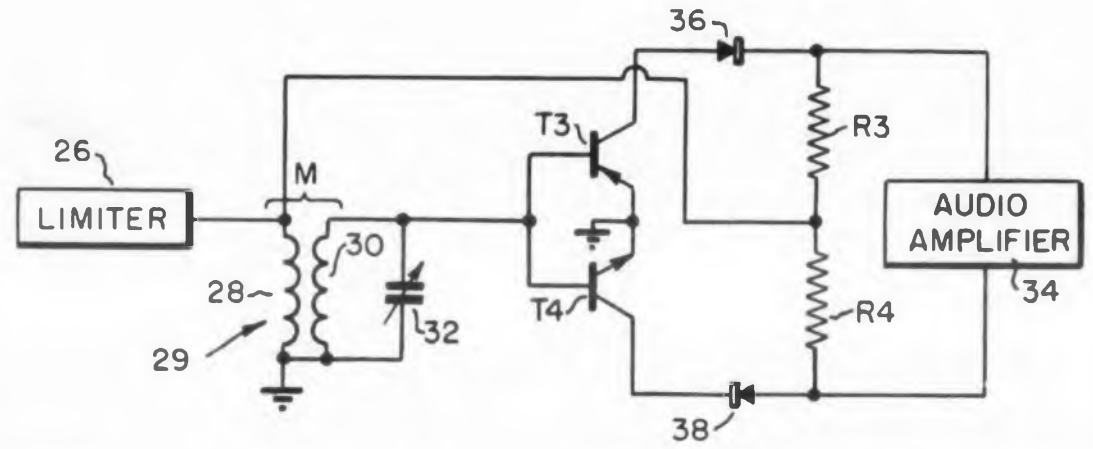
PATENTS

Phase Shift Detector

Patent No. 2,901,612. Leo E. Dwork, Chaang Huang. (Assigned to Sylvania Electric Products, Inc.)

An fm discriminator comprises complementary symmetry transistors which produce a resultant output linearly related to phase shift, essentially the deviation off resonance.

The pnp transistor *T3* and npn transistor *T4* are connected with the emitters and bases in common with diodes *36* and *38* to prevent collector current flow when the emitter to base is cut off. At resonance, the input signals are shifted 90 deg in phase; below resonance the shift is less than 90 deg and above resonance the shift is greater than 90 deg. Due to the symmetrical arrangement of the complementary transistors, the voltage developed across the load increases with frequency.

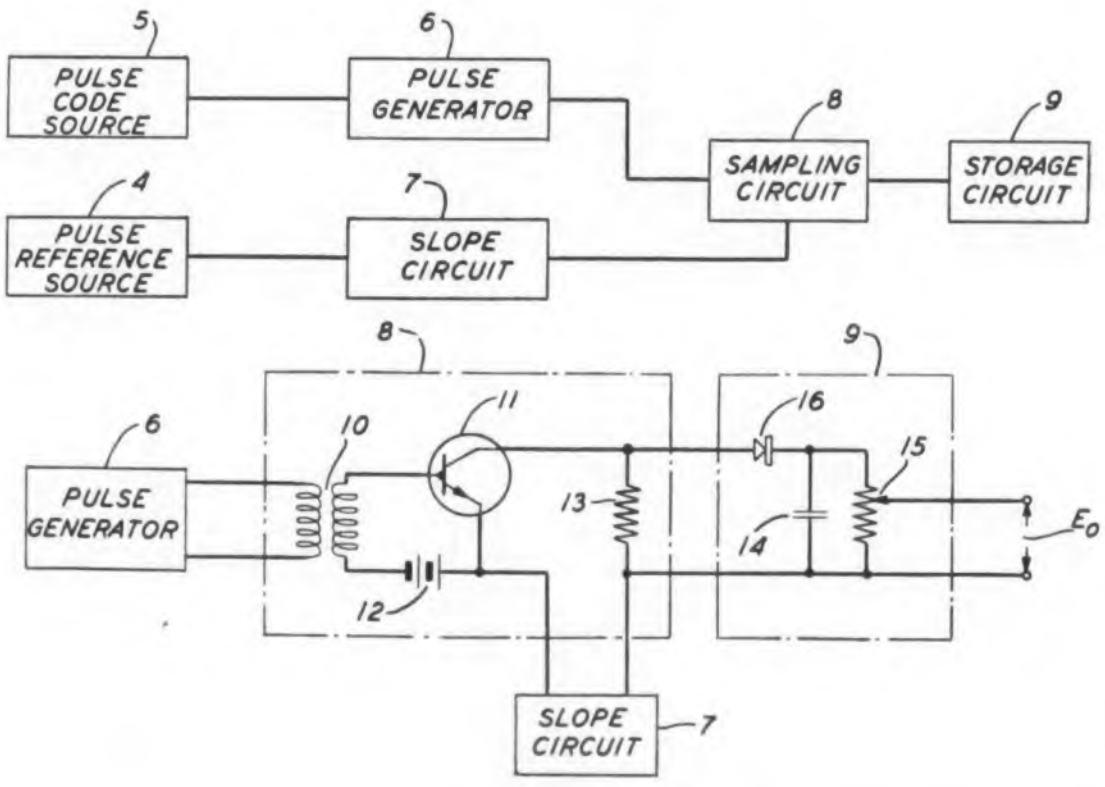


Sampling Circuit

Patent No. 2,900,507. Samuel C. Rogers. (Assigned to Bell Telephone Labs, Inc.)

The pulse position demodulator develops a dc voltage proportional to the time separation of two pulses.

Slope circuit *7* generates a linear voltage waveform triggered by pulse reference source *4*; no current flows through resistor *13*, however, since battery *12* initially sets pnp transistor *11* beyond cut off. Later, pulse code source *5* triggers generator *6* to drive the transistor to saturated conduction and capacitor *14* charges during the pulse time to the instantaneous value of the linear voltage waveform. Subsequent discharge of the capacitor is determined by leakage resistor *15*.

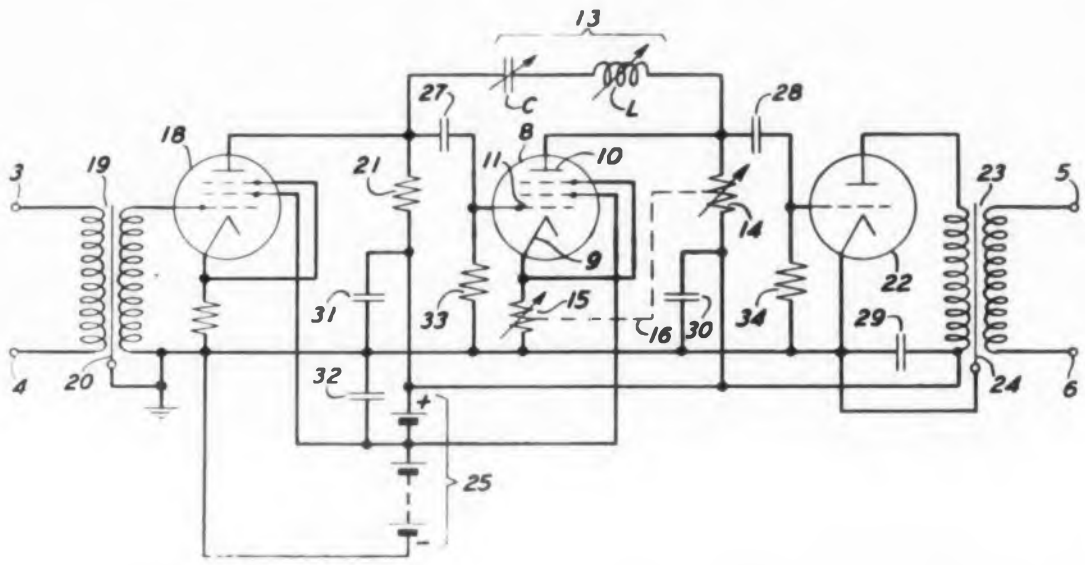


Delay Network

Patent No. 2,890,333. Manvel K. Zinn. (Assigned to Bell Telephone Labs., Inc.)

The circuit shown in the figure is an all-pass network, since there is no loss at any frequency; the delay varies directly with change of adjustable resistance.

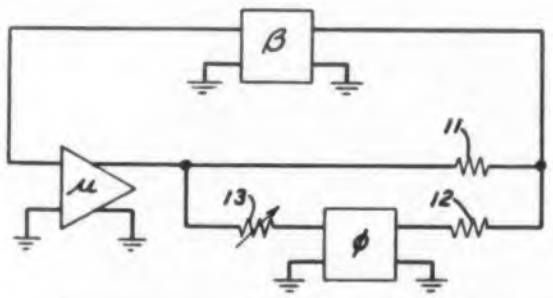
Tubes *18* and *22* isolate phase adjuster stage *8* which is characterized by a series *LC* between output and input and coupled resistors *15* and *14* which respectively adjust the tube transconductance and output impedance reciprocally. When the resistors track, the delay varies as resistor *14*. The height and shape of the delay characteristic may be varied further by making *L* and *C* variable.



Variable-Frequency Oscillator

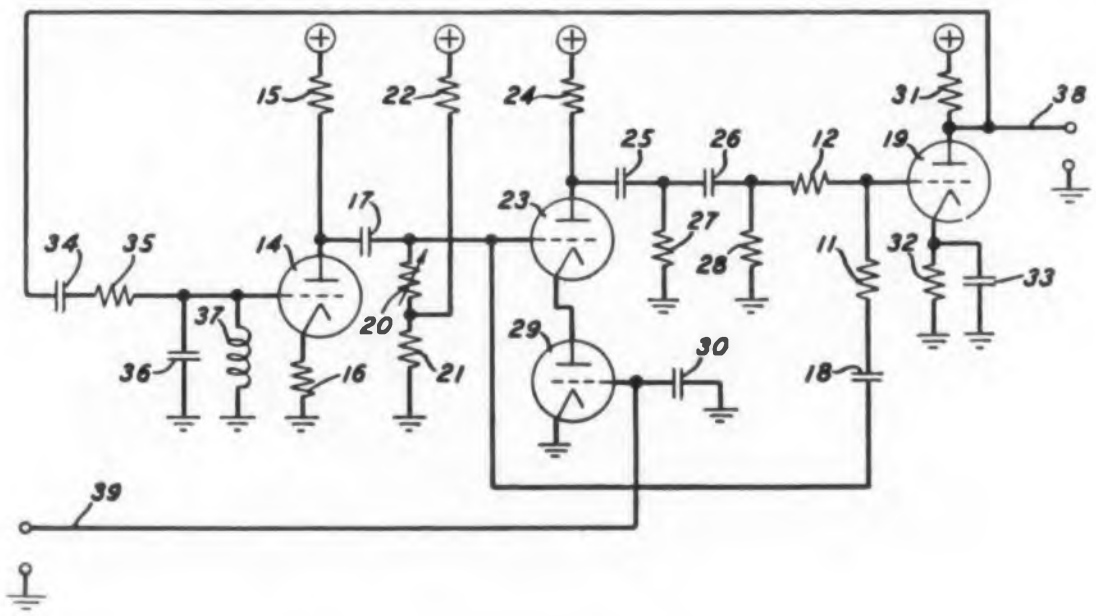
Patent No. 2,902,656. Robert O. Soffel. (Assigned to Bell Telephone Labs, Inc.)

The oscillator is made variable by means of an adjustable phase shifter in the feedback network. This constitutes an improvement over the conventional reactance tube devices.



Amplifier *14* is tuned by the *L-C* tank in the grid-cathode circuit and oscillations are produced by feedback through capacitor *18* in series with amplifier *19*. The frequency of oscillation may be changed by resistor *20* in conjunction with capacitor *17* and resistor *21*.

The feedback path contains an additional phase shifter comprising the internal resistance of tube *23*, capacitors *25* and *26*, and resistors *27* and *28*. A control signal applied to terminal *39* changes the internal resistance of tube *23*, shifting the phase of the feedback voltage; the frequency of oscillation changes to maintain zero phase shift at the grid of tube *14*.



PATENTS

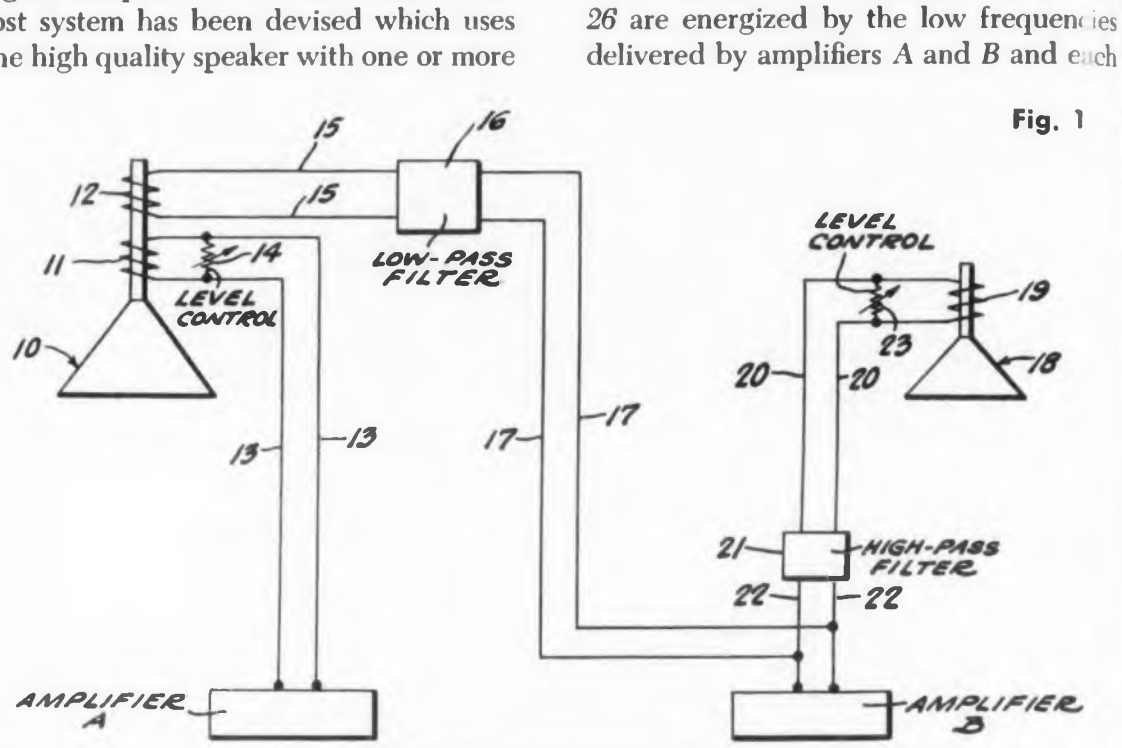
Stereophonic Sound Propagation System

Patent No. 2,904,632. Sidney E. Levy. (Assigned to University Loudspeakers, Inc.)

Since, in a stereo system, only the higher frequencies are directive, a low cost system has been devised which uses one high quality speaker with one or more cheap middle and high frequency reproducers.

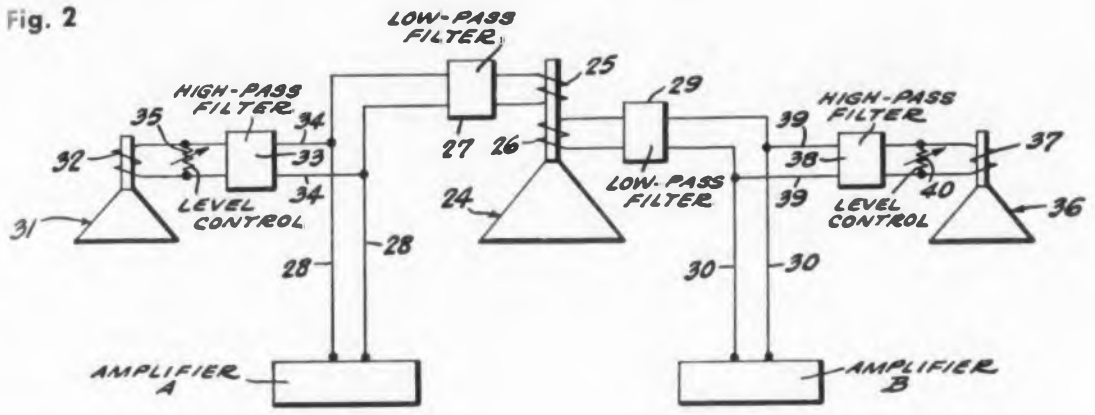
Two systems are illustrated. In Fig 1, speaker *10* reproduces the full range of amplifier *A* and the low-pass filter *16* energizes a separate voice coil *12* with signal from amplifier *B*; speaker *18* reproduces the high-frequency output of amplifier *B*. In Fig. 2, the two separate coils *25* and *26* are energized by the low frequencies delivered by amplifiers *A* and *B* and each

Fig. 1



additional speaker is controlled by an amplifier exclusively at the higher frequencies. It is obvious that speaker *24* might otherwise be a full-range reproducer of the outputs of the amplifiers in a more expensive system.

Fig. 2

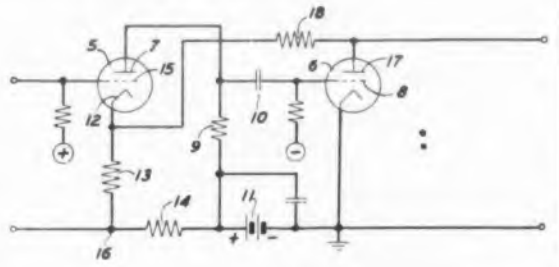


Broadband Balanced Amplifier

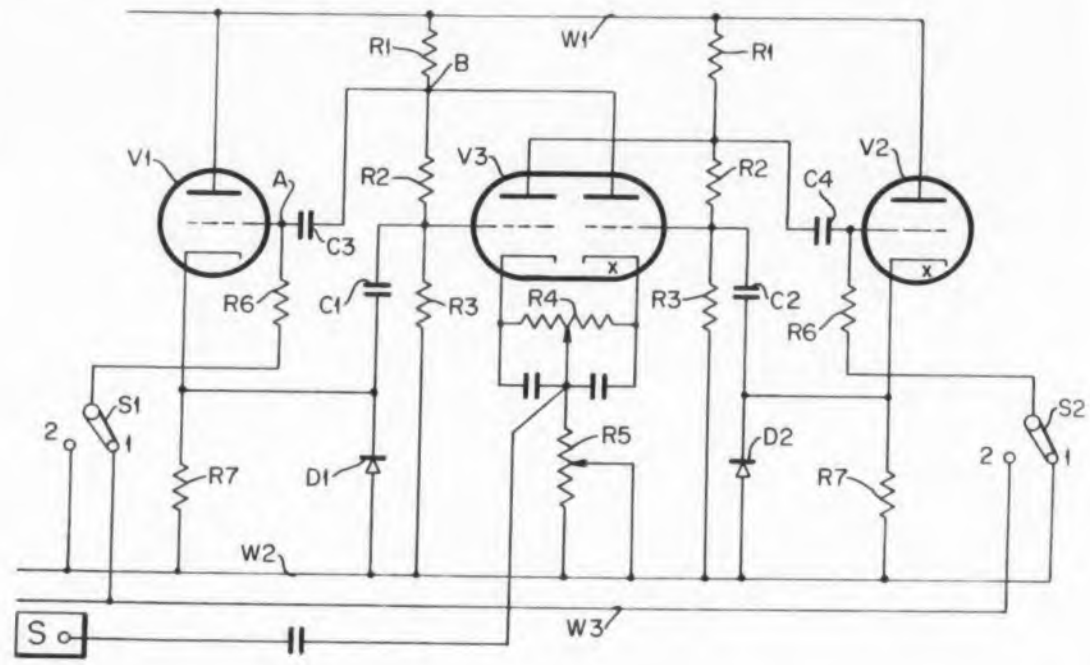
Patent No. 2,904,643. Hugh P. Kelly and Robert L. Nichols. (Assigned to Bell Telephone Laboratories.)

In an RC feedback circuit, the amplifier is frequency-sensitive since the capacitive reactance is high for low frequencies. The invention is a circuit arrangement which provides dc coupling of the degenerative feedback.

A simple embodiment is shown. Uniquely the plate supply of amplifier *6* is fed through resistor *13* in the cathode of the driver amplifier *5*. The sense of the feedback through the common resistor *13* is negative and the connection is direct without a coupling capacitor.



PATENTS

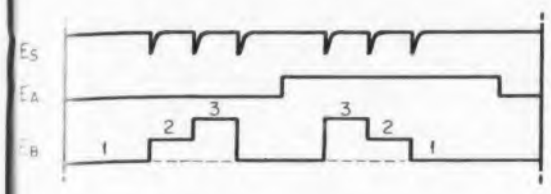


Polystable Trigger Circuit

Patent No. 2,901,608. Robert C. Paulsen and Arthur H. Dickinson. (Assigned to IBM Corp.)

A modified Eccles-Jordan trigger circuit permits polystable switching which can easily be reversed. The circuit is sufficiently stable for data processing applications.

Let the manual switches be set to position *1* as shown and let W_3 return to a negative bias supply. In this condition, triode *x* of V_3 is conducting, tube V_1 is cut off and tube V_2 conducts slightly. A negative pulse from source *S* causes the

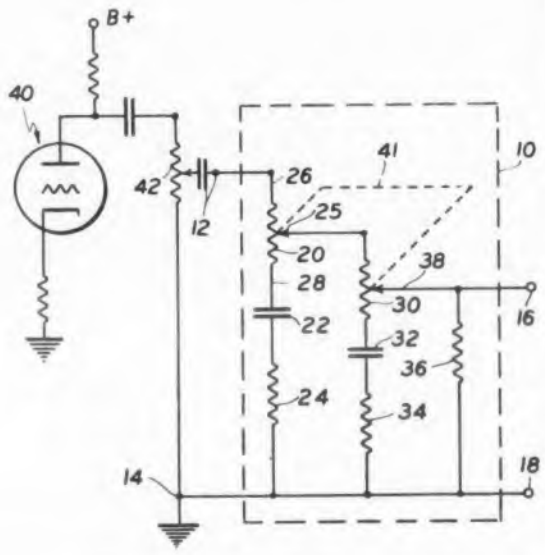


left section of V_3 to conduct making section x conduct less; the positive pulse at B drives V_1 to conduct weakly since its grid ties back to the negative supply W_3. A second negative pulse from source S drives the left section of V_3 harder and feedback through capacitor C_1 causes this side to saturate with section x of V_3 cutoff. A third negative pulse from source S causes no change in the left section of V_3 but section x conducts hard and the feedback from V_2 through capacitor C_2 causes section x to saturate as the left section is driven to cutoff. The waveform at terminal B, E_B, reverses as the switches are shifted to position 2.

Tone Compensated Loudness Control

Patent No. 2,900,609. Michael H. Estowski. (Assigned to V-M Corp.)

A voltage divider comprising an adjustable resistor *20* in series with capacitor *22* and resistor *24* produces uniform hearing loudness over the audio frequency spectrum according to the Fletcher-Munson curves. Essentially, for all power levels, the circuit attenuates the midfrequencies to the level of the high and low frequency components. In the specified design, the reactance capacitor *22* at 20 cps is selected to equal the resistance of potentiometer *20*. At midfrequency, say 1500 cps, resistor *24* is chosen to match the reactance of capacitor *22*. The circuit consists of the ganged dual arms so that the Fletcher-Munson curves are matched more precisely.



BOOKS

Fourier's Series And Spherical Harmonics
William Elwood Byerly, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 287 pp, $1.75

The development of functions, series and their differential equations is concretely explained in great detail; throughout the text, theory is applied to practical problems which are fully and lucidly worked out. In addition, the reader is given 190 problems to solve, many with helpful hints as to method. An appendix includes 6 tables of surface zonal harmonics, hyperbolic functions, and Bessel's function. As a handbook, reference and lucid exposition of fundamental methods, there is no duplicate for this book in such areas as mathematical physics, wave mechanics, and advanced engineering including communications technology, aerodynamics, radar, acoustics, etc.

Partial contents: Development in Sine Series; Legendre's Coefficients; Bessel's Functions; Development in Trigonometric Series; in Cosine Series; Fourier's Integral Obtained; Convergence of Fourier's Series; Graphical Presentation of Successive Approximations to a Sine Series; Conditions Under Which a Function Can Be Expressed as a Fourier's Integral; Solutions of Problems in Physics; Logarithmic Potential; One Dimensional Flow of Heat; Disturbance Along an Infinite Stretched Elastic String; Flow of Heat in a Sphere; Nodal Lines in a Square Drumhead; Polar Coordinates; Conduction of Heat in Space; Zonal Harmonics; Problems in Potential; Tesseral Harmonics; Development in Spherical Harmonic Series by Aid of Laplacians; Differ-

entiation. Along an Axis; Nomenclature Justified; Bessel's Functions of nth order; Stationary Temperatures in Cylindrical Shell; Laplace's Equation in Curvilinear Coordinates; Ellipsoidal Harmonics; much more.

Microwave Measurements for the Technician

Ralph W. Ritchie, Wm. C. Brown Co., 135 S. Locust St., Dubuque, Iowa, $3.50

Purpose of this book is to provide a comprehensive, simplified manual on basic microwave measuring techniques. Subjects covered include: "Operation of Microwave Test Bench," which includes tuning, frequency measurement and power measurement, "Standing Wave Ratio Measurement," "Use of Smith Chart," "Measurement on Directional Couplers," "Measurements on Klystrons," and "Attenuation Measurements."

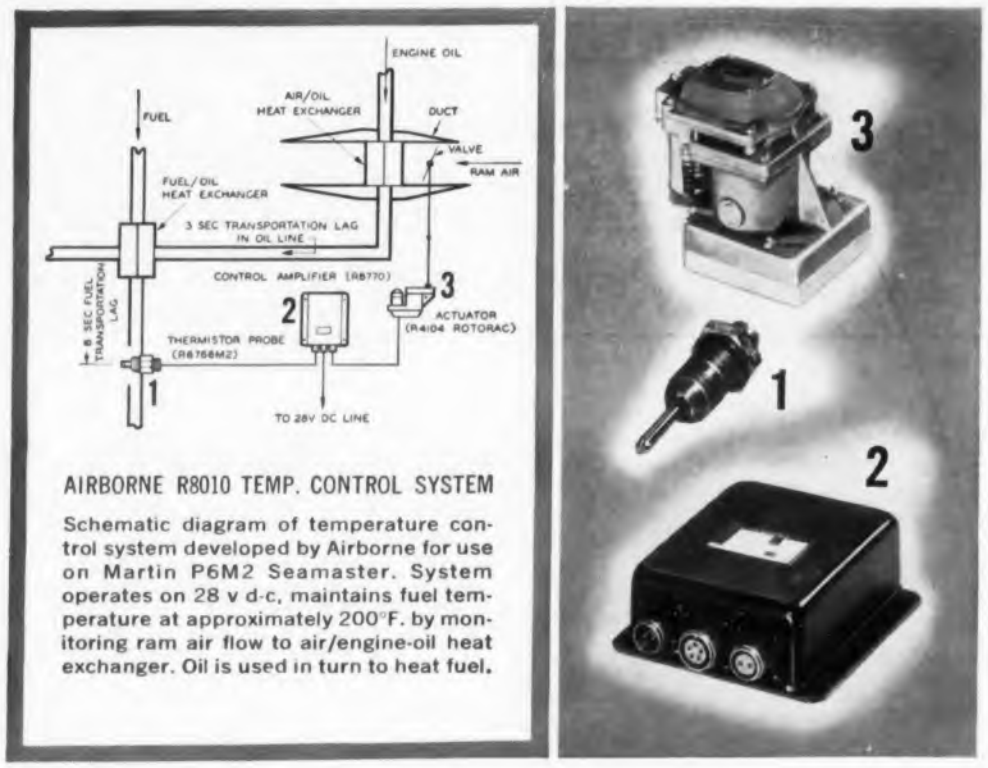
A "how-to" book, it will be especially helpful to electronics engineers and technicians assigned to microwave measurements, with little or no previous indoctrination in the field.

Welding of Plastics

J. A. Neumann and F. J. Bockhoff, Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 288 pp, $7.25

Here is a comprehensive treatment of all phases of this subject ranging from initial design procedures to final detailed fabrication methods. Various physical and chemical properties of individual plastics presently used for welded construction are completely covered with regard to their use in chemical and allied processing. All presently known techniques of welding are covered in detail and many step-by-step procedures with photographs are included. In addition, the book contains one of the most complete corrosion resistance tables yet published, plus a concise guide for the choice of an appropriate plastic construction material. An entire chapter is devoted solely to design considerations as they specifically affect welded construction. Testing and evaluation are also given separate treatment.

This book is of substantial help to engineers and manufacturers who are interested in present and potential applications of plastics in the process industries.



AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine-oil heat exchanger. Oil is used in turn to heat fuel.

Airborne electromechanical system regulates jet fuel temperature

An integral part of each main engine installation on the Martin P6M2 Seamaster is an Airborne R-8010 custom-engineered temperature control system. By regulating air flow through a heat exchanger, this system maintains supply line fuel at 180-220°F.

As developed for the P6M2, the R-8010 system consists of a thermistor probe, a control amplifier and a rotary actuator. The probe (mounted in an MS10057-12 fitting) is in direct contact with the temperature-regulated fuel and presents to the control box a resistance which is proportional to fuel temperature. In response, the control box energizes the actuator to change the setting of a ram air intake valve, thus regulating volume of air flow through an air/fuel heat exchanger. This sensing and response continues until prescribed fuel temperature is attained, at which point the system reaches a state of electrical balance.

A fail-safe feature is also provided. In the event of power failure, a magnetic clutch in the actuator is released, permitting the air valve to be pushed open by the force of the ram air.

This application* on the P6M2 illustrates only one of many possible adaptations of the Airborne R-8010 system for temperature control functions on aircraft, missiles and related equipment—cabin temperature control, engine temperature control, temperature regulation of fuel, oil, electronic cooling packages, etc. If you have requirements in these areas, we will be happy to make a proposal. Contact any of our offices.

*Described in detail in new Bulletin PS-4A, available on request.

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BOOKS

Algebraic Theories

Leonard E. Dickson, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 276 pp, $1.50

This book develops theories centering around matrices, invariants, and groups, which are among the most important concepts in mathematics. All important theories are studied with rigorous, detailed proofs. This volume provides courses in higher algebra, the Galois theory of algebraic equations, finite linear groups, including Klein's "icosahedron" and theory of equations of the fifth degree, and algebraic invariants. Higher algebra is fully treated, including matrices, linear transformations, elementary divisors and invariant factors, and quadratic, bilinear, and Hermitian forms, whether taken singly or in pairs. The results are classical with due attention given to questions of rationality. Elementary divisors and invariant factors are introduced in a simple, natural way in connection with the classical form, and a rational, canonical form of linear transformations. These topics are developed more lucidly than usual, and in close connection with their most frequent mathematical applications.

Chapter titles: Introduction to Algebraic Invariants; Further Theory of Covariants of Binary Forms; Matrices, Bilinear Forms, Linear Equations; Quadratic and Hermitian Forms, Symmetric and Hermitian Bilinear Forms; Theory of Linear Transformations, Invariant Factors, Elementary Divisors; Pairs of Bilinear, Quadratic, and Hermitian Forms, First Principles of Groups of Substitutions; Fields, Reducible, Irreducible Functions; Group of an Equation for a Given Field; Equations Solvable by Radicals; Constructions with Ruler and Compasses; Reduction of Equations to Normal Forms; Groups of Regular Solids; Quintic Equations; Representations of a Finite Group as a Linear Group; Group Characters.

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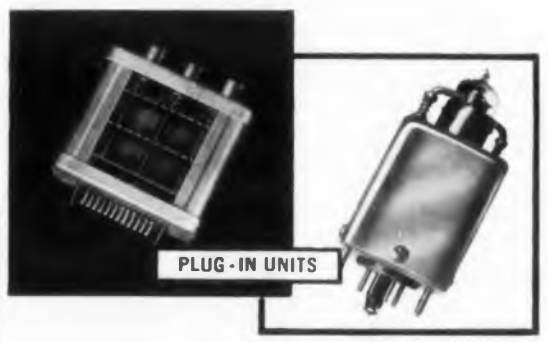

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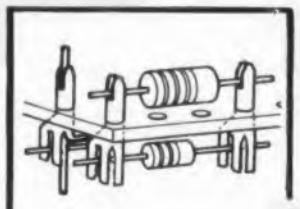

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Modern Electronic Components

G. W. A. Dummer, Philosophical Library, 15 E. 40th St., New York 16, N. Y., $15.00

Users of components will appreciate this book in which all the characteristics of the commonly-used components are given. Components are now used under arduous environmental conditions and several chapters have been written to cover those aspects in detail.

The bibliography at the end of the main chapters has been carefully chosen to provide a comprehensive, although brief, summary of the literature.

The information in this book will help the user to an understanding of the basic characteristics of components and enable him to choose the best component for his particular purpose.

Nomography

Alexander S. Levens, John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y., 296 pp, $8.50

Nomography is considered one the clearest expositions of the basic theory and construction of charts involving straight line scales, curved scales, and combinations of the two. This 1959 edition recognizes that from the launching of a satellite to the more mundane realm of food technology, nomographs are apt to be called to the rescue. Statistics, electronics, ballistics, heat transfer, radioactivity, medicine, the physical and biological sciences, engineering, and business are only a few of the fields in which nomographs are constructed today.

This second edition of "Nomography" has three new chapters on circular nomograms, projective transformations, and the relationship between concurrency (Cartesian) and alignment nomographs with applications to experimental data. Three earlier chapters have been expanded to include: methods for designing nomographs for four variables without the need of a turning axis; material on nomograms which consist of two curved scales and a straight line scale, and three curved scales; and a more extensive treatment of the use of determinants. Professor Levens has also simplified the mathematical developments for the various type forms throughout the book, and introduced many new problems and examples, in addition to other up-to-date material.

BOOKS

Group Theory in Quantum Mechanics

Dr. Volker Heine, Pergamon Press, Inc., 122 E. 55th Street, New York 22, N.Y., 370 pp. $10.00.

This book gives an elementary introduction to the use of group theory in quantum mechanics together with an account of the simpler applications in all branches of physics and chemistry. Throughout, there is an emphasis on applications.

The book introduces the three main uses of group theory in quantum mechanics: firstly, to label energy levels and the corresponding eigenstates; secondly, to discuss qualitatively the splitting of energy levels as one starts from an approximate Hamiltonian and adds correction terms; and thirdly, to aid in the evaluation of matrix elements of all kinds, and in particular to provide general selection rules for the non-zero ones.

The level of the text is that of a course for research students in physics and chemistry, such as is now offered in many universities. A previous course in quantum theory is assumed, but the matrix algebra required is included as an appendix.

The view adopted throughout is that group theory is not simply a specialized tool for solving a few of the more difficult and intricate problems in quantum theory. In advanced quantum mechanics, practically all general statements that can be made about a complicated system depend on its symmetry properties, and the use of group representations is a systematic, unified way of thinking about and exploiting these symmetries. For this reason simple results are included for which one could easily produce ad hoc proofs from first principles.

A series of examples is appended to each section. Some of these are simple drill in the concepts introduced in the section; others, particularly in later chapters, indicate extensions of the theory and further applications. Chapter headings include: Symmetry Transformations, Quantum Theory of a Free Atom, Representations of Finite Groups, Further Aspects of the Theory of Free Atoms and Ions, Structure and Vibrations of Molecules, Solid State Physics, Nuclear Physics, and Relativistic Quantum Mechanics.

Metropolitan Miami Manufacturers
Dade County Development Dept., 345 N.E. Second Avenue, Miami 32, Fla., $3.50

A new 1959 directory, listing 2403 individual manufacturing plants in Metropolitan Miami, is now in distribution. It is the second part of a comprehensive printed factual effort by Dade County devoted to presenting the economic attributes of Metropolitan Miami to interested national management. Part I is the "Economic Survey of Metropolitan Miami" which appeared in January 1959.

The new directory lists manufacturing plants of the area alphabetically by name as well as by product under the Standard Industrial Classification format. It affords market researchers, particularly, a far wider range of professionally geared information by inclusion of:

- name, address, postal zone, telephone number;
- top firm officer identified by name and title and whether owner, partner or otherwise;
- type of product and product trade name by SIC classification;
- total number of square feet floor space occupied by plant;
- Census Tract location of each plant;
- areas of relative market importance emphasizing major geographical distribution of local sales.

Physical And Engineering Properties Of Materials For Nuclear Fuel Elements
Dr. Henry H. Hausner, Sylvania-Corning Nuclear Corp., Bayside, L. I., N. Y., 55 pp, $1.00

This is a compendium of physical and engineering data about elements, alloys, compounds and other materials of particular interest to those engaged in the design, fabrication and use of nuclear fuel and control elements. It serves admirably its intended purpose of supplying information not yet widely available in conventional reference sources.

Eighty tables are presented: the first contains thermal-neutron cross sections of 50 commonly available elements; succeeding ones give various physical and thermal properties of uranium, uranium alloys, thorium, plutonium, ceramics, zirconium and zircaloy-2, aluminum, stainless steel, graphite, and other high-temperature materials.

RUSSIAN TRANSLATIONS

J. George Adashko

Novel LC Filter Using Mutual Inductance

THE FILTER shown in Fig. 1 is designed to suppress one frequency, and to take advantage of LC elements even at very low frequencies. In this filter, the parallel circuit II and the resistor R serve as a voltage divider.

The resonant-frequency voltage is divided in the ratio of the Q of circuit II and the resistance R. Since, in real circuits, Q is finite and decreases with the frequency, this leads to filtering of the resonant frequency.

The losses in circuit II, which cause the low Q of the circuit and the poor filtering effect, can be compensated by coil L_1, inductively coupled with L_2. This increases the power drain (the filter input resistance is decreased), but greatly increases the equivalent Q of circuit II.

A circuit with greatly enhanced Q results in a filter that has all the advantages of LC filters over RC filters (low losses and steep slopes), even at frequencies of several cycles.

In addition, by varying the parameters of the circuit of Fig. 1 it is possible to obtain either a high-pass or low-pass filter without increasing the number of elements. If circuits I and II are pretuned, the filter has only one tuning element—the resistance ρ_0 with which the losses in circuit II

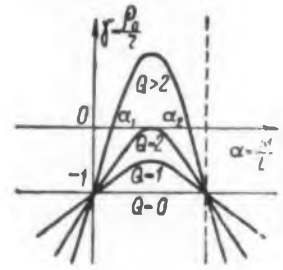


Fig. 1. This LC filter drains more power than simpler LC filters, but it provides sharper filtering.

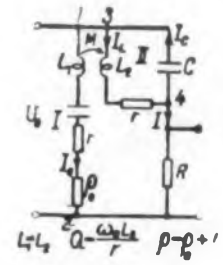


Fig. 2. Conditions for infinite Z_R.

Russians Reveal New Patent Regulations

In an unsigned article "New Regulations for Inventions and Efficiency Suggestions," in the journal *Vestnik Svyazi* (*Communications Herald*) of July 1959, the Russians revealed new pay scales for inventiveness. Their "Regulations for Discoveries, Inventions, and Efficiency Suggestions" and "Instructions on Remuneration for Discoveries, Inventions, and Efficiency Suggestions" became effective on May 1, 1959.

The new regulations and instructions differ from previous ones in that they provide for increased bonuses to inventors and efficiency experts. The minimum compensation is set at 200 rubles for an invention and 100 rubles for efficiency suggestions which don't result in any saving. (The official exchange rate is about four rubles per dollar; tourist rate is ten for one).

Compensation is paid to the inventor even if his invention relates to the field in which he works.

The article in which this information appears was abstracted in the Central Intelligence Agency's *Scientific Information Report* of September 4, 1959. This semi-monthly publication is distributed by the U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C. Annual subscriptions cost $28.00. Single copies $2.75.

are compensated.

The resonant impedance Z_K of the parallel circuit *II* (between points 3 and 4) can be determined with Kirchhoff's equations as follows:

$$1.\ u_0 = I_0\left(\rho + \mathrm{i}\,\omega\,L_1 + \frac{1}{\mathrm{i}\,\omega\,C}\right) + \mathrm{i}\,\omega\,M\,I_L$$

$$2.\ 0 = I_L\,(r + \mathrm{i}\,\omega\,L_2) + I_C\,\frac{1}{\mathrm{i}\,\omega\,C} + I_0\,\mathrm{i}\,\omega\,M$$

$$3.\ I_L = I + I_C$$

$$4.\ u_0 = I\,R - I_C\,\frac{1}{\mathrm{i}\,\omega\,C}$$

$$5.\ Z_K = \frac{u_0}{I} - R$$

After solving for u_0/I and after suitable transformation, one obtains

$$Z_K = \frac{R\,\dfrac{M}{\rho} + L + i\,\omega_0\left(\dfrac{M^2}{\rho} - \dfrac{r}{\omega_0{}^2}\right)}{M^2 - ML + CL\,\rho\,r}\,\rho\,L$$

This impedance vanishes when

$$M = \frac{L}{2} \pm \sqrt{\frac{L^2}{4} - \frac{r\,\rho}{\omega_0{}^2}}$$

i.e., it is necessary to have

$$\rho = \frac{\omega_0{}^2\,M}{r}\,(L - M) = r\,Q^2\,\frac{M}{L}\left(1 - \frac{M}{L}\right)$$

Since $\rho = \rho_0 + \mathrm{r}$, ρ and M must satisfy additional conditions if Z_K is to be infinite.

Since $M/L = \alpha$, and $\rho_0/\mathrm{r} = \gamma$,

$$\gamma = Q^2\,\alpha\,(1 - \alpha) - 1$$

This condition is represented graphically in Fig. 2.

The points α_1 and α_2 can be defined :

$$\alpha_{1,2} = \frac{1}{2} \pm \sqrt{\frac{1}{4} - \frac{1}{Q^2}}$$

Thus, knowing the Q of the initial circuit, it is possible to choose ρ_0 and M so as to ensure normal operation of the filter. Such a circuit can be successfully used in many circuits. It readily yields an attenuation of 10^4 to 10^6 at frequencies from 100 cps to several tens of kilocycles. The fronts are steeper than in an ordinary LCR circuit.

The principle of compensation of the losses in tuned circuits by increasing the power drain and using inductive coupling is applicable also to more complex filter circuits.

This article is abstracted from Electronic Filter with Mutual Inductance *in the July 1959 issue of Radiotekhnika.*

Double RC Integrator

THE INTEGRATOR circuit shown in Fig. 1 has *R-C* branches on both grid and plate side of the tube. For this circuit, the complex transfer function is

$$\frac{V_2}{V_1} = -gm\,\frac{R_2}{j\omega R_1 C_1}\cdot\frac{1+\dfrac{1}{R_2/R_0 + j\omega R_2 C_2}}{1+\dfrac{1}{j\omega R_1 C_1}}$$

if $R_1C_1 = R_2C_2$ and if $R_2/R_0 < \omega R_2C_2$ the integration of periodic functions can be performed with high precision and greater simplicity than the Miller integrator requires. In Fig. 2, the phase and amplitude errors are shown as functions of frequency, for $R_2/R_0 = 2/3$, in comparison to the

Multilayer Microwave Terminations

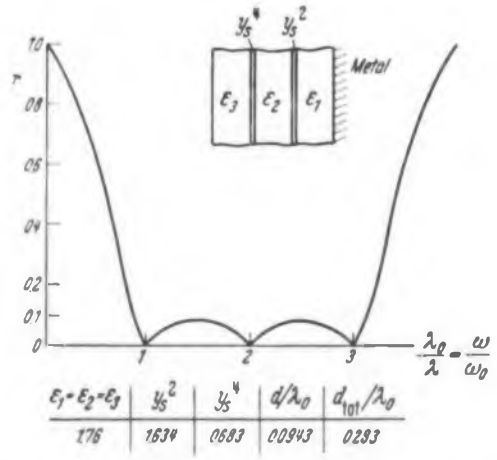


Fig. 1. Reflection factor as a function of normalized frequency for a five layer structure. The symbols y_s refer to the normalized admittance of the metal foils and the superscripts 2 and 4 refer to their position in the structure relative to the metal wall.

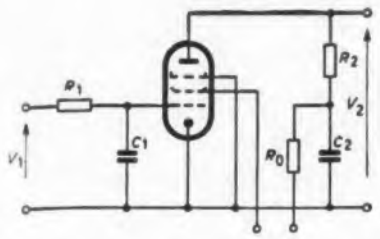


Fig. 1. Double RC integrator.

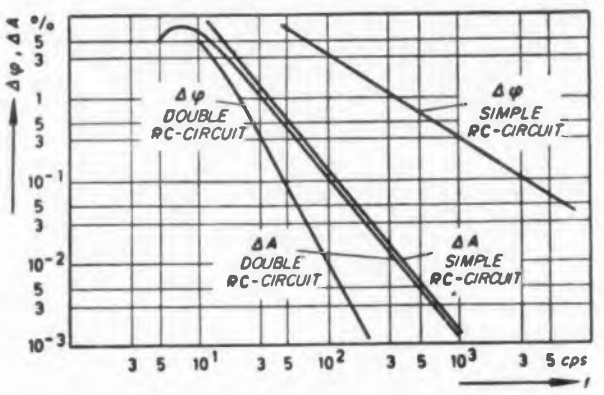


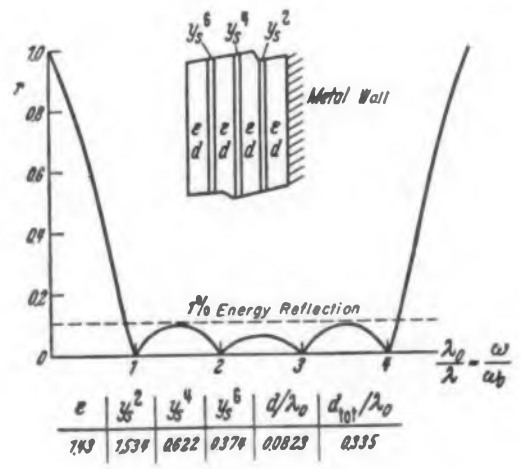
Fig. 2. Amplitude and phase error as functions of frequency for the simple and the double RC integrators.

performance of the simple *R-C* element.

Abstracted from an article by W. Berger, F. Hoevelmann and H. J. Koessler, Elektronische Rundschau, *Vol. 13, No. 9, September 1959, pp. 336-338.*

THE USE of multiple resonant structures for reflectionless broadband absorbers of microwave energy offers considerable broadbanding possibilities. Such structures consist of layers of nominally lossless dielectrics alternating with conducting foil in front of a metal wall. A structure is designed on the basis of transmission line equations (normal incidence).

For simplicity in computation, it is assumed



e	y_5^2	y_5^4	y_5^6	d/λ_0	d_{101}/λ_0
1.43	1.534	0.622	0.374	0.0823	0.335

Fig. 2. Reflection characteristics of a seven layer structure. As in Fig. 1, y_e^n is the normalized admittance of the metal foil in the nth position from the metal wall.

GERMAN ABSTRACTS

that all dielectric layers have the same geometrical and optical properties, i.e. the same dielectric constant. The five-layer structure shown in Fig. 1 has the reflection characteristics indicated. A seven-layer structure has the 4:1 band shown in Fig. 2. For 15 deg and 45 deg angle of incidence, the experimental curve shown in Fig. 3 for a seven-layer structure shows good agreement with Fig. 2.

Abstracted from an article by H. J. Schmitt, Zeitschrift fuer Angewandte Physik, *Vol. 11, No. 9, September 1959, pp. 335-339.*

High-Frequency Crystal

FOR MEASUREMENT of the properties of silicon mono-crystals, an axial current is fed to the crystal rod by means of two solder contacts and the resulting voltage is measured between two closely-spaced point contacts on the rod. The use of solder contacts has the disadvantage of producing surface dirt which results in lowering the resistance and the charge carrier lifetime. If solder contacts are avoided by use of pressure contacts, metal traces result which cannot be neglected for high resistance samples.

The use of high-frequency techniques makes it possible to use contact-free circuits by use of inductive coupling for low-resistance materials and capacitive coupling for high-resistance materials. In addition, the sample may be protected from surface dirt by wrapping in protective foil.

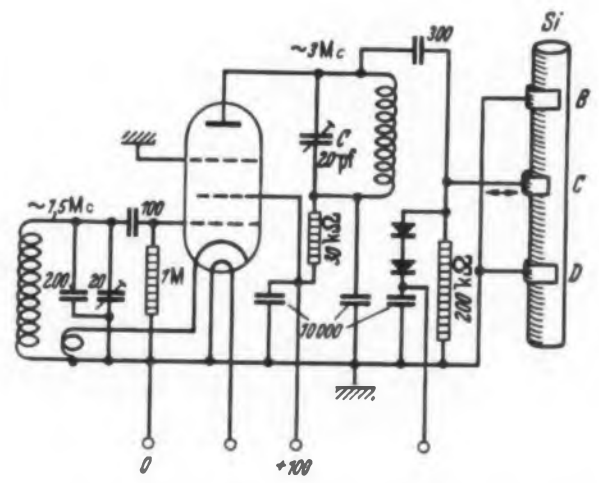


Fig. 1. Circuit of a 3 mc apparatus for resistance measurement in the 1000 to 30,000 ohm-cm region.

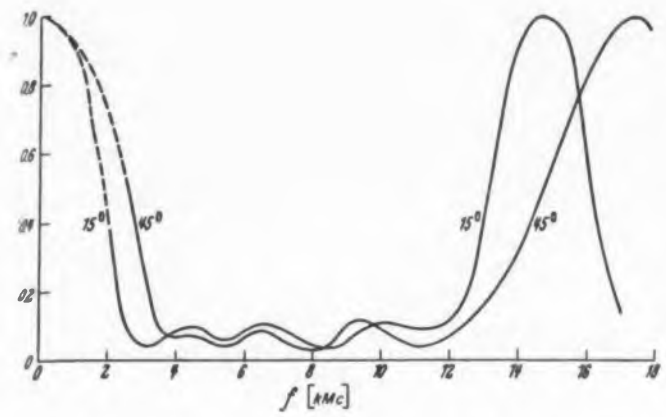


Fig. 3. Measured reflection factor as a function of frequency for a seven-layer absorber for two angles of incidence.

Measurement of Silicon Parameters

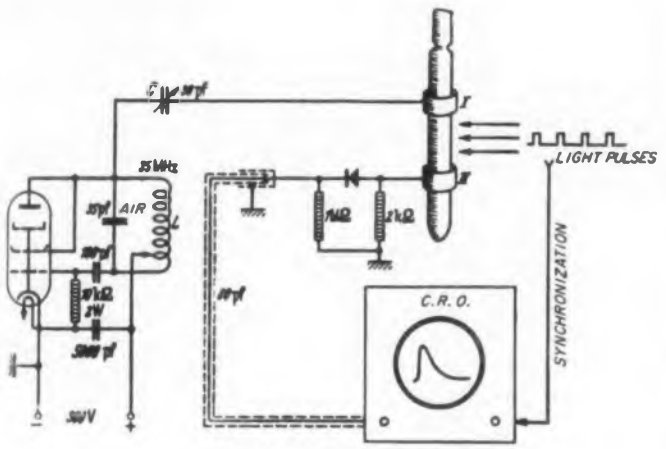


Fig. 2. Circuit for lifetime measurement.

For resistance measurement of samples whose resistivity is between 1000 and 30,000 ohm-cm, a circuit which has been used successfully is the 3 mc circuit shown in Fig. 1. In the tuned circuit, the capacitive coupling of the silicon rod to the tank is at points marked *B*, *C* and *D*.

For measurement of charge-carrier lifetime, the modulated light method may be adopted to the high frequency method shown in the 35 mc circuit of Fig. 2 where capacitive coupling is at points *I* and *II*.

In each application cited, the results obtained by the high frequency method agree well with standard values.

Abstracted from two articles by W. Keller, Zeitschrift fuer Angewandt Physik, Vol. II, No. 9, September 1959, pp 346-352. Dr. Keller notes that I. R. Weingarten and M. Rothberg in the U.S. have presented a high frequency method to the Electrochemical Society on Apr. 29, 1958.

REPORT BRIEFS

Vibrations

Some of the environmental problems in equipment design for military applications are outlined and the need for power spectrum analysis of vibrations shown. Various systems for frequency analysis, including swept filter and fixed types are discussed. An ideal fixed filter system meeting certain necessary specifications on response to simple inputs is proposed. This system is commercially unavailable. *Line Power Spectrum Analyzer For Mechanical Vibrations, Frank Amoroso, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. May 1958, 76 pp, Microfilm $4.50, Photocopy $12.30. Order PB 140853 from Library of Congress, Washington 25, D.C.*

Silicone Insulated Cables

A comparison of the dielectric breakdown results of gas flame exposed Class E and Class T insulated cable specimens indicates that the dielectric strength of specimens vibrated for 15 min at a frequency of 20 cps and an amplitude of 1/16 in. is not significantly different from the dielectric strength of similar specimens which had not been vibrated. *Dielectric Strength Of Silicone Insulated Cables After Exposure To Flame and Vibration, Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y. 23 July 1958, 9 pp, Microfilm $1.80. Photocopy $1.80. Order PB 139527 from Library of Congress, Washington 25, D.C.*

Magnetron Research

The results cover the following: (1) comparison of experimental results with various design equations and a set of simplified design equations; discussion of the cause of upper current or diode cut-off and a means for avoiding it; discussion of the cause of minimum current cut-off and pulsing and methods for its reduction; measurements of cathode back-heating and one method for protecting the hot cathode; and various anode structures and their performance; (2) a method for voltage tuning magnetrons; (3) the use of a magnetron as a reactance for frequency modulating another oscillating magnetron; and (4) the use of a magnetron as an amplifier or controlled oscillator thereby permitting stable external frequency control and therefore, either amplitude or frequency modulation. *C. W. Magnetron Research, D. A. Wilbur and R. B. Nelson, General Electric Research Laboratories, Schenectady, N.Y. 1 Apr. 1950, 174 pp, Microfilm $8.10, Photocopy $27.30. Order PB 137249 from Library of Congress. Washington 25, D.C.*

Networks

If a network contains a variable parameter x (capacitance, or g_m of a vacuum tube, etc.) the polynomials of the driving-point and transfer functions describing the network have coefficients which are linear functions of x. The roots of the polynomials are also functions of x. Since the locations of the poles and zeros of these network functions are important in both analysis and synthesis of the network, it is desirable to know quantitatively the tendency for a root to vary with the parameter x. A measure of this tendency to vary is provided by the sensitivity function $S = dp/dx$, where p is a root of a polynomial. Properties and theorems pertaining to this sensitivity function are given in this work. *Pole-Zero Sensitivity In Network Functions, Franklin F. Kuo, Electrical Engineering Research Laboratory, University of Illinois, Urbana, Ill. 1 May 1958, 84 pp, Microfilm $4.80, Photocopy $13.80. Order PB 137069 from Library of Congress, Washington 25, D.C.*

Designing Video Interstages

This study presents a method of designing interstages for transistor video amplifiers. The transistors are represented by the hybrid-pi equivalent circuit. The problem of designing interstages is shown equivalent to the problem of synthesizing a transfer impedance function proportional to the stage gain where the resulting interstage network must have certain specified terminating impedances. These terminating impedances represent the effects of the transistors. The interstage synthesis technique developed emphasizes the importance of the interstage using a limited number of elements and providing a satisfactory gain-bandwidth product. *Interstages for Transistor Video Amplifiers, J. J. Spilker, Stanford Electronics Laboratory, Stanford University, Calif., Apr. 1958, 139 pp, Microfilm $6.90, Photocopy $21.30. Order PB 139459 from Library of Congress, Washington 25, D. C.*

Microwave Resonant Cavities

This report describes the design and testing of two types of resonant microwave cavities operating near 9435 mc in which the end plates are replaced by terminations which leave the cross-sections of these cavities essentially unobstructed. *Design of Open-Ended Microwave Resonant Cavities, Donald C. Thorn, Electrical Engineering Research Laboratory, University of Texas, Austin, Tex., Aug. 1958, 23 pp, Microfilm $2.70, Photocopy $4.80. Order PB 142035 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Designing Crystal Filters

A set of convenient insertion loss equation is derived, which is applicable to the design of multisection, reactive, symmetric filters. Specific network designs for quartz crystal bandpass filters with sharp cut-off characteristics, and more than 60 db attenuation in the stop bands, are presented for two categories of fractional bandwidths: (1) less than or equal to 0.4 per cent; (2) equal to or larger than 1.5 per cent. Several network structures for each of these two categories are worked out and the corresponding insertion loss characteristics are plotted. Element values are given for a filter with a 6 db bandwidth of 40 kc with respect to a center frequency of 11.5 mc. A design for a filter with a bandwidth of 400 kc with respect to a center frequency of 24 mc is included. This design makes full allowance for the effects of coil dissipation. In an appendix, a general approach is outlined to the formation of lattice-type filters with 4, 6, and 8 peaks of infinite attenuation (i.e., zeros of transmission) and with image impedances suitable for (1) quartz crystal-capacitor-inductor filters with a constant-k image impedance. Recent design progress is announced, which took place subsequent to the close of the first quarter and promises to lead to a very satisfactory filter design in the fractional-bandwidth region between 0.4 per cent and 1.5 per cent. *High Frequency Crystal Filters, Leo Stroch, Hughes Aircraft Co., Culver City, Calif., 1957, 84 pp, Microfilm $4.80, Photocopy $13.80. Order PB 142388 from Library of Congress, Washington 25, D. C.*

Crystal Oscillator Circuits

Performance information for the cathode coupled and grounded grid oscillators for the 10 to 75 mc frequency range is reported. Reference circuits and their performance as a function of frequency have been established. Effects of component variation have been determined, and shown to be adequately described by the normalized curves developed for higher frequency operation. Initial problems of frequency and crystal voltage correlation have been resolved. These are shown to be caused by the effect of the plate-to-cathode capacitance. Correction is obtained by the addition of an inductor in series with the crystal in the feedback path. The design information for the grounded grid circuit in this frequency range has been found to be essentially an extension of the results obtained in the higher frequency range. A discussion of the problems encountered

with the cathode coupled circuit is given. However, its performance at the lower frequencies is compared with that at the higher frequency range and differences are noted. Temperature characteristics and oscillator output harmonic content measurements for the two series resonant circuits in the 75 to 150 mc frequency range are reported. Extension of the antiresonant circuit design information to 20 mc has been completed for the Colpitts circuit, and work on the electron coupled Colpitts is in progress. The previously developed design information is shown to be useful to 20 mc without any loss of accuracy over that originally specified. *A Study of Crystal Oscillator Circuits, H. E. Gruen and A. O. Plait, Armour Research Foundation, Chicago, Ill., Feb.-May 1957, 35 pp, Microfilm $3.00, Photocopy $6.30. Order PB 142400 from Library of Congress, Washington 25, D. C.*

Traveling Wave Tubes

This report refines the conventional MacLaurin's series representation for audio amplifiers to include the frequency sensitivity of microwave devices and uses the condition of linear combinations of input frequencies to predict the response. An apparatus suitable for measuring the frequencies and relative amplitudes from X-band to uhf frequencies is discussed and the procedure used in measuring intermodulation in the X-259 B traveling wave tube is presented. The indications obtained are that terms of the MacLaurin's series up to and including the 15th term are significant in the region of saturation, which presents the possibility that 240 new frequencies were produced in varying amplitudes. *Intermodulation in Traveling Wave Tubes, James E. Green, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, Mar. 1959, 64 pp, Microfilm $3.90, Photocopy $10.80. Order PB 140926 from Library of Congress, Washington 25, D. C.*

UHF Amplifiers

This report will present the synthesis considerations, design procedures, and constructional features of uhf amplifiers described in Technical Report No. 11, "A 400 Mc 1-F Amplifier," June, 1952. The reader is referred to this report, which serves as an introduction to the present report and indicates the results that can be obtained. *The Synthesis and Design of Grounded-Grid Staggered-Triples at UHF, Donald O. Pederson, Electronic Research Laboratory, Stanford University, California, Sept. 1952, 60 pp, Microfilm $3.60, Photocopy $9.30. Order PB 142433 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Ceramic Capacitors

Techniques have been developed to measure temperature coefficients of capacitors to an increased degree of accuracy. Capacitance increments due to temperature variations can be measured to 0.0001 μμf or one per cent, whichever is greater, with the exception of a very small range of capacitors. A test-panel sample holder was developed with a maximum contributing error of 0.00001 μμf per deg C change over a 225 deg C total temperature variation. A switching mechanism to allow measurement of one hundred samples in a day was devised, utilizing statistical techniques to reduce resettability errors as small as desired. A capacitance sensitive device in the form of a variable oscillator and standard increment capacitors were designed and developed for detecting and recording 0.0001 μμf capacitance changes. A discussion of the specifications of temperature coefficients of capacitors and recommendations for their amendment are included. Details concerning the construction of a temperature coefficient test set and measurement techniques are also given. *Design Study Toward Development of A Test Set to Measure Temperature Characteristics of Ceramic Capacitors, Joseph Seton Smith, New York University, College of Engineering, N.Y., 1951, 87 pp, Microfilm $4.80, Photocopy $13.80. Order PB 142176 from Library of Congress, Washington 25, D. C.*

Detection of Signals in Noise

A detection criterion is formulated which leads to the design of detectors on the basis of much less a priori information. These non-parametric detectors are proposed as possible alternatives to the detectors studied in those situations where little a priori information is available. A concept known as asymptotic relative efficiency is employed to compare nonparametric detectors with some of the detectors investigated in the past. Using this criterion the efficiency of nonparametric detectors is found to be quite high. The application of the nonparametric detection criterion to the detection of nonstationary signals in noise is discussed. Nonparametric detectors are shown to possess certain advantages in detecting such signals. *Nonparametric Methods For The Detection of Signals In Noise, Jack Capon, Columbia University, School of Engineering, New York, Mar. 1959, 234 pp, Microfilm $10.20, Photocopy $36.30. Order PB 142327 from Library of Congress, Washington 25, D. C.*

Design of Radomes

This report considers radome design requirements and construction and the manner in which absorption losses affect radome performance. Equations for lossy radomes are given, and a number of transmission curves are computed for lossy sandwich panels. The report also contains the design procedure for lossy high-incidence radomes, methods for obtaining optimum core thickness for maximum transmission, and a discussion of the effects of dimensional tolerances on transmission. *Electrical Design of Lossy High-Incidence Radomes, S. Wolin, Aeronautical Electronic and Electrical Laboratory, Naval Air Development Center, Johnville, Pa., Jul. 1950, 139 pp, Microfilm $6.90, Photocopy $21.30. Order PB 142015 from Library of Congress, Washington 25, D. C.*

Power Distributed Amplifier

This report presents the results of an investigation by the Electronic Defense Group into means of increasing the frequency capabilities of power distributed amplifiers. The design, physical construction, and electrical characteristics of a 6-tube 4X150A distributed amplifier and a 6-tube 4X250B distributed amplifier are described. These amplifiers demonstrate experimentally the validity of the theory of distributed amplifiers using dummy constant-*k* line sections between tubes. The amplifiers have upper cut-off frequencies in the neighborhood of 450 mc and useful output power capabilities. The output power capability is, however, a function of the duty cycle at which the amplifier is operated. *The Design and Measured Characteristics of 450 Mc Power Distributed Amplifier, D. Hamburg, Michigan University Research Institute, Ann Arbor, Mich., Jul. 1957, 31 pp, Microfilm $3.00, Photocopy $6.30. Order PB 139442 from Library of Congress, Washington 25, D. C.*

Silicone Insulated Cables

Representative specimens of electric cables utilizing silicone compounds as primary insulation were subjected to laboratory conditions simulating a fairly severe shipboard fire and subsequent extinction with salt water fog. A majority of the specimens sustained their rated operating voltage throughout the period of exposure to fire and subsequent salt water fog. *Effect of Combined Fire and Water on Silicone Insulated Cables, A. M. Deleeuw, Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y., Feb. 1959, 9 pp, $0.50. Order PB 151751 from OTS, Washington 25, D. C.*

LETTERS

1000 Times Too Good

Dear Sir:

We would like to bring to your attention a mistake in the article, "Packaged Switching Circuits Designed for On-Site Processing", which appeared in the September 30, 1959, issue of ELECTRONIC DESIGN. The first sentence in paragraph three should be corrected to read: "So far, seven logical components have been developed, all operating at 50-kc pulse repetition rates.", not 50-mc.

James A. Cunningham
Data Processing Systems Division
U. S. Department of Commerce
Washington 25, D. C.

Inside-Out Twin-T Useful Despite Upside-Down Symbol

Dear Sir:

Referring to Mr. Howden's article "Inside-Out Twin-T Varies Rejection Frequency" (*ED*, Oct. 14, 1959, p. 198), may I point out an error, undoubtedly a misprint.

In the third column, at three separate locations, $r\omega_c$ should be $r\omega c$. This is required to make the results dimensionally correct.

Thank you for an interesting and useful article. We have already made use of it in our equipment as a feedback network.

Paul I. Wolf, Engineer
Medico-Technological Research Dept.
St. Barnabas Hospital
714 9th Ave., South
Minneapolis 4, Minn.

Difference of Opinion on Exclusive "Or" Circuit

Dear Sir:

We agree that Mr. Maki's circuit, published in your "Ideas for Design" in July 22nd issue, performs an Exclusive Or function for two inputs $(\overline{A} + \overline{B}) \cdot (\overline{A} + \overline{B})$. However, it does not perform the Exclusive Or function for more than two inputs.

For example, the Exclusive Or function for

three inputs takes the form $(\bar{A} + \bar{B} + C) \cdot (A + \bar{B} + \bar{C}) \cdot (\bar{A} + B + \bar{C}) \cdot (A + B + C)$. This reads that the Exclusive Or function is true when one (1) or three (3) inputs are present (logical *1*'s). In general, the Exclusive Or function for *N* variables (inputs) is true when an odd number of variables are in the logical "*1*" state. This property of the *N*-input Exclusive Or circuit makes it extremely useful in performing parity checks in digital computers.

N. P. Breault, Assoc. Engineer
E. F. Morris, Assoc. Engineer
International Business Machines Corp.
Poughkeepsie, N. Y.

Floating Decimal Points Again

Dear Sir:

Although the editing of the article, "Building Block Circuits for Transistorized Digital Computers," *ED*, September 2, was in general very satisfactory, there were two obvious errors:

a) page 20, column 3, par. 5, line 2: "25 v" should have read "2.5 v" and

b) page 21, column 1, par. 1, line 5: "+70" should have read "−70."

You may be interested to know that several engineers have expressed interest in the "Monostable Multivibrator Featuring Quick Recovery."

Frederick C. Hallberg
John M. Hovey
Harold H. Levy
U. S. Naval Research Laboratory
Washington, D. C.

Improper Credit Given

Dear Sir:

On page 11 of the October 14, 1959 issue of your excellent magazine there appeared a picture of a plating thickness gage. The caption implies that it was developed at or by the National Bureau of Standards.

Actually this gage was developed at Boeing Airplane Co., Seattle, Wash. To measure rhodium plating thickness (on printed circuits) to a few millionths of an inch, the principle of beta particle backscattering is used, this part of the gage having been developed in the Radioisotopes and Nuclear Instrumentation Group of the Nuclear Physics Unit at Boeing Aero-Space Division. The picture shows Mr. Don Frazer of Boeing Manufacturing Research Group, using the gage.

We were happy to see the gage in print, though, even with the wrong information.

David L. Dye, Ph.D.
Boeing Airplane Co.
Seattle 24, Wash.

▶ Our apologies to the Boeing gentlemen.

Blocks to Creativity

II Cultural Barriers

A. L. Simberg, Supervisor
Personnel Research & Development
AC Spark Plug Div.
General Motors Corp.
Flint, Mich.

This is the second of three articles on obstacles to creativity. The first article (*ED*, Nov. 11, 1959) discussed perceptual blocks. The third article will consider emotional blocks.

A. L. Simberg, instructor and lecturer in creative thinking, is not averse to taking his own advice. When he entered the field of personnel research, he found a paucity of standard tests to spot creative talent. Whereupon he undertook to create his own. He became co-author of the "AC Test of Creative Ability," a paper-and-pencil examination of idea fluency and flexibility.

The 36-year-old specialist, who holds an MA in psychology, has lectured on creativity before the Industrial Education Institute, American Management Assoc., Society of Automotive Engineers, and at several colleges and other professional societies.

SOCIETY lays down rules of behavior, thought and action. If the individual does not obey these, he is considered a nonconformist. But conformity and creativity do not go hand in hand.

Conformity requires that the young engineer act in a certain way merely because it is customary. Creativity requires that the present way be challenged, investigated and, if necessary, changed.

Cultural blocks to creativity are among the most difficult to eliminate. We have a whole force of blocks to contend with, resulting from years of training in the home and in school. Add to this the difficulty of a new, young engineer in a company challenging the parties in power, perhaps getting off to a wrong start, and it is obvious why engineering changes are not easily brought about.

It requires a certain courage to create, an attitude that enables the engineer to strike off in new directions. Let us investigate more closely some of the blocks we term cultural.

■ ***The desire to conform to an adopted pattern.***

Most people do not like to be different; it is not a very comfortable feeling. However, many of our routine actions are really not necessary for conformity. They are the patterns of behavior that, for one reason or another, we have developed ourselves. These patterns can be eliminated only by our own effort. The human mind is fascinating in that it is able to develop patterns where none existed. The mind seems able to "correct" our perceptions, to organize them into the meaningful objects we know.

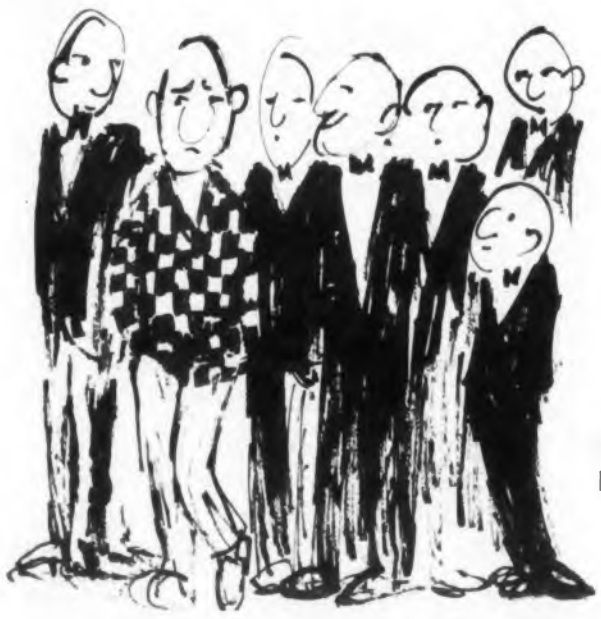
For example, try the problem of the nine dots below (solution at end of article). The task is to join these nine dots by four straight, continuous lines (do not raise pencil from paper).

o o o
o o o
o o o

■ ***We must be practical and economical above all; so often judgment comes into play too quickly.***

Our lives are composed of a series of paradoxes. On the one hand, we are taught to be practical, thrifty, etc., while on the other our teachers are the first to admit that "it takes money to make money."

Our chief engineer gives us the assignment of developing a new product. He tells us that he wants something that is really "practical" but yet it must be startlingly different. Unfortunately what often happens is that at the sound of the word "practical," our imaginations cease to function.



Most people do not like to be different.

Would it not be just as simple to start with the "startlingly different" idea and engineer this back to practicality? Learn to try to shoot for the single great idea at the outset. Take your chance on the "one in a million shot." You can always come back to reality by stages, either because of cost, processing problems, etc.

Our minds seem to function either imaginatively (creatively) or judiciously (using judgment). When we are using judgment—deciding, placing values upon something, etc.—we cannot also be creative.

Lest it be thought that judgment is of no value, let me hasten to add that it is of the utmost importance. But it has its place, and this, is after, not during the time when we are trying to find ideas!

■ ***It is considered impolite to be too inquisitive and unwise to doubt.***

People who are inquisitive are often considered "nosy." In business language they are often told

It is considered impolite to be too inquisitive.

An Unprecedented Opportunity to Enter the Field of

VERY LARGE SCALE SYSTEMS

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412 L EXPEDITE

OPENINGS NOW ON PROGRAM 412L

(Air Weapons Control System)

The Heavy Military Electronics Department of G.E. has been awarded responsibilities for Systems Management, Systems Integration and Systems Engineering of AWCS 412L—a Universal Electronic Control System to meet the vast problem of Air Defense outside the continental United States.

Designed for both fixed and mobile applications, 412L will be an ultra flexible system. It can be used to defend a single airfield or—by linking control sites together—provide air control for an area the size of Alaska. By integrating capabilities of several countries, it can operate as the air defense system for an entire continent.

In addition to its prime function of Systems Management, HMED will design, develop and produce the Data Processing and Display Subsystem, which is the heart of 412L.

Also Openings on Diversity of Other Far-ranging Programs in:

Fixed & Mobile Radar; Shipborne Radar; Shipborne Search Sonar, AN/SQS-26 (a new responsibility), Underwater Detection Systems; Missile Guidance; Far Flung Communications.

Yesterday's systems must today be considered only "subsystems" to be integrated into a larger entity. The growing demand of the defense establishment for super-systems offers challenges of unprecedented scope to the engineering profession.

Now HMED offers able engineers an opportunity to get full exposure to this field of the future—to learn, grow and develop their capacities for systems thinking, by working with men who have been in-at-the-beginning of major systems design and integration programs.

Facts and Figures Behind Growth Opportunities Here:

At HMED you are joining an organization providing professional people with an outstanding combination of CAREER STABILITY plus INDIVIDUAL PROGRESS. In the last few years this G. E. department has *doubled* its dollar business volume; *tripled* its engineering laboratory and office space; *quadrupled* the number of its supervisors and managers, from 26 to 101, with 90% promoted from within; *quintupled* its professional engineering staff.

CUT COUPON ON DOTTED LINE

☐ **COMMUNICATIONS ENGINEERS**—To work with Propagation consultant in frequency choice versus sight configuration, and design of optimum communication and sight configuration. (BS in EE and 3 years' experience necessary)

☐ **RADAR SYSTEMS ENGINEERS**—To integrate varied data acquisition equipment into complex electronic control systems. (Advanced EE degree preferred with minimum 3 years' experience)

☐ **TELECOMMUNICATIONS ENGINEERS**—To design and develop advanced communications subsystems of ground electronic control system complex. (EE degree and 5 years' experience)

☐ **PROPAGATION CONSULTANTS**—To assist in the design, development and management of radar and communications subsystems as applicable to an air defense system. (Advanced degree in EE or Physics with 5 years' experience)

☐ **RADAR RECEIVER & VIDEO PROCESSING ENGINEERS**—To establish receiver design criteria for optimum system performance in varied environments, particularly ECM. (Advanced EE degree or equivalent and minimum 5 years' experience)

☐ **ECM SPECIALISTS**—To provide threat models and consultation to design and management engineers. (Advanced degree in EE and 3-5 years' experience)

☐ **ANTENNA AND MICROWAVE ENGINEERS**—To establish antenna design and sighting philosophies for optimised detection system performance. (Advanced EE degree and 5 years' experience)

☐ **RADAR DESIGN ENGINEERS**—To work on advanced designs and development of receivers utilizing parametric amplifiers. (BSEE and 2-4 years' experience)

☐ **PERSONNEL SELECTION AND TRAINING SPECIALISTS**—To prepare job evaluations, manning structures for complex military systems, and forecast training aid needs. (PhD or EdD required)

☐ **EQUIPMENT EVALUATION SPECIALISTS**—To solve man-machine problems, evaluate alternative components, displays, or techniques and devise simulators. (PhD in Experimental Psychology)

☐ **CABLING ENGINEERS**—To resolve varied problems in grounding and associated shielding problems of complex electronics equipments. (EE degree with minimum 2 years' experience)

☐ **LOGIC DESIGNERS**—To organize and perform logic designs of a high speed digital computer. (Degree in EE, Math or Physics with minimum 4 years' experience)

☐ **CIRCUIT DESIGN ENGINEERS (DISPLAY)**—To analyze equipment and circuit design requirements in data utilization and display subsystems. (Electrical Engineering degree with minimum 5 years' experience required)

☐ **SYSTEMS ANALYSTS**—To conduct system analysis programs and feasibility studies which lead to the conception and development of new systems, subsystems, and equipments of advanced design and function. (Advanced degree in EE, Math or Physics preferred with 3 years' previous experience)

☐ **TECHNICAL WRITERS**—To organize, write and publish progress and planning reports. (Engineering degree preferred with previous technical writing and editing experience in advanced electronics)

Dear Mr. Callender: Please send me an application form and additional information on the positions I have checked off above.

I am a graduate engineer with _____ degree (s) and _____ years experience.

NAME_____

ADDRESS_____

CITY_____ ZONE_____

STATE_____

Mr. George B. Callender, Div. 76-SMU
HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

CIRCLE 900 ON CAREER INQUIRY FORM

that the matter is "out of the realm of your immediate responsibility."

The engineer who accepts this code literally, who fails to question methods, processes, materials and personnel, will remain noncreative. Usually if a person is properly approached, he is happy to answer any questions. Not many managements expect complete obedience to the established procedures merely because they are "policy."

Harlow Curtice, former president of General Motors, wrote last year:

"Men of science and engineering . . . possess what I have called the inquiring mind. This type of mind is never satisfied with things as they are. It is always seeking ways to make things better and do things better. It assumes that everything and anything can be improved."

To worry about the cultural taboo on asking questions is to deprive yourself of needed information. It could mean the difference between solving a problem and not solving it.

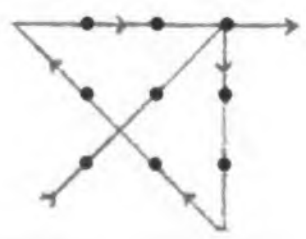
■ ***Over-emphasis on competition or on co-operation.***

One other seeming paradox in our society is that of competition or co-operation. We usually think of these as opposites, while in reality they may be considered in another way. An over-emphasis on co-operation may very well mean that the engineer must temper his creative ideas to fit in with the current thinking of the organization for which he works. This situation may be true in some companies. However, in many others there is no such barrier, except that within the engineer himself.

Competition in itself implies that one is working against someone else. An over-emphasis on competing will lead the engineer to lose sight of his primary goal, that of solving the problem at hand rather than trying to "beat someone else to it."

Emphasis on competition or cooperation tends on the whole to make technical people rely less on their initiative, resources and creativity. They feel they are either in a race against someone else or must co-operate to keep their jobs. Either attitude, on an all-or-nothing basis, leads to stagnation of ideas. ■ ■

Solution to problem:



Advancement Your Goal?

Use New Form To Speed Action

ELECTRONIC DESIGN's new Career Inquiry Service form is designed to help engineers advertise themselves. This new service speeds applicants to the jobs they seek. It is the first such service offered in the electronics field and is receiving high praise from personnel managers.

To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will act as your private secretary and type neat, duplicate copies of your standardized resume and send them to all companies you may select . . . *the same day the resume is received.* (ELECTRONIC DESIGN will detach the circle number portion of the form so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personnel-manager requests for resumes from applicants who proved ineligible.

MAIL CAREER INQUIRY SERVICE FORM TO READER SERVICE, ELECTRONIC DESIGN, 830 THIRD AVE., NEW YORK 22, N. Y.

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE** USE BEFORE JAN. 6, 1960

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below. (24)

(Please print with a soft pencil or type.)

Name _____ *Telephone* _____

Home Address _____ *City* _____ *Zone* _____ *State* _____

Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Trcining _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

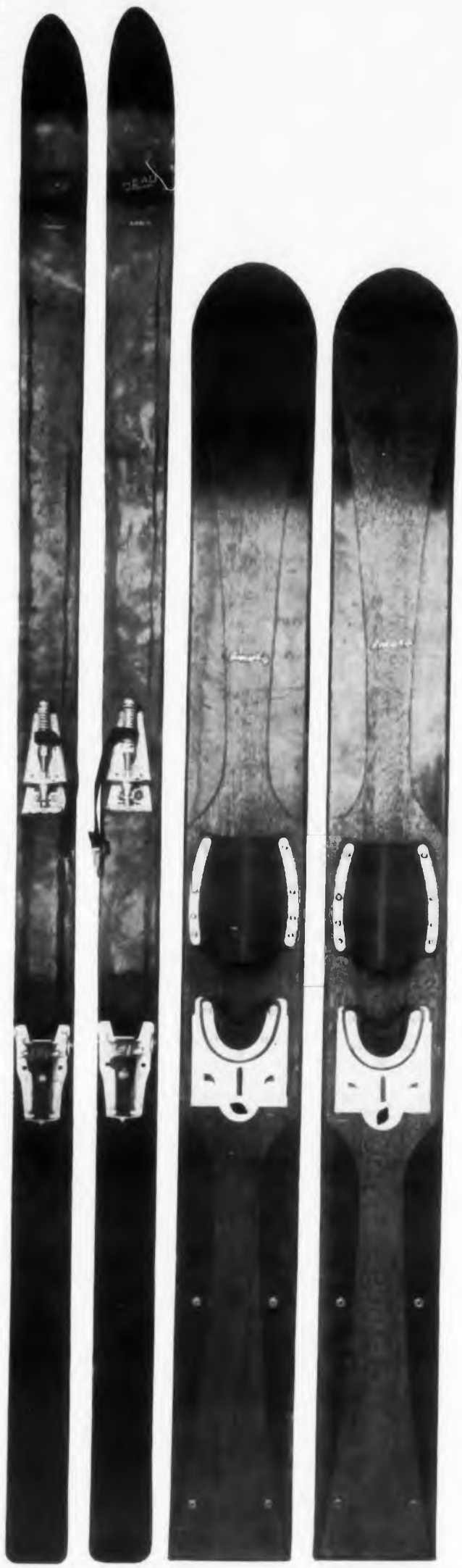
Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

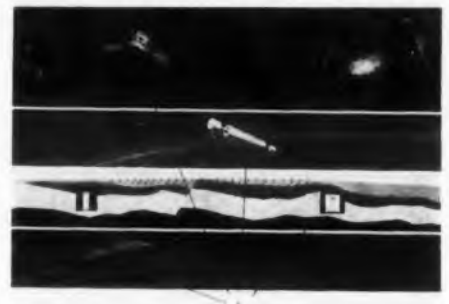
900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924

925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949



CAREER OPPORTUNITIES BROCHURES

Space Electronics Corporation



Space Electronics Corporation has presented in this eight-page illustrated brochure its past and present achievements and future aims in conducting advanced and practical research and development on electronic problems associated with missile and space technology. The company's scope of activities includes: systems analysis, instrumentation, communications, computing equipment, ground checkout equipment and guidance components. An 8-page tip-in is devoted to the experiences and capabilities of SEC's management and staff. An organization chart and a graph depicting staff and business growth are given.

Space Electronics Corp., Dept ED, 930 Air Way, Glendale 1, Calif.

CIRCLE 870 ON READER-SERVICE CARD

Westinghouse

The activity at Westinghouse in Youngwood, Pa., is devoted exclusively to the design, development and production of semiconductor devices. The Advanced Development Section is charged with the development of materials and devices up to the pilot plant stage. The company's 6-page brochure and pitch letter describe briefly the section's prime interests and aims. Facilities, on-the-job photos, and living conditions within the Youngwood, Pa., community are illustrated and outlined.

R. G. Snyder, Industrial Relations, Semiconductor Dept., Westinghouse Electric Corp., Dept. ED, Youngwood, Pa.

CIRCLE 871 ON READER-SERVICE CARD

YOUR CAREER

NEWS AND NOTES

Engineers and scientists may not always agree on what makes them happy on the job. But the majority of 622 interviewed recently had little hesitation about disclosing what made them unhappy: it was company management.

Seventy-two per cent of those responding to the survey accused management of misusing their talents; 80 per cent complained they were underpaid compared with other groups; 75 per cent felt hemmed in by corporate pressures and unable to work in the most creative way; 67 per cent believed that "pull," not necessarily knowledge, was the key to success in management.

The survey, conducted by Opinion Research Corp. of Princeton, N.J., covered six big corporations in electrical equipment and electronics, aviation, chemicals, drugs, petroleum and rubber. The opinions of 105 managers at the corporations were also recorded.

Half of the professionals who were surveyed held advanced degrees, a third had doctorates and many were lauded by their managers as "presently or potentially most valuable" to their corporations.

"***Management's push for profits*** sharply conflicts with the scientists' and engineers' quest for perfection," Opinion Research concluded in a report on the survey. "Companies have put forth increasing money and effort to motivate and satisfy their technical people without much evident success."

The research organization noted this split in motivation between management and science-engineering personnel: managers obtain satisfaction from being identified with a successful company, but scientists and engineers want recognition based on individual contributions. Managers who were interviewed agreed that the scientific intellect required a different type of recognition from management's, but the survey found that "little has been done to fill this need."

Typical of differences between the two groups were these examples uncovered by the survey:

Engineers said: Budgets, production timetables, demands for immediate results are stifling scientific goals.

A manager replied: Research freedom like this "is actually a form of laziness; the place for such freedom is in academic institutions, not competitive industry."

A scientist: "The company only pays lip service to the idea and policy that a scientist can advance in stature, pay, recognition and prestige without getting into administrative work. Without

(continued on page 182)

Catalog Information

. . Right at Your Finger Tips

Here is a valuable new information service to augment your data files. Manufacturer's catalogs are now being accepted for binding, directly in *Electronic Design*. The catalogs may be easily removed, or if you wish, filed with the magazine (all catalogs will be listed in the semi-annual index of articles).

This unique service is one more step in providing our readers with the latest, complete, product information obtainable in a single reference source. Up-to-the-minute product data can break design bottlenecks, create additional time for more important work, speed the completion of your project.

If there is a particular type of product for which you would like to have information on a regular basis, let us know about it, we will relay your requests to the appropriate manufacturer.

How to Request Additional Catalogs

If you need extra catalogs for other engineering groups or for central files, use the appropriate Reader-Service number to request additional copies.

CIRCLE 800 ON READER-SERVICE CARD

CAREER NEWS

(continued from page 181)

getting out of actual research, there appears to be nowhere to go after about 10 years of service."

Most managers: Knowledge and not "politics" determines who will get ahead.

There was general agreement, however, on the contribution of science and technology to this country's high standard of living. Thirty-two per cent of the engineers and scientists said they were "mainly responsible" for the rising standard, and 79 per cent of the managers agreed.

But most engineers and scientists appeared to doubt that the public was aware of their key roles in national progress. Asked to name those "well thought of" in the community, 56 per cent of the engineers and scientists listed management; only 9 per cent cited themselves.

Opinion Research recommended that companies explore ways to mold managerial policies without losing sight of the special needs of scientific and technical personnel. It urged that a dose of realism be injected into the college training and job recruitment of engineers and scientists to offset any disillusionment on entering the world of business.

"It's time to call a halt to over-promising, to building unrealistic hopes for a life very much like an extension of graduate school," the research organization said.

° ° °

Seven new employment offices for engineers and technical personnel have been opened in strategic parts of the United States by AC Spark Plug, the electronics division of General Motors.

The offices—at New York City, Dayton, Boston, Detroit, Washington, Dallas and Los Angeles—will seek top-flight personnel for AC Spark Plug operations in Milwaukee, Boston and Los Angeles. The company is developing inertial guidance for the Titan ICBM and holds other advanced research contracts. It also produces inertial guidance for Thor and Mace missiles.

Directors of the new job recruiting program and addresses of the area employment offices are as follows:

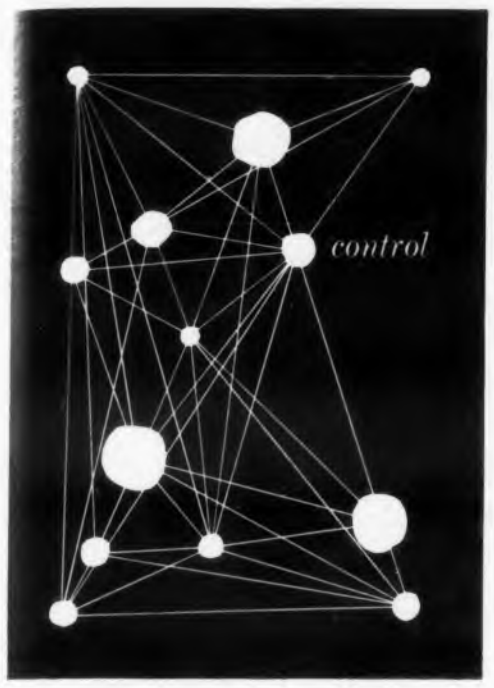
New York City—Richard Klann; Franklin National Bank Building, 600 Old Country Rd., Garden City, L.I., N.Y. (PI 1-8955).

Dayton—William B. Clark; Talbott Tower, Suite 1005, 118 W. First St., Dayton, Ohio (BA 8-9522).

Boston—Thomas S. Crutcher; 59 Park, Beverly, Mass. (WA 7-1474).

Detroit—John P. Donovan Jr.; Room 204, Tech Center Service Section, Box 56, North End Station, Detroit (JE 9-5000).

(continued on page 184)



careers in control of space

For 74 years, Minneapolis Honeywell has pioneered and led the development and production of advanced automatic controls. Today, with work in this area more demanding and more rewarding, new opportunities exist for engineers.

PRODUCTION: Develop and establish assembly processes for a wide range of products. Requires background in complex devices such as gyros, accelerometers, flight systems, and a thorough knowledge of production processes.

COMPONENT APPLICATION: Senior development engineer (BSEE) to pioneer as specialist on radio noise suppression. Also, a specialist in application of capacitors to aid and guide design engineers.

INSTRUMENTATION: Development and design in the critical areas of test instrumentation for Aero Division products. Two years' experience in test instrumentation desired.

FIELD SERVICE: Monitor airborne system performance in U.S. and overseas. Conduct training, liaison with military. BSEE preferred, or graduate engineer with high electronic aptitude.

If you're interested in a challenging career in advanced automatic controls, write Mr. Bruce H. Wood, Technical Director, Dept. 73C.

Honeywell

AERONAUTICAL DIVISION

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CIRCLE 906 ON CAREER INQUIRY FORM ➤

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TEST OPERATIONS
WEAPONS SYSTEMS MAINTENANCE
PLANS AND PROGRAMS
DESIGN INSTALLATIONS

MARTIN
ACTIVATION

CAREER NEWS

(Continued from page 182)

Washington—Earl W. Sherburne; 1625 First St. N.W., Washington, D.C. (EX 3-1133).

Dallas—Gerald Raasch; Rice Building, 5641 Yale Blvd., Dallas, Tex. (EM 1-5813).

Los Angeles—James Kronner; 950 N. Sepulveda, El Segundo, Calif. (EA 2-5750).

* * *

Engineers are often thought of as more interested in "things" than people. The General Electric Engineers Assoc. of Syracuse, N.Y., aims to counteract that belief. One of its goals for the coming year is to heighten the work of its Civic Activities Committee.

Under the chairmanship of Richard Charles, the committee sees its job as a dual one: to serve the community and to educate it to the role of engineers as professionals.

"We want the community to know us not as transient technical people interested only in ourselves, but rather as permanent residents gifted with an ability to analyze community operations, appreciate community problems and actively participate in helping to solve them," Mr. Charles was quoted in the association's publication, *The Engineer*.

Among activities that the committee is undertaking is repair work for a Talking Book Project for the blind, installation of a public address system at a meeting place used by the blind, help in maintaining portable polio respirators in the Syracuse area and a role in metropolitan development.

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographic areas: One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

National Courses

UCLA Engineering and Management Course, January 25-February 4

A course for the professional development of managers and designers, will be held at the University of California, Los Angeles. The 10-day program will offer a choice of 22 subjects to fit the

QUALIFICATIONS: B.S. or advanced degree in Electrical or Mechanical Engineering, Physics or Mathematics — and proven ability to assume a high degree of technical responsibility in your assignments.

TYPICAL ASSIGNMENTS

Planning and logical design of solid state computers, input-output systems, and peripheral equipment. Knowledge of digital systems required with experience in transistor circuitry and switching techniques.

Analysis of ferrite "memory" and buffer systems and design of new high-speed configurations, including drive and addressing circuitry, for advanced solid state data processing systems. Familiarity with digital computer systems and magnetic core "memory" design.

Solutions of real-time control problems with digital techniques; mathematical analysis of navigation and fire control systems, ray tracings, and signal cross-correlations.

Application of information theory to signal processing. Familiarity with signal cross-correlation techniques, statistical data processing, sampled-data control theory, analog-digital data processing techniques, signal propagation, and beam formation. Naval experience required in at least one of these specialties: sonar, fire control, ASW, navigational systems, signal processing.

Investigation of new computer applications and techniques, based on observation and analysis of customer needs; establishment of broad systems concepts, assisting in both logic and machine design. Experience required in digital computer applications, technical organization of a medium or large machine installation.

Circuit design of advanced data processing systems and input-output equipment, working closely with logic designers. Experience required in design of arithmetical control and switching circuitry to reduce logic diagrams to component counts for cost-estimating development.

Application of transistor-diode logic to develop advanced circuitry; review of new circuits for possible use in digital control systems, defining basic techniques for improving performance characteristics.

Laboratory facilities are located in Endicott, Poughkeepsie, Kingston, Owego, and Yorktown Heights, N. Y.; Lexington, Ky.; and San Jose, California.

CAREERS ALSO AVAILABLE IN THESE AREAS . . .

Acoustics
Applied mathematics & statistics
Applied physics
Circuit design & development
Component engineering
Computer analysis
Cryogenics
Flight test analysis
Human factors
Inertial guidance
Information retrieval
Logical design
Magnetics
Microwaves
Operations research
Programming
Radar circuitry
Transistor circuit design

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CIRCLE 907 ON CAREER INQUIRY FORM

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He's a top liaison man too, able to work smoothly with management, project engineers, test engineers, and others to insure that specifications are current and accurately reflect contractual requirements. And he's constantly negotiating specifications with customers and subcontractors. He knows how to *lead* too, supervising engineers working on lower level specifications.

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Please Send Resume To:

Mr. Walter N. Wells, Professional Personnel,
Missile Systems Division, Raytheon Company,
520 Winter Street, Waltham 54, Massachusetts.

RAYTHEON MISSILE SYSTEMS DIVISION

CIRCLE 908 ON CAREER INQUIRY FORM

CAREER COURSES

needs of both executives of large industries or of middle-level personnel from small companies. Emphasis will be on the principles and techniques which form a systematic approach to management, and on the quantitative methods which supply the facts for such an approach. Information on registration and living accommodations may be obtained from Reno R. Cole, College of Engineering, University of California, Los Angeles 24, Calif.

Training Course In Value Engineering and Analysis, IEI, November 30

This five-day course, which will be held in Boston, starting Nov. 30, has been developed by the Industrial Education Institute, in cooperation with the Materials Handling Institute. The program, covering all phases of the subject, has been designed especially for men responsible for product design, procurement and manufacturing in industry and government.

Value Engineering and Analysis is a technique developed for reducing product cost. It is concentrated effort to improve the value of any product by eliminating unnecessary costs in product design, manufacture and procurement.

The five-day training will combine formal instruction, guest lectures, informal discussion, demonstration, case study and problem solving. Through specially developed work projects, the participants will learn "by doing" by value analyzing a wide variety of products. Through the free exchange of information with men with similar responsibilities and problems, the registrants will pick up new functional design and procurement techniques they can apply to their own products.

The members of the "faculty have been drawn from industry, government and education. They include L. S. Miles, Manager of Value Services, General Electric Co.; Rear Admiral A. G. Mumma (USN Ret.), Vice President, Engineering, Worthington Corp.; Rear Admiral R. S. Mandelkorn, (USN Ret.), Chairman of Value Engineering Committee, Electronic Industries Association; Vincent de P. Goubeau, Vice President, Materials, Radio Corp. of America; Frederick S. Sherwin, Manager, Value Analysis Service, Raytheon Co.; Don Otis, Controller, Electric Typewriter Div., IBM Corp.; Bernard W. Eades, Manager, Value Engineering, Stromberg-Carlson Co., and President of the Society of American Value Engineers; Raymond J. Spenard, Value Analysis Education, U. S. Army Ordnance; Morgan D. Roderick, Office of Value Engineering, Bureau of Ships, U. S. Navy; Louis J. De Rose, Executive Director, Materials Management Institute, and others. Further details and

registration information may be obtained from the Registrar, Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.

One-Day Seminars

Plastics Engineers One-Day Seminar, Washington, D.C.

The Baltimore-Washington Section of the Society of Plastics Engineers, Inc., in conjunction with the Prevention of Deterioration Center of the National Academy of Sciences, has scheduled a Regional Technical Conference entitled "Stability of Plastics." Dr. Herman Mark, Director, Polymer Research Institute, Polytechnic Institute of Brooklyn, will preside as moderator of the program.

The objective of the conference is to present a program covering current concepts of mechanisms governing natural and synthetic polymer stability and degradation. Degradation under the conditions of mechanical processing, untraviolet or other radiational exposure, elevated temperatures, and enzymatic attack will be among the topics covered by well-known contributors to these fields. While papers will report results of original investigations, each author will present a brief survey of the current theories of the mechanism of polymer degradation under the influences of the various factors enumerated above. The conference will be held December 1, in the auditorium of the National Academy of Sciences Building, 2101 Constitution Ave., Washington, D.C.

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

December 15: Deadline for abstracts of 150-200 words for the **1960 Electronic Components Conference** scheduled for **May 10-12** in Washington, D. C. Please send in triplicate to: *Gilbert B. Devey, Technical Program Chairman, Sprague Electric Co., North Adams, Mass.*

January 15: Deadline for 100 word abstracts in triplicate and 500 word summaries in triplicate for the 1960 IRE Professional Group On Microwave Theory And Techniques to be held May 9-11 at the Hotel del Coronado in Coronado, Calif. Papers to be presented should deal with microwave components, systems and physics. Send all material to: Dr. David B. Medved, Chairman, Technical Program Committee, 1960 Dynamics Corp., Mail Zone 6-172, P. O. Box 1950, PGMTT Symposium, Convair, A Div. of General San Diego, Calif.

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