COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

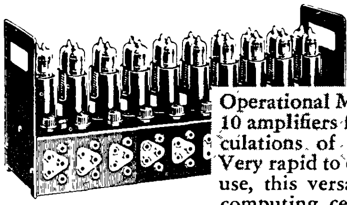
Vol. 4
No. 1

JAN.
1955

ELECTRONIC ANALOG COMPUTING COMPONENTS

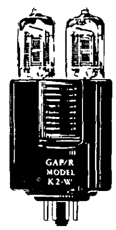
FOR SYNTHESIS & ANALYSIS, PLANNING & PLOTTING, PROVING & IMPROVING

GAP/R Modular Components give remarkable flexibility of structure and application
They adapt winningly to every size of project and budget, and to all operating speeds

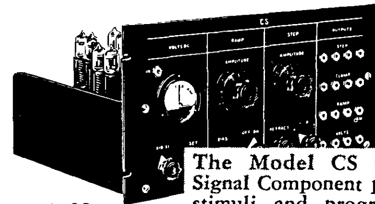


The Model HK Operational Manifold offers 10 amplifiers for analog calculations of great variety. Very rapid to connect and to use, this versatile unit is a computing center in itself.

COMPARE MODEL MK



The Model K2-W Operational Amplifier is an octal-based plug-in unit which will serve as nucleus for accurate feedback functions. It has differential inputs, high DC gain, and useful bandwidth over 100 KC. Other models include the K2-X, which puts out ± 100 V and more power.

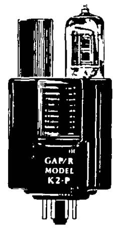


The Model CS Central Signal Component provides stimuli and programming commands for automatic repetitive computing. It sets initial conditions, and checks all calibrations.

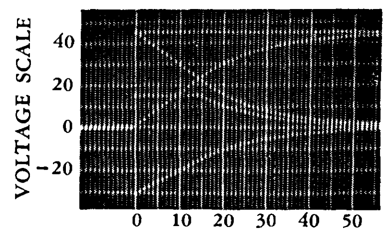
SEE ALSO MODEL CR BELOW

The Model RK Regulated Power Supply employs premium transformers and inductors, plus a high-stability regulating circuit. Capacity of this Supply is sufficient for 4 of the above Model HK.

COMPARE MODEL RS



The Model K2-P Stabilizing Amplifier, used in tandem with the above, provides long term DC stability measured in microvolts. It installs directly in the HK Manifold or in other environments. We also manufacture dozens of other useful plug-in units in this unique package.

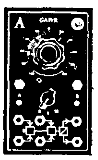


ELECTRONIC GRAPH PAPER

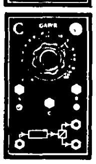
For repetitive Analog solutions, this method of display enables simultaneous plotting, to high precision, of many concurrent variables. Calibration is automatic for time and voltage, and is proof against all oscillographic errors.

For normal time-scale purposes, a variation of this method is directly applicable. Known best for High Speed, GAP/R methods are actually *Pan-celerative.*

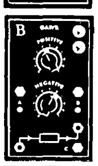
THE K3 SERIES OF COMPUTING COMPONENTS



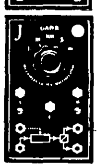
The Model K3-A Adding Component accepts from one to 4 input voltages, and supplies both plus and minus their instantaneous sum. An additive constant may be set in manually. All signal inputs and outputs are at the front, and power is simply plugged in at the rear. At the right is shown a utilizing system.



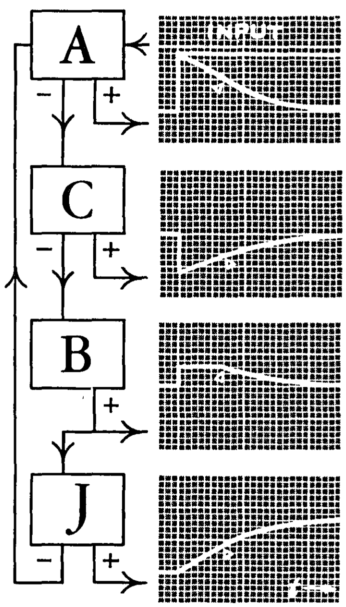
The Model K3-C Coefficient Component multiplies its input voltage by an adjustable constant, and gives outputs which are positive and negative versions of the instantaneous product. The scale shows unity (the most likely scale-factor) at the center, and sets readily down to zero and up to infinity.

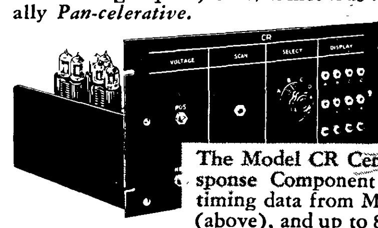


The Model K3-B Limiting Component permits the input voltage to be passed on directly to the output whenever the input is within adjustable positive and negative bounds, but otherwise holds the output fixedly at the bound last exceeded. Such nonlinearities are readily analyzed with these handy tools.

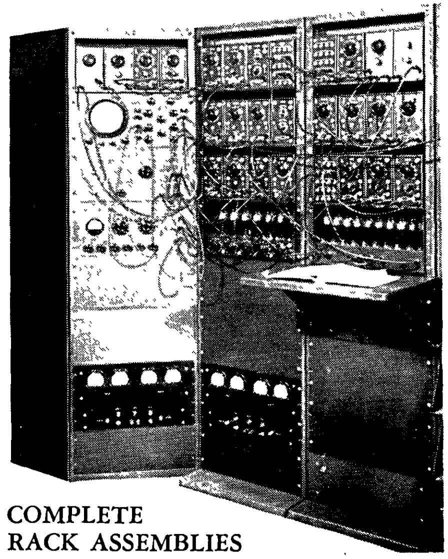


The Model K3-J Integrating Component computes plus and minus the time integral of the input, at selected rates. An input is available for clamping, to set the starting point. This unit serves, like our others, for fast or slow operation. In this same modular form, we offer 10 other fundamental types.

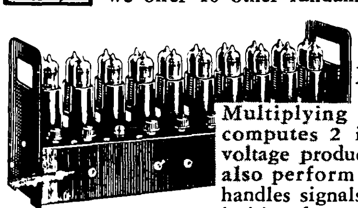




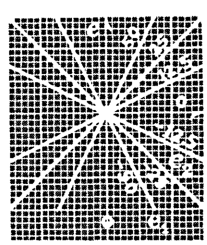
The Model CR Central Response Component accepts timing data from Model CS (above), and up to 8 signals for display; it generates the calibrated graphical display (as shown) for any 'scope.



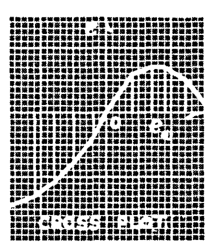
COMPLETE RACK ASSEMBLIES



Model MU Multiplying Component computes 2 independent voltage products, and will also perform division. It handles signals of both polarities, from DC to above 50 KC, with accuracies to ½% or better.



Model FF Functional Component produces an output voltage which follows an adjustable instantaneous function of the input voltage. The adjustment is simple and direct. Applications abound for nonlinear problems.



GAP/R STANDARD products are too numerous for a single page. Included are accessories to fulfill all your analog needs.

SPECIAL equipment may be engineered for new or unusual applications.

ADVICE is available on how our methods may be applied to your problems. Our staff is experienced and knowledgeable and cooperative.

George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

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THE EDITOR'S NOTES

NATIONAL TELEMETERING CONFERENCE,
May, 1955

A "National Telemetering Conference", sponsored by the IRE, the AIEE, IAS, and ISA will be held in Chicago May 18, 19 and 20, 1955. Papers are invited covering new developments and ideas in the fields of remote control and telemetering. The program will be organized about the following main subjects:

1. Declassified developments in remote control of guided missiles and aircraft, including: guided missile data reduction; reference systems for guidance; use of computers for simulating remote control problems; all-weather flight control; automatic landing of aircraft.

2. Remote control in industry and business, including: remote control aspects of an automatic factory; application to business and industry of techniques developed in guided missile work; telemetering systems; converting remote information into computer input.

3. Instrumentation for flight testing of aircraft, including handling of test data; and programmed flight tests.

4. New components for telemetry such as: transducers; transmission equipment; recording equipment; data reduction equipment.

It is planned to have a distribution of the Proceedings of the Conference in the hands of advance registrants one week before the meeting.

The chairman of the program committee is Conrad H. Hoeppner, W. L. Maxson Corp., 460 West 34 St., New York 1, N. Y., to whom inquiries in regard to papers and proposed abstracts should be sent.

WESTERN JOINT COMPUTER CONFERENCE,
March, 1955

The Joint Western Computer Conference and Exhibit will be held at the Statler Hotel, Los Angeles, California, on March 1, 2, and 3, 1955. It is sponsored by the IRE, AIEE, and Association for Computing Machinery. Pre-registration fee is $2.50 and covers admission to lectures and exhibits and a copy of the Transactions. The main subject of the Conference is "Functions and Techniques in Analog and Digital Computers". Technical papers and discussions will include descriptions of existing systems and techniques, language and communication problems between machines, the possibilities of managerial and computer systems revision to achieve rapid integration, and new developments in analog computers and analog computing methods. The exhibit will be limited to the products of manufacturers who make computers or major computer sub-assemblies and will be open during the day and evening hours. In addition to the technical sessions and the exhibit, there will be evening field trips to major Los Angeles electronics firms, a cocktail party, and luncheons. Those interested in attending should write William Gunning, Conference Secretary, International Telemetering Corp., 2000 Stoner Avenue, Los Angeles 25, California.

UNIVERSITY OF WISCONSIN CONFERENCE,
August, 1955

The University of Wisconsin is planning to hold a conference entitled "The Computing Laboratory in the University", August 17 to 19, 1955.

It is planned to invite speakers to cover the applications, organization, financing, and educational aspects of university computing laboratories. The University of Wisconsin is holding this conference in order to re-assess its own computing program, which, through the Numerical Analysis Laboratory, offers an extensive free service to its faculty. For more information, write to Preston C. Hammer, Director, Numerical Analysis Laboratory, University of Wisconsin, Madison 6, N. Y.

4000 COPIES

This issue of COMPUTERS AND AUTOMATION, starting vol. 4, is a double-printing issue: our usual print order is 2000, and for this issue the print order is 4000. We are setting aside a substantial part of the additional 2000 to give copies to friends and acquaintances of our subscribers. If you desire us to send a free copy to someone you know who is interested in computers and automation, tell us and send us his address; and so long as we have the extra supply set aside, we shall be glad to send him a copy with your and our compliments.

BULK SUBSCRIPTION RATES

Also, in order to make the information we publish more available to more people, we are adopting bulk subscription rates. These rates apply to subscriptions coming in together direct to us. For example, if 5 subscriptions come in together, the saving on each one-year subscription will be 25 percent, and on each two-year subscription will be 33 percent. The bulk subscription rates, depending on the number of simultaneous subscriptions received, are shown in Table 1, on page 13.

(continued on page 13)

STATISTICS AND AUTOMATIC COMPUTERS

Gordon Spenser
Whippany, New Jersey

Modern, high-speed, high-capacity, automatic computers have made possible the analysis of statistical techniques hitherto impossible. These computers have as a result revolutionized procedures in many fields. Problems have been recast into statistical terms open to automatic computation where, ten years ago, there was no method for solving them. From aerodynamics to zoology, automatic statistical computation is opening doors previously shut.

Nuclear Biophysics

For example, in nuclear science laboratories and, increasingly, in industries using radioactive tracer techniques, it is important to ascertain that people do not receive harmful amounts of radiation. But the penetrating power of radiation and its effects vary greatly, depending upon the type and energy of nuclear particles emitted.

A recent study was made of the effects of neutrons, those electrically uncharged particles that are frequently emitted at high energies and velocities during an atomic transmutation. The study was designed to investigate the effects in animal tissue. A direct mathematical attack was hopelessly complicated. So the physical situation was approximated by the following process: allow a neutron to be emitted from a source; let it collide at random with constituent elements of the tissue; record, at each collision, the amount of energy lost and the location of the collision; simulate the path of the neutron using the computer; compute the damage to tissue as a direct function of energy loss; and do this over and over for a succession of neutrons, making random choices wherever necessary. In this way, a statistical sample is compiled.

The statistical procedure involved choosing randomly: (1) the type of element involved, for example, carbon, phosphorus, oxygen, etc.; (2) the direction of rebound; (3) the length of track until the next collision; etc. The process is repeated until the neutron is entirely degraded in energy. With a sufficiently large number of neutrons tracked in this manner on a computer, standard statistical techniques will provide estimates of the damage resulting in specific regions from neutrons having various starting energies. Moreover, measures of the statistical precision of these estimates are available.

This general method of attack, now named the Monte Carlo method, is ideally suited for a modern, automatic computer since the basic steps involved in generating each collision are the same, while many repetitions and therefore many computations are required to obtain the desired precision. What is accomplished in hours on a high-speed computer would have taken years by hand or months by punch card equipment.

Chemical Engineering

Continually improving technology in chemical engineering frequently poses the question: "Does a projected change in technology significantly improve my product with respect to a specified characteristic?" Standard statistical techniques are available to supply the answer to the investigating engineer, but these techniques may be laborious and time-consuming computationally, or they may be valid only under restrictive conditions. In this case, the preparation of the problem for a computer is generally impractical in view of the computation time, which is short for a computer, and the fact that the computer solution may not take into account the restrictive conditions.

But there is a recently developed body of technique, known as "distribution-free" or "non-parametric" statistics. This technique will provide the answer to the chemical engineer's question under very general assumptions, frequently with little or no computation. For example, one method calls simply for the listing of the measurements of the particular characteristic in order of magnitude, distinguishing between the standard procedure, A, and the proposed revision, B. The record of a listing of 14 measurements may look like "A A B A A A B B A A B B B B." Now all that needs to be done is to count the resulting runs, or number of sets of consecutive appearances of the same letter. In the above sequence there are six runs. Tables in handbooks will then tell at once the degree of statistical significance that can reasonably be attached to the experimental results.

The judicious use of a technique such as this however depends on the knowledge of how frequently the experimenter will come to a wrong decision: specifically, how often he would conclude there is a significant difference from the proposed change when in fact there is none; or vice versa. The probability of concluding that there is a difference is what statisticians call the "power of a test." The mathematical calculation of the power of a test is frequently difficult; in this case it involves the evaluation of an integral whose order is that of the sample size, 14 in the above case.

A statistical calculation for estimating the power of a test is however possible with automatic computers. This method is to generate samples from populations known to differ by a certain amount, and then apply the test to estimate the frequency of correct decisions. The generation of many similarly derived samples and the application of the same testing procedure is a repetitive operation ideally suited to a modern computer. And where handbook tables do not exist, machine sampling can be used as a convenient method for constructing them.

Economics

A goal of many economists is to be able to obtain a mathematical equation which would predict the state of the nation's economy. Naturally one of the requisites for the validity of such an expression is the existence of comprehensive information about the varied constituents of the economic whole, for example, freight car loadings, the volume of currency in circulation, inventory supplies on hand, the number of new construction projects started, and a multitude of other constituents, both general and detailed. The statistical problem is to obtain estimates of the relative importance of the various components, assuming they were to be combined in a certain manner, such as in the equation

$$y = a_1x_1 + a_2x_2 + a_3x_3 + \ldots,$$

where y is the state of the economy expressed in some arbitrary units, the x's represent the various constituents, and the a's are measures of the importance of their respective constituents. The main problem is twofold: to determine the a's; and to determine how much a predicated value of y is likely to vary from the actual value of y.

The estimation of the a's is equivalent to the mathematical problem known as inverting a matrix. To invert a matrix, in general, requires a number of multiplications proportional to the third power of the number of unknown a's (the "order" of the matrix). Thus, doubling the number of constituents requires eight times as much multiplying. Not long ago, the inversion of a twentieth order matrix was a notable event; but now the technical literature contains reports of the inversion of matrices whose order runs into the hundreds. In this way horizons are being pushed further back, and more knowledge of our economic system is becoming available.

Psychology

Similar techniques and advances are to be found in psychology. Multiple factor analysis is a technique in psychological testing to isolate independent traits. The problem of isolation of traits or characteristics may arise in analyzing manifestations of intelligence, in solving classification problems (where one attempts to assign a specimen to one of several species on the basis of a combination of measurable physical characteristics), or in other areas. The ability to invert higher order matrices makes it possible to discriminate between specimens on the basis of the information contained in many more types of measurements, thus increasing the precision of classification.

Demography

The usefulness of the U.S. census of 1880 was severely impaired by the fact that the compilation of the total tabulation was not completed until 1887, and by this time vast changes in the population of the United States had taken place. The use of punch cards, developed by Herman Hollerith, in response to the needs of the Census Bureau, alleviated the condition at the time; but now again the growth of the population and the increase in the size of the census questionnaire are threatening to produce harmful delays. To meet this threat, the Bureau of the Census has begun to use magnetic tape and a modern electronic computer to store primary information and to prepare all tabulating and printing reports, suitable for photographic reproduction.

The new computer system was used on a mass scale for the first time in the 1950 Census of Population and Housing. One of the problems successfully handled was the tabulation of general population characteristics for certain areas in Alabama, Iowa, Louisiana and Virginia with a total census population of some 11.7 million individuals.

These are only a few of the applications of modern, automatic computers to statistics, but they illustrate the diversity of fields of application. Besides, techniques, described under one heading, have similar counter-parts in many other fields. Finally, of key importance in the field of statistics and automatic computers is the use of computers to pursue research in mathematical statistics. Although new procedures may be developed with full mathematical rigor, yet they find their way into the applied statistician's set of tools ordinarily only when adequate tables have been computed. Many of these functions

(continued on page 13)

THE DIGITAL DIFFERENTIAL ANALYZER

George F. Forbes
Pacoima, California

The Digital Differential Analyzer (DDA) can be most conveniently described in terms of its relation to the more familiar Bush Analyzer.[1] The Bush device is an established tool in engineering and research. Its principles and construction are simple and generally understood, and units are available in relatively inexpensive and flexible form.

The main obstacle to wider use of Bush Analyzers in industry has been large bulk, high cost of precision mechanical parts, long set-up time, the limitations imposed by mechanical error, and relatively slow running speed. Although the DDA has some of these limitations, they are not inherent in the principle of operation, as is true of the Bush device.

The Bush Analyzer accomplishes integration through the rotation of mechanical integrator units. A tangent disk rolls on its edge on the surface of a rotating disk. The axes of the disks are perpendicular and in the same plane. As the tangent disk slides along its own axis, the gear ratio between the two disks changes smoothly and is proportional to the distance from the contact point of the tangent disk to the center of the rotating disk. The rotation of the surface disk serves as the input variable, while the rotation of the tangent disk becomes the output variable.

The derivative equation solved by each integrator unit may be expressed as $\frac{dz}{dt} = y \frac{dx}{dt}$. y is the gear ratio, mentioned above, x represents the angle of rotation of the surface disk, z represents the angle of rotation of the driven tangent disk, and t is time. If we consider only the relation between disk angles, the equation becomes the differential equation, $dz = ydx$. If z is accumulated by counting turns or by some device for indicating angle, the equation becomes $z = \int ydx$.

The Bush Analyzers at the various universities tend to be somewhat elaborate. Photoelectric devices are often used to pick up the motion of a very light tangent disk. Thus the disk contact point is not required to transmit any force beyond that needed to overcome the tangent disk inertia and the very slight contact friction. Large plotting tables serve as plotters or as manual or photoelectric curve followers. In all, such an installation occupies a good sized room and includes dozens of gear assemblies and hundreds of feet of mechanical shafting.

Bush integrator units have considerable application in industrial and military calculating devices where they are used in conjunction with cams and servo-mechanisms. These compact units are precision built to transmit the required torque with acceptable error in the minimum possible space.

A small industrial type Bush integrator calculator contains six integrators, two plotter-followers, six constant multipliers, and four adders. It occupies about the space of an office desk, weighs only five hundred pounds, and operates on 500 watts of 60 cycle 115 volt supply. The saving in bulk is accomplished by replacing all shafting with synchro motors and generators. Connections are made on an electrical plug board. The device is rugged and well-built. One-tenth of one percent accuracy is claimed.

Present models of the Digital Differential Analyzer[2] accomplish integration through the use of numerical registers recorded as pulses on the surface of a rotating magnetic drum. Using the same notation as that used above, each integrator consists of an integrand register, y, successively adding or subtracting its contents into a remainder register at a rate $\frac{dx}{dt}$. The output, $\frac{dz}{dt}$, is the overflow rate of the remainder register. In terms of the Bush integrator, the number in the integrand register is analogous to the gear ratio, of the Bush Analyzer. The rate at which the integrand register adds into the remainder register is analogous to the turning speed, $\frac{dx}{dt}$, of the Bush surface disk. The rate of overflow of the remainder register is analogous to the turning speed, $\frac{dz}{dt}$, of the Bush tangent disk.

A machine may include sixty or more integrators, each of which is brought up to date about 60 times a second. The effect is similar to solving a differential equation stepwise by finite differences, using Euler integration and calculating at the rate of 60 steps per second. The number of significant figures used is limited by considerations of practical running time. The usual engineering run of about an hour permits a minimum of three significant figures in initial conditions. This corresponds to a mechanical or electrical component accuracy of one tenth of one percent. Initial conditions in engineering problems are seldom needed, known, or measurable to this accuracy.

A DDA advantage of great potential value is the fact that component accuracy may be increased at the expense of running time. In addition to the flexibility permitted, this advantage leads to an increase in accuracy with greater basic pulse rate. For a given running time, a problem could be run with one tenth the component error if the basic pulse rate were increased by a factor of ten. Inasmuch as the basic pulse rate in present equipment is at about the practical working limit of the drum (100 kilocycles), it is probable that the faster and more accurate machines of the future will utilize mercury column or electrostatic memory devices.

A second major advantage over the Bush Analyzer is the sign reversal property of the integrators. When the tangent disk of a Bush integrator runs off the edge of the surface disk, the machine must be stopped and the problem rerun with new scale factors. The DDA may be coded to stop under these conditions. However, if it is allowed to continue, the overflowed integrand changes the sign of its value. The analogous condition for the Bush integrator would be for the tangent disk to move off the original surface disk onto another disk turning in the same angular direction. That is, the tangent disk would transfer so as to suddenly reverse its direction of rotation.

This sign reversal property is extremely useful. It permits the use of integrators as switching devices, adders, limiters, servomechanisms, discontinuity generators, pulse rate multipliers, absolute value generators, and generators of many other kinds of special functions or responses.

Two very convenient advantages of the DDA are the possibility of summing several inputs directly into an integrand without the use of a separate adding device, and the possibility of multiplying by a constant at the same time integration is being performed. In terms of our notation, each integrator will generate the function z of the form:

$$dz = k(y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7)dx$$

Another advantage of the DDA over the Bush Analyzer, and some other types of analog equipment, is its rapid set-up time. A numerical coded system is used for everything except the connections to the external plotters and curve followers. Integrator interconnections, initial values, constant multipliers, sign changes, and everything internal to the calculating unit are inserted by means of integrator and channel selector switches and a single bank of keyboard decimal digits. No hardware need be manipulated unless filling by tape is used.

A problem involving the full machine capacity may be inserted and checked in less than an hour. Once inserted, the program and initial conditions are retained as long as needed. Constants and connections may be changed at will without losing or restarting the problem. The problem may be readily reset to its initial conditions in several seconds plus the time necessary to reset external equipment.

The DDA is compact, consisting of a keyboard console, a calculating unit, a typewriter, and accessory plotters and curve followers. The calculating unit is comparable in size to several racks of analog equipment.

The DDA is not, however, without its disadvantages. In common with other electronic digital calculators, maintenance and dependability are somewhat of a problem. Thousands of crystal diodes require very high dependability and long service life in order to prevent unreasonable down-time. Although trouble is usually obvious, it is difficult to locate the component causing the trouble. The maintenance man must have a practical knowledge of electronics and enough mathematical interest to master the logical equations of the calculating system. However, maintenance down-time is much less than the time involved in setting up a problem on the "hardware type" Bush Analyzer.

Errors arising from the operating principle may occur, but they are related to the exactness of the DDA rather than to any error in operation. Because the pulse rates used follow a cyclic pattern in representing other than full rates, any integration will integrate this pattern in addition to the desired variables. If the operator overlooks the fact, for example, that a zero rate is actually a 30 cycle oscillation, and integrates it with respect to another zero rate, the result will be a relatively small error due to the machine's giving the correct answer. Methods are available for eliminating the effects of these "carrier" pulse rates, and some machines are supplied with partial compensation built in.

Present models of the DDA cannot compete with the network and DC amplifier type of analog equipment when a comparison is made on the basis of problem running time. However, such analog equipment, in spite of its speed, is not comparable to the DDA. The analog equipment is limited in that each integration must be performed with respect to time. That is, the $\frac{dx}{dt}$ (which, for the DDA, may be anything) must always be a constant.

In practice, the DDA is more flexible in dealing with nonlinear equations and the generation of conventional functions. A product of terms in an integrand can be obtained without use of a special multiplying device or accessory. It is not necessary to rewrite or approximate the mathematics in order to avoid integration with respect to other than the independent variable.

As a generalization, any problem capable of being solved on the Bush Analyzer may be solved more easily on the DDA. Many problems too complex for the Bush Analyzer can be done on the DDA.

To present an illustration of the method of attack of the DDA, a rather simple classical problem is available, namely the simple rigid pendulum with air friction proportional directly to the angular velocity. The equation for this problem is $mL\theta'' = -W \sin\theta - kL\theta'$ where θ is the angle, W the effective weight of the bob, L the effective length of the pendulum, k the coefficient of air fluid friction, and t time. It is assumed that m includes the effect of the moment of inertia of the pendulum. The equation may be rewritten in a form more suitable for the DDA: $d\theta' = \frac{-W}{mL} \sin\theta\, dt - \frac{k}{m} d\theta$

The equation is now broken up into several equations, each of which represents an integrator with an output and one or more inputs. In our notation, each integrator is represented by an equation of the form:

$$(dz) = (K)(y)(dx)$$

(1) $(d\theta) = (\theta')(dt)$

(2) $(d \sin\theta) = (\cos\theta)(d\theta)$

(3) $(d \cos\theta) = (-1)(\sin\theta)(d\theta)$

(4) $\left(\frac{-kd\theta}{mL}\right) = \left(\frac{-k}{mL}\right)(d\theta)$

(5) $\left(\frac{-W}{mL} \sin\theta\, dt\right) = \left(\frac{W}{-mL}\right)(\sin\theta)(dt)$

(6) $(d\theta') = \left(\frac{-W}{mL} \sin\theta\, dt\right) + \left(\frac{-kd\theta}{m}\right)$

These equations represent five integrators.* This is less than ten percent of the available machine capacity. The problem may be run without limitation as to the size of the angle, that is, the pendulum may swing through more than 360°. If a pendulum of about two seconds period were used, running speed would be about two and a half minutes per second of problem time with component error of about one tenth of one percent.

Although the method used in the illustrative example may seem rather direct, problems of scale, limits, and efficient utilization have not been mentioned. The problem contains none of the usual engineering elaborations such as arbitrary functions, absolute values, limit stops, additional supplementary equations, or squared first derivatives. These elaborations can be put into problems on the DDA. They increase the complexity, planning time and check-out time considerably, and require more capable and experienced personnel.

The factor most delaying the wider industrial application of the DDA is the somewhat abstract nature of its operating principles. Mechanical, analog, and digital computing devices usually apply mechanical, electrical and arithmetic methods which are familiar to technical people. The resulting sense of familiarity encourages the use of these devices. On the other hand, the involved explanations usually required to describe, "How the DDA Works," tend to leave the average engineer in a rather insecure state of mind. This psychological effect considerably delays interest and utilization on the part of even the most capable of engineering specialists.

In summary, any problem which is practical on a Bush Analyzer is a simple problem for the DDA. The potential capacity of the DDA is nearly unlimited. Improvements in running speed, integrator capacity, available accuracy, dependability and operator know-how will greatly extend the practical utility of the DDA as new models are produced and as new applications are made of them.

References:

1. D. R. Hartree, Calculating Instruments and Machines; University of Illinois Press, 1953
   The Analyzer Corporation
   2140 Westwood Blvd.
   Los Angeles 25, Calif.

2. Bendix Computer Division
   Bendix Aviation Corporation
   5630 Arbor Vitae
   Inglewood, Calif.

   and

   Computer Research Corporation
   3348 W. El Segundo Blvd.
   Hawthorne, Calif.

* Note: Equations (6) and (1) represent the same integrator.

- END -

Forum

BINARY ARITHMETIC

J.B. McCall
Winnipeg, Canada

It seems to me that some of your readers may be interested in binary arithmetic, since it is important in many automatic digital computers, and is not explained or illustrated at all fully in most mathematical works. After all, anyone's introduction to automatic computers includes learning to feel at home with binary arithmetic. For these reasons, the following notes may be worth putting in your pages as a part of "Forum".

The binary number scale, or binary notation, is one in which numbers are expressed to the base 2, instead of the base ten as in the usual decimal notation. That is to say, the binary symbol "10" means two, "11" means three, "100" means four and so on. Only two different digits are needed to express any number, namely "0" meaning zero, and "1" meaning one. The positions of the digits report powers of two instead of ten.

For computing machinery applications the binary system offers many advantages. Any mechanical or electrical device which has two stable states may be used to represent a binary digit, and a bank of them, therefore, can represent any number. Some devices which have been used to represent binary digits are: switches, relays, vacuum tubes, electric lights, cam shafts. For instance, with an electric light, a glowing lamp could represent "1" and a lamp that is out or off "0". By suitable wiring, employing either electromechanical or electronic elements, it is possible to combine the numbers so represented in various ways and so perform the ordinary operations of arithmetic.

However, the use of binary notation is not confined to machines. It is quite possible to do ordinary paper-and-pencil arithmetic in this system. In order to do so we only need an addition table and a multiplication table. The addition table is as follows:

+	0	1
0	0	0
1	1	10

and the multiplication table:

x	0	1
0	0	0
1	0	1

It will be noted how simple these tables are. In decimal notation each of the corresponding tables has 100 entries and every child spends several hundred hours of his school career being drilled in them; whereas the tables for binary notation and the ways to use them could be learned by any child in a very short time. Leibnitz was so impressed with the superiority of binary to decimal notation that he advocated its universal use. However, for accounting purposes it has some disadvantages which have prevented this suggestion from being adopted.

As an example of the use of binary notation, suppose we calculate the value of the well-known mathematical constant "e" in binary. "e" is defined as the limit of the sum of the series

$$1+\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}+\frac{1}{4!}+\frac{1}{5!}+\cdots\ \frac{1}{n!}\quad \text{as n increases without limit.}$$

where 2! equals 2 x 1, 3! equals 3 x 2 x 1, ... and $n! = n(n-1)(n-2)\ \ldots\ 3\cdot2\cdot1$. In binary notation the corresponding expression for "e" is

$$1+\frac{1}{1!}+\frac{1}{10!}+\frac{1}{11!}+\frac{1}{100!}+\frac{1}{101!}+\cdots\cdots\ \frac{1}{n!}$$

The first two terms are each 1. The third term is obtained by dividing the second by (binary) 10. As in decimal notation this is done by shifting the dividend one place to the right; so the term is 0.1.

The fourth term is obtained by dividing the last by 11. Let us do this in detail so as to illustrate the operation of binary arithmetic. We have

```
    0.
11 )0.1
```

11 is larger than 1; so we place a 0 in both the quotient and partial remainder, which gives us

```
    0.0
11 )0.10
```

Again the divisor (11) is larger than the partial remainder so again a zero is appended to both quotient and partial remainder:

```
    0.00
11 )0.100
```

The divisor (11) is now smaller than the partial remainder (100); so we place a 1 in the quotient, place the divisor under the partial remainder, and subtract to form the new partial remainder. The subtraction is easily done by reference to the addition table. Another digit from the dividend is brought down into the partial remainder, exactly as in decimal long division. The following expression results:

```
    0.001
11 )0.100
       11
        1 0
```

Again the divisor, 11, is less than the partial remainder, 10; so a 0 is attached to both quotient and remainder:

```
    0.001 0
11 )0.100 00
       11
        1 00
```

The divisor now being less than the partial remainder, a 1 is placed in the quotient, the divisor subtracted from the remainder, and another digit brought down,

```
     0.001 01
11 ) 0.100 000
       11
        1 00
          11
          10
```

It is evident that the quotient will repeat. So we finally have for the fourth term,

0.001 010 101 010 101 010 101 010 101 010 101 010101

The fifth term is obtained from this by dividing the last by 100, which is simply done by displacing all digits two places to the right,

0.000 010 101 010 101 010 101 010 101 010 101 010 101....

For the sixth term, the above result will have to be divided by 101:

```
      0.000 000 100 010 001 000 100 010 001 000 100 010 001
101 ) 0.000 010 101 010 101 010 101 010 101 010 101 010 101
        000 010
              1 01
              1 01
                0 101   etc.
```

As before, if the divisor is larger than the partial product, we put a 0 in the quotient; if equal or smaller, we put a 1, and subtract the divisor from the partial product to obtain the new partial product.

It will be noticed how much simpler binary long division is than decimal long division where a trial divisor and multiplication must frequently be tested.

Details of the division will not be set down for the remaining terms; but the quotients obtained are as follows:

```
1.0
1.0
0.1
0.001 010 101 010 101 010 101 010 101 010 101 010 101..
0.000 010 101 010 101 010 101 010 101 010 101 010 101..
0.000 000 100 010 001 000 100 010 001 000 100 010 001..
0.000 000 000 101 101 100 000 101 101 100 000 101 101..
0.000 000 000 000 110 100 000 000 110 100 000 000 110..
0.000 000 000 000 000 110 100 000 000 110 100 000 000..
0.000 000 000 000 000 000 101 110 001 110 111 100 011..
0.000 000 000 000 000 000 000 100 100 111 111 001 001..

0.000 000 000 000 000 000 000 000 011 010 111 001 100..
0.000 000 000 000 000 000 000 000 010 001 111 011..
0.000 000 000 000 000 000 000 000 000 001 011 000..
0.000 000 000 000 000 000 000 000 000 000 000 110..
```

We now have to add these up to obtain the sum of the terms. It is easy to do an addition in binary arithmetic: starting at the right hand column, go down each column, cancelling the 1's in pairs. For every pair so cancelled, insert a 1 in the column one place to the left. The result is Table A shown at the top of the next page.

In this table, the 1's below the dotted line are the carries resulting in each case from the cancellation of a pair of 1's in the previous column. The final total is obtained by inserting a 1 at the foot of any column which has an uncanceled one in it, a 0 at the foot of the other columns. The last 8 digits in the above result might be changed if there were carries from the terms beyond the 39th which have not been used; so we adopt as our value of "e" the first 34 digits only of the above result, that is, e 10.101 101 111 110 000 101 010-001 011 000 1, in binary.

To check that the above result is correct we need only note that a 1 in the nth binary place is equivalent to $(1/2)^n$ in decimal. The whole expression is, therefore, equal to the sum of the following:

```
 2.5
  .125
  .062 5
  .015 625
  .007 812 5
  .003 906 25
  .001 953 125
  .000 976 562 5
  .    488 281 25
  .    015 258 789
  .    003 814 697
  .    000 953 674
  .        059 604
  .        014 901
  .        007 450
  .        000 465
  .            058
  .             29
  .             14
  .              7
  .              3
                 1
 2.718 281 828 4.......,which
```

is the well-known value of "e".

This discussion will have illustrated the following features of binary notation:

First, the elementary operations of arithmetic become very easy. For addition and multiplication we do not need to remember long tables. In division, trial divisors and multiplications need not be carried out. Secondly, however, we notice how much space is required for a simple calculation. Our final expression for "e" required 34 significant figures while the decimal equivalent needs 11 only, and a similar proportion prevailed throughout the calculation.

Men use decimal in preference to binary because the human mind can quite easily carry two 10x10 tables but it is difficult for us to grasp the significance of such an expression as 10.1011011111000010101000-

BINARY ARITHMETIC
Table A

```
10.1
.001 010 101 010 101 010 101 010 101 010 101 010 101
.    010 101 010 101 010 101 010 101 010 101 010 101
.        100 010 001 000 100 010 001 000 100 010 001
.            101 101 100 000 101 101 100 000 101 101
.                110 100 000 000 110 100 000 000 110
.                    110 100 000 000 110 100 000 000
.                        101 100 001 110 111 100 011
.                            100 100 111 111 001 001
.                                011 010 111 001 100
.                                    010 001 111 011
.                                        001 011 000
.                                                110
.................................................
      101 011 111 111 111 111 111 111 111 111 111 11
              111 111 1 1  11 111 111 111 111 111 11
                1   1    1  11 1 1 111 111 111 111 11
                                1  11 1 1 11  111
                                  11 1 1  1
10.101 101 111 110 000 101 010 001 011 000 100 111 111
```

10110001..... at a glance. But machines, often, use binary in preference to decimal because it greatly simplifies wiring to have such simple addition and multiplication tables and because they operate so fast that the necessity of using 34 digits instead of 11 is of no significance to them.

- END -

STATISTICS AND AUTOMATIC COMPUTERS
(Continued from page 7)

are so complex that before automatic computers, they could not be tabulated. The more widespread use of fast, automatic computers will undoubtedly result in the dissemination of new and powerful techniques of mathematical statistics that will find their way into applied fields of endeavor everywhere.

- END -

THE EDITOR'S NOTES
(continued from page 4)

Number of Simultaneous Subscriptions	Rate for Each Subscription, and Resulting Saving to Subscriber: One-Year	Two-Year
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Table 1 - Bulk Subscription Rates, (United States)

For Canada, add 50 cents for each year; outside of the United States and Canada, add $1.00 for each year.

GREETING TO COMPUTERS

In the December issue, we posed a "Numble" (a number puzzle for nimble minds) — a "greeting to computers". It was:

```
          M E R R Y
    times   X M A S
    ---------------
        O R T E E Y
      L C R A A Y
    P L A T T Y
  O R T E E Y
  -----------------
  S L Y X M P M O Y,
plus S R E E A T X A Y C
  -----------------
  P E A C E T O A L L

          S I X = C I S
```

and we wish you 32763 61456 38856 156513 4

Solve for the digits — each letter stands for just one digit 0 to 9.

The solution follows: Change S and C to X. Each of Y times X, A, M ends in Y; therefore Y is 5, and X, A, M are odd. None of X, A, M is one. M plus zero or one plus A ends in A; therefore M is 9, and X, A are 3, 7 or 7, 3. O plus one is X, and O plus Y produces a carry. O (X minus 1) plus Y (5) equals X plus 4; therefore X cannot be 3 and must be 7. A is 3. O is 6. P (X plus one) is 8. Etc. The ten digits in order 0 to 9 are T, E, L, A, R, Y, O, (X, C, S), P, M. The numerical part of the message is A, L, (S, C, X) O, A, O, E, R, Y, O, A, P, P, Y, O, E, O, Y, E, A, R, which clearly is "ALSO A VERY HAPPY NEW YEAR".

We would like to know if any automatic digital computer has been programmed to solve this kind of puzzle.

- END -

NOTICES

Address Changes. If your address changes, please notify us giving both old and new address, and allow three weeks for the change.

Back Copies. See the information on page 46.

Manuscripts. We are interested in articles and papers. To be considered for any particular issue, the manuscript should be in our hands by the 5th of the preceding month.

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He

(continued on page 22)

Eastern Joint Computer Conference, Philadelphia, Dec. 8–10, 1954

Milton Stoller
New York

The Eastern Joint Computer Conference and Exhibition took place in the Bellevue-Stratford Hotel, Philadelphia, Dec. 8 to 10, 1954. The three organizations which render the conference "joint" are the Association for Computing Machinery, the Institute of Radio Engineers, and the American Institute of Electrical Engineers. Well over 1700 persons attended the conference. The theme of the conference was "The Design and Application of Small Digital Computers," these being defined roughly as automatic digital computers costing less than $150,000 or using less than 20 kilowatts of power.

Towards this central idea a number of papers and panel discussions were given. The titles and abstracts of these papers are given on an adjoining page. Included in the talks were comparisons of existing small computers, reports on recent developments in magnetic drum storage systems, magnetic core circuit applications, and automatic coding techniques.

Exhibits

The exhibits, which were provided by 32 companies (listed below) created considerable interest. Many phases of computer techniques were represented, running the gamut from the simplest components to complete systems.

Among the exhibits were the experimental transistorized computer of International Business Machines Corporation, (described in December "Computers and Automation"); it is analogous to the electronic calculating punch IBM Type 604 but uses transistors instead of tubes. Also there were shown Raytheon magnetic shift registers with built-in transistors; rapid readers of punched paper tape made by Ferranti, Potter Instrument, Soroban, and Teletype Corporation. Technitrol showed a system of "dynamic computer blocks" for purposes of control, arithmetic, and memory; they are based on Seac and Dyseac components and adapted to one megacycle repetition rate, and may be assembled in different quantities and arrangements to make digital computers of different capacity.

The exhibitors were the following companies:

Aircraft-Marine Products, Inc.
Anderson Laboratories, Inc.
Atlas Precision Products Co.
Bendix Aviation Corp.
Benson-Lehner Corp.
Burroughs Corp.
C. B. S.-Hytron
C. E. C. Instruments, Inc.
Commercial Controls Corp.
Electrodata Corp.
Electronic Associates
Erie Resistor Corp.
Ferranti Electric, Inc.
Friden Calculating Machine Co., Inc.
General Ceramics Corp.
Hughes Aircraft
International Business Machine Corp.
International Resistance Co.
Magnetics Research Co.
Micro-Switch Co.
National Cash Register Co.
Phillips Control Corp.
Potter Instrument Co.
Radio Receptor Co., Inc.
Raytheon Manufacturing Co.
Remington Rand Inc.
Rese Engineering Inc.
Soroban Engineering, Inc.
Sprague Electric Co.
Technitrol Engineering Co.
Teletype Corp.
Victor Adding Machine Co.

Inspection Tours

Inspection trips were arranged to five centers of interest for computer people. The Automatic Message Accounting installation of Bell Telephone Laboratories at 1835 Arch St., was visited: the equipment keeps track of thousands of customer dialed telephone calls; it records who made the call, the number that was dialed, and how long the conversation lasted; it then compiles this information in suitable form for further processing by the billing revenue office.

The Burroughs Corporation Research Center in Paoli was the objective of another inspection trip. It is a new air-conditioned research and development laboratory accommodating 400 people, devoted to research and development in pulse control equipment, tubes, electronic digital computers, magnetic memory drums, and other frontiers for electronic machines.

At the plant of the Eckert-Mauchly Division of Remington Rand, a new completed Univac was demonstrated, and other Univacs in various stages of assembly and test were seen, as well as the Model 2 Unityper, which produces a coded magnetic tape directly as a result of type-

(continued on page 17)

EASTERN JOINT COMPUTER CONFERENCE, DECEMBER, 1954 — TITLES OF PAPERS AND ABSTRACTS

Small Computers in a Large World

C. W. ADAMS, *Digital Computer Laboratory*
Massachusetts Institute of Technology

Characteristics of Currently Available Small Digital Computers

ALAN J. PERLIS, *Computing Laboratory, Purdue University*

The characteristics of commercially available small digital computers are examined. In particular, a comparison is made on the basis of memory (mean), speed of arithmetic operations, types of available input-output equipment, flexibility of operation codes, power, space, maintenance requirements, availability and utility of auxiliary memories such as magnetic tapes.

The applicability of these computers to data handling and scientific and engineering calculations is discussed.

Why Not Try a Plugboard?

REX RICE, JR., *Tally Register Corp.*

The general acceptance of the internally-programmed computer has imposed restrictions, both real and artificial, upon its users. Utilizing advances made possible by the versatility of the plugboard, many of these limitations and the consequent economic losses can be removed by a functional approach to the computing problem. With the proper design, a plugboard machine allows a more direct approach to the solution of computing problems. In addition, the plugboard keeps programming simple and the size and cost of the machine within reasonable bounds. This paper draws comparisons between plugboard techniques and internal programming. The advantages of a plugboard machine are discussed. A description of the essential elements of this type of machine are given, as well as examples illustrating component usage and the powerful techniques of parallel operation.

Techniques for Increasing Storage Density of Magnetic Drum Systems

HARRISON W. FULLER, PAUL A. HUSMAN, ROBERT C. KELNER
Laboratory for Electronics, Inc.

Where a compact magnetic drum unit is required with a given storage capacity, the drum unit size and cost may be reduced if the pulse packing density of the stored information can be increased. Some alternative techniques of writing and reading will be described that were developed to increase the pulse packing density of magnetic storage without sacrifice of reliability. These techniques are equally applicable to in-contact and out-of-contact magnetic drum and tape systems.

Application and Performance of Magnetic Core Circuits in Computing Systems

ROBERT D. KODIS, *Raytheon Manufacturing Company*

Several applications which have been implemented with magnetic core circuits are discussed. Performance and life data are presented for these cases. The major functions of magnetic core circuits used in logical units, buffers, control functions, and registers are discussed and compared as best applied to small scale computer systems and input-output conversion equipment. The circuits discussed are magnetic core shift registers, core-diode memories, magnetic core manipulative circuits, and special purpose coincident current magnetic core memories.

A Self-Checking High-Speed Printer

EARL MASTERSON, ABRAHAM PRESSMAN
Eckert-Mauchly Division, Remington Rand Inc.

The paper describes the development and design of a new high-speed printer which is particularly adapted to the business machine field. This has necessitated that the design include complete self-checking features along with the best possible control of the appearance of the printed page and including considerable flexibility in editing and general format features.

Many of the self-checking and control circuits were adopted from the UNIVAC® design and therefore will not be covered in detail. The paper will therefore stress the development and design of the cold cathode gas tube memory and the details of the printing mechanism.

Teletype High Speed Tape Equipment and Systems

WILLIAM P. BYRNES, *Teletype Corporation*

This paper describes mechanical tape readers and perforators: electronic distributors, selectors, and controls; and systems incorporating these mechanical and electronic devices. A complete tape system will transmit and receive a 3600 character per minute telegraph signal over one line. Applications in both the computer and communications fields will be covered since the two are closely related technically, and since a reliable high speed communications system is of vital interest to the computer field.

Operating Characteristics of the National Cash Register Company's Decimal Computer CRC 102-D

R. M. HAYES, A. D. HESTENES, L. P. MEISSNER
Electronics Division, National Cash Register Company

The CRC 102-D is similar to the CRC 102-A in its basic operation and structure. However, the CRC 102-D incorporates several major advances in design, including the following: 1) decimal arithmetic operation, 2) more powerful decision operation, 3) significant improvements in magnetic tape handling commands, 4) alphabetic input, output, and sorting, 5) high speed paper tape input and output.

A Marchant Miniac Computer System

GEORGE B. GREENE, *Marchant Research, Inc.*

A magnetic drum stored program computer of unusual features applied to a system of magnetic tape peripheral equipment of advanced philosophy is discussed. A unique magnetic tape unit which serves as data communication medium as well as interim and long term storage in this system is described. A perforated-to-magnetic tape, card-to-tape and tape-to-card translation equipment which enable practical hybrid system operation is described.

Performance of the TRADIC Transistor Digital Computer

J. H. FELKER, *Bell Telephone Laboratories*

The transistor digital computer TRADIC was completed in January of 1954 and put on life test May 1, 1954. Since then the machine has been running 24 hours a day, 7 days a week. TRADIC is the first solid state computer and represents the largest number of transistors that has been put to use. There are approximately 700 transistors and 10,500 semiconductor diodes in the machine. Although the machine was designed for a military application and has a very restricted memory capacity, it is a general purpose computer. The speed, the power consumption and the reliability achieved with the computer will be used as a basis for the prediction of the engineering possibilities for commercial transistor computers.

Application of a Burroughs E101 Computer

ALEX ORDEN, *Burroughs Corporation*

The Burroughs E101 computer has been developed to bridge the gulf between conventional desk top calculators and large scale digital computers. The desk size machine features a novel pin board for easy set up of program controls and provides direct access by the operator for inspection of data form and overriding supervisory operations. It includes an accounting machine input-output unit, in combination with an electronic computer and memory system. Selected application in fields of business, engineering, science and management control will be described.

Panel discussions will be held simultaneously.

Small Digital Computers and Business Applications

Chairman, WILLIAM D. BELL, *Mellonics*
WALTER L. MURDOCK, *General Electric Co.*
ROBERT P. FOSTER, *Prudential Insurance Co.*

Redundancy Checking for Small Digital Computer

Chairman, RICHARD W. HAMMING, *Bell Laboratories*
SIBYL ROCK, *Electrodata*
A. L. SAMUEL, *IBM*
WILLIAM C. CARTER, *Raytheon Mfg., Co.*

Small Digital Computers to Assist Large Digital Computers

Chairman, JOHN W. CARR, III, *University of Michigan*
WALTER RAMSHAW, *United Aircraft Corp.*
JOHN LOWE, *Douglas Aircraft Corp.*

Numerical Solution of Differential Equations

HERBERT M. GURK, MORRIS RUBINOFF
Moore School of Electrical Engineering, U. of Pa.

A criterion is given in order to evaluate a priori the worth of a given numerical method in solving a set of differential equations. The validity of this criterion is discussed with respect to linear constant coefficient equations, linear varying coefficient equations, linear equations with forcing functions and non-linear equations. Results of applications are also given.

Applications of Automatic Coding to Small Calculators

LEROY D. KRIDER, *Applied Mathematics Division*
U. S. Naval Ordnance Laboratory

Automatic coding techniques are attempts to shift as much as possible of the clerical labor of coding onto the calculator. Several programming techniques currently used as well as some contemplated will be summarized. Several desirable features for a machine that is to have automatic coding techniques applied to it will be presented. Arguments for designing a small calculator of this type will be given.

Automation of Information Retrieval

J. W. PERRY, *Battelle Memorial Institute*

Providing knowledge when needed is the function of publications, reports, and similar records. With extensive files, identification of items of pertinent interest is a major problem. Identification requirements, definable by sets of features, lead to the theory of class definition as the basis for defining both the functions of automatic equipment and also the semantic problems of analyzing records preparatory to machine searching. Practical cost considerations and related parameters must be taken into account when engineering equipment and code systems.

Message Storage and Processing with a Magnetic Drum System

A. P. HENDRICKSON, G. I. WILLIAMS, J. L. HILL
Engineering Research Associates Division, Remington Rand Inc.

This electronic data processing system performs routine clerical functions of accepting, filing and finding and delivering out specified messages in a file of 2,000 messages (316,250 characters). Logical operations of verifying format, insuring proper placement of significant characters, determining presence or absence of duplicate message already on file, and delivering up copy for transmission to initiating agency are all performed in less than ½ second using techniques developed for high-speed computers. Separate "wired" routines are available for processing nine message types, each of which is selected by information contained in the incoming message. Each machine action, except two, is stimulated by receipt of a teletype message and may include an appeal for supervisory assistance in case a garbled character makes positive action impossible.

A magnetic drum surface is used for storage of all message characters and also provides buffer storage for incoming and outgoing communication lines. Four separate buffer units function to alter 75 wpm teletype message speed to the internal data processing rate of 230,000 wpm. A fifth unit functions similarly with a 1050 wpm communication system.

The described equipment has been in service since September 1953, filing and processing CAA weather observation messages. After 2500 hours of service, more than 98 per cent of the original 1900 vacuum tubes and 2100 germanium diodes are still in service.

Analysis of Business Application Problems on IBM 650 Magnetic Drum Data Processing Machine

GEORGE W. PETRIE III, *International Business Machines Corp.*
JOHN M. BOERMEESTER, *John Hancock Mutual Life Ins. Co.*

The automatization of data processing in the modern business office is keeping pace with the rapid strides made in the computation field and the factory automation developments. Conventional multi-step machine procedures are greatly simplified, accelerated, and overall costs are markedly reduced through the use of the magnetic drum calculator. Analysis of over 100 programs of various business applications illustrates the percentage use of various basic functions of arithmetic and logical decisions. Also included are summary statistical details which include size of program, running time, capacities, and so forth.

Small Digital Computers and Automatic Optical Design

N. A. FINKELSTEIN, *Bausch & Lomb Optical Company*

A large portion of optical design consists of making small changes in the lens formula, computing the aberrations, and attempting to relate these aberrations to image quality. An automatic procedure for optical design based upon image quality measurements is proposed for performing this task. The instrumentation consists basically of a small digital computer (IBM 607), apparatus for measuring image quality electronically and an aberration synthesizer. The process is an iterative one, each iteration being; perturb the lens formula, compute the new aberrations, set these in the synthesizer, measure the image quality factor. Advantages and basic limitations of the proposed system are discussed.

Computation of the Performance of Decision Element Circuits by Means of the IBM CPC

B. F. CHEYDLEUR, *Minnesota Electronics Corp.*
L. P. GIESELER, H. L. STEVENS
U. S. Naval Ordnance Laboratory

Magnetic Decision Elements are elementary components which combine the functions of logical computation and delay. Address counters, shift registers and other computer circuits can be made up using these elements. This paper describes a method for producing a time history chart of the performance of a specific circuit by using an IBM CPC. The design of computer circuits is thereby greatly facilitated.

Some Applications of Electrodata Computer Systems

KENNETH L. AUSTIN, *Electrodata Corp.*

Data-reduction problems appropriate for solution on the Electrodata Computer are discussed. An automatic data-reduction system resulting from a linking of digitizing equipment and Electrodata computing equipment is described. Input to the combined system is from an analog recording equipment and output is reduced data printed on a line printer. Semi-automatic editing of input data is also discussed.

EASTERN JOINT COMPUTER CONFERENCE
(continued from page 14).

writer key depressions, and a punched-card-to-magnetic-tape converter.

The Research and Development Laboratories of the Franklin Institute now has the largest of 45 A. C. network calculators now in operation throughout the world. This machine was installed there by seven major electric power companies and the Westinghouse Electric Corporation. As a miniature electric power system it can represent generating stations, substations, transmission lines, and distributing networks; and its purpose is to reflect the behavior of complicated electric power and distribution systems in a small-scale but accurate model.

The Aviation Supply Office of the Naval Aviation Supply Depot has an IBM 701. On this machine the office calculates gross and net requirements for 120,000 stock items located at 65 naval depots. In this way the machine provides a basis for centralized control of procurement and distribution.

Proceedings

A copy of the conference proceedings including the full text of all papers and floor discussion may be obtained, when it is ready, from any one of the sponsoring societies' headquarters, such as the Association for Computing Machinery, 2 East 63 St., New York 21, N. Y.

- END -

PATENTS

Hans Schroeder
Milwaukee, Wisconsin

The following is a compilation of patents pertaining to computers and associated equipment from the Official Gazette of the United States Patent Office, dates of issue as indicated. Each entry consists of: patent number / inventor(s) / assignee / invention.

October 26, 1954: 2,692,726 / G W Hobbs and W B Jordan, Scotia, N Y / General Electric Co / Binary computer using a multi-target cathode ray tube
2,692,947 / B F Spencer, East Meadow, N Y / Sperry Corp / Device for locating inflection points in a response curve

November 2, 1954: 2,693,552 / R K Steinberg, Poughkeepsie, N Y / Intl Business Machines Corp / Glow discharge type storage tube

November 9, 1954: 2,693,907 / G C Tootill, Shrivenham, England / Natl Research Development Corp, London, Eng / Digital computing circuits

November 16, 1954: E A Newman, Teddington, and D O Clayden, London, England / Natl Research Development Corp, London, Eng / Binary adder using dual triodes
2,694,801 / A E Bachelet, New York, N Y / Bell Tel Labs, Inc, New York, N Y / Pulse counting and registration system

A SMALL HIGH-SPEED MAGNETIC DRUM

M. K. Taylor
Chief Engineer, Ferranti Electric Limited, Toronto, Ont., Canada

The requirement arose recently of operating the Manchester Ferranti Computer (Ferut) at the University of Toronto in conjunction with punched card equipment, instead of the punched paper tape input and output for which the computer is designed. To carry out this requirement, it appeared that a rapid access magnetic drum would provide the most reliable and economical temporary data store for the code translation and information rate changing requirements of the system. No drum of suitable characteristics existed. But fortunately there was available a considerable amount of experience on the design and manufacture of gyroscope rotors operating at very high speed, and having about the dimensions required for the drum. This experience was put to good use in the design and manufacture of the drum to be described; the drum is shown in Figure 1, and was exhibited at the Eastern Joint Computer Conference, Philadelphia, Dec. 8 to 10. It is identified as the Ferranti Type 200 B drum.

Size and Density of Information

The drum is two inches in diameter and just over one inch long. The length would allow a maximum of 30 tracks. However to ensure safe values of crosstalk in reading, the track separation is increased to .050", and this results in 20 tracks being available. The maximum storage under these conditions, with 20 tracks and 200 binary digits per inch (see below) is of the order of 24,000. This drum is therefore economical in terms of initial cost per digit, about 5 or 6 cents per digit. While this figure does not of course compare with the figures for larger drums it seems to compare very favorably with other types of store in view of the simplicity of the associated electronics.

Rotation, and Spacing Between Heads and Drum

The drum is essentially a brass rotor, similar to one of the gyro rotors used as a model, and is driven by an internal rotating magnetic field, at 23,500 R.P.M. This provides an access time once per revolution of just over 2.5 milliseconds. The supply is 400 cycle 3 phase 115 volts, and is fed to windings on a set of internal stator laminations mounted on a fixed spindle. The drum consists of a brass ring having a solid end flange on one end, and carrying a ball bearing and a beryllium copper loading spring on the other end to provide axial loading for the bearings which are carried by the rotor. This most useful fact has allowed digit stacking to be as high, under experimental conditions, as 250 return to zero digits to the linear inch of track surface. An upper practical limit for apparatus built for customer use would be perhaps 200 digits to the inch, assuming careful initial adjustment.

The high rotational speed of 23,500 R.P.M. is provided with adequate safety factor. Operating lives in excess of 5000 hours have been run on test samples without measurable deterioration. As a result of this high rotational speed, access time becomes just over 2.5 milliseconds; and this comparatively fast access is of course useful in many applications.

The ball bearings used in the drum have been especially selected for very long life. Stationary lubrication reservoirs are fitted and the bearings are sealed with suitable material. To ensure longevity the bearings are run in for 24 hours after the drum has been balanced, after which the drum is balanced a second time. The drum bearings are rejected if this second balancing operation indicates possible bearing trouble. The balancing is carried out on Micro balancing equipment.

The care which is taken in connection with the drum manufacture may seem excessive and costly, but it has been found that not only does this care result in very long life, but it also enables the clearance between the drum and the magnetic heads to be safely reduced to a low value, half a thousandth of an inch.

Mounting

The drum spindle is carried in a U-shaped aluminium support frame which is held at its base on a stiff spring of laminated fiberglass plastic. This serves as a hinge for the support frame and enables a pair of stop screws attached to the head mounting frame to serve as adjustments on head clearance, by moving the U shaped support frame which carries the drum spindle. The heads are mounted on short rectangular section rods loosely set on brass bars fixed to the main body of the assembly. To set the heads, these are brought in contact with the stationary drum surface and lined up to the surface. A clamping mechanism then locks all the heads accurately together, still in contact with the drum surface. The drum axis adjustment screws are then turned to allow the head-to-drum gap to be set to the desired value.

Finally, the whole assembly is mounted upon a neoprene diaphragm set in a cast aluminum base and is fitted with a glass cover. The drum and head assembly is as light as design allows, and is resiliently mounted; by this means inertia forces on the bearings due to remanent unbalance are kept to a small value, and do not therefore cause possible trouble due to pitting in the ballraces. This arrangement, though not fully vapor-sealed, is dustproof. For military use the drum assembly can be readily fitted in a fully vapor-sealed casing.

Heads

The heads themselves were especially designed for this drum, in view of the necessity for very small size. They each carry a winding of 20 turns, with a resistance of 0.5 ohms and an inductance of 8 microhenries. In spite of their small size, the close spacing to the drum, and the high peripheral speed allow of an output direct from the head of 30 millivolts at 400 kc/s. Writing currents up to 1 ampere have been used satisfactorily.

Surface

The magnetic surface of the drum is made by spraying a carefully filtered suspension of Minnesota Mining and Manufacturing Type M3010 red oxide, to which a polyester is added. This results in a durable surface which is then given a high polish. The surface is then electrically tested for track faults; if such are present, the surface is removed and a fresh coating applied.

Reliability

Every effort has been made to see that this drum is as reliable as a mechanical device can ever be. The reduction in the number of vacuum tubes or equivalent devices frequently possible by incorporating a small drum instead of say a large bank of shift registers is likely to result in increased reliability and simplified maintenance.

Uses

The kind of uses foreseen for this drum are likely to include: information rate changers, that is, storage "until ready", as in the initial application; the "derandomizing" of randomly received information, as in the case of transmission on a communication channel of limited bandwidth; the reverse, that is, storage of information for burst transmission; use in secrecy coding, wherein the drum takes the place of a continuously or intermittently changing code book; etc.

The success of these drums in the application for which they were designed has led to the possibility that they will be attractive for other purposes, and their production is being increased to allow of early availability.

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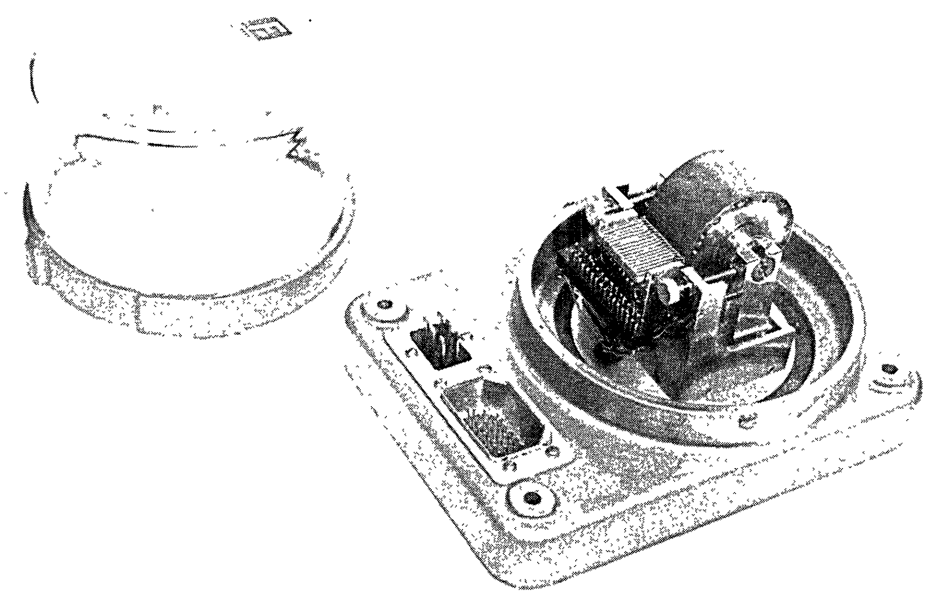

Figure 1 -- Small high-speed magnetic drum of Ferranti Electric; 24,000 binary digits, 2.5 milliseconds access, 20 heads; also glass dust cover

Roster of Automatic Computing Services

(Cumulative; information as of December 3, 1954)

The purpose of this Roster is to report organizations (all that are known to us) offering automatic computing services and having at least one automatic computer, either analog or digital. Each Roster entry contains: name of the organization, its address / analog or digital computation provided / notes on equipment / any restrictions as to clients.

We shall be grateful for any additions or corrections that any reader is able to send us.

Some of the abbreviations are as follows:

A	analog
anal	analyzer
CPC	IBM card programmed calculator
D	digital
diff	differential
govt0	available to government agencies or contractors only
unres	unrestricted

ROSTER

Armour Research Foundation of Illinois Inst of Tech, 10 West 35 St, Chicago 16, Ill / A, D / Goodyear Electronic Differential Analyzers, Two Channel Electronic Function Generator, CPC / unres

Askania Regulator Co, 240 East Ontario St, Chicago 11, Ill / A / Philbrick / unres

Battelle Memorial Inst, 505 King Ave, Columbus 1, Ohio / A, D / diff anal, CPC, punch card / unres

Burroughs Corporation Research Center, Paoli, Pa. / D / Burroughs Laboratory Computer / unres

Cornell Computing Center, Rand Hall, Cornell University, Ithaca, N Y / D / CPC, punch card / unres

Electro-Data Corporation, 717 North Lake Ave, Pasadena 6, Calif / D / CEC 30-201, etc. / unres

Engineering Research Associates, Division of Remington Rand, 555 23rd St South, Arlington 2, Va / D / ERA 1101 / unres

General Electric Co, Schenectady, N Y / A / network anal AC and DC, diff anal / unres

The George Washington University, Logistics Research Project, 707 22nd St, Washington, D C / D / ONR automatic relay computer / unres

Financial Publishing Co, Mathematical Tables Div, 82 Brookline Ave, Boston 15, Mass / D / CPC's, punch card / unres

The Franklin Inst Laboratories for Research and Development, 20 St and Benj Franklin Pkwy, Philadelphia 3, Pa / A / A.C. network analyzer / unres

Harvard Computation Laboratory, Harvard University, Cambridge 38, Mass / D / Harvard IBM Mark I, Harvard Mark IV / unres

International Business Machines Corp, 590 Madison Ave, New York, N Y, and elsewhere / D / IBM 701, 650, 604, CPC, punch card, etc / unres

Machine Statistics Co, 27 Thames St, New York 6, N Y / D / IBM 604, punch card / unres

Mass. Inst. of Technology, Office of Statistical Services, Cambridge 39, Mass. / D / IBM 604, CPC, punch card / unres

Moore School of Electrical Engineering, 200 South 33 St., Phila. 4, Pa. / A, D / diff anal, CPC, punch card / unres

National Bureau of Standards, Applied Mathematics Laboratory, Washington, D C / D / Seac, Dyseac, punch card / govt0

National Bureau of Standards, Institute for Numerical Analysis, 405 Hilgard Ave, Los Angeles 24, Calif / D / Swac, etc / govt0

National Cash Register Company, Electronics Division, (formerly Computer Research Corporation), 3348 West El Segundo Boulevard, Hawthorne, Calif / D / Cadac 102A, etc / unres

Northrop Aircraft, Inc, Director of Computing, Hawthorne, Calif / A, D / CPC's, Maddida, Binac, punch card, etc / unres

G A Philbrick Researches, Inc, 230 Congress St, Boston 10, Mass / A / Philbrick / unres

Purdue Univ, Dept of Math, Lafayette, Ind / D / CPC, punch card / unres

Raytheon Mfg Co, Computing Services Section, Waltham, Mass / D / automatic electronic digital computer, etc / unres

J B Rea Co, Inc, 1723 Cloverfield Blvd, Santa Monica, Calif / A, D, simulation / Electronic Associates analog computer, Beckman EASE analog computer, CPC / unres

Reeves Instrument Co, 215 East 91 St, New York, N Y / A / Reac / unres

Remington Rand, Inc, 315 4th Ave, New York, N Y / D / Univac, punch card, etc / unres

Rensselaer Polytechnic Institute, Computer Laboratory, Troy, N Y / A / Reeves Electronic Analog Computer, precision magnetic tape re-

Rome Air Development Center, Computer Facilities Section, Griffiss Air Force Base, Rome, N Y / A, D / Elecom 120, Bendix Digital Differential Analyzer D 12, Reeves Electronic Analog Computer, Benson-Lehner data reduction equipment, etc / govto

corders for analog computing applications / unres

Scientific Computing Service, Ltd, 23 Bedford Sq, London W C 1, England / D / - / unres

Swedish Board for Computing Machines, Drottningatan 95A, Stockholm, Sweden / D / Bark, Besk / unres

Telecomputing Corp, 133 East Santa Anita Avenue, Burbank, Calif / A, D / IBM punch card, CPC's, automatic graph readers, digital plotters / unres

U S Air Force, Computation Research Sec, Wright Air Development Center, Wright Patterson Air Force Base, Dayton, Ohio / A, D / CPC's, Reac's, punch card / govt0

U S Army, Ballistic Research Laboratories, Aberdeen, Md / D / Ordvac, Edvac, Eniac, Bell Model V, CPC, punch card / govt0

U S Navy, Naval Proving Ground, Dahlgren, Va / D / Norc, Harvard Mark II, Harvard Mark III, punch card / govt0

(continued on page 22)

Forum

THE CAPACITY OF COMPUTERS TO "THINK"

Russell Chauvenet
Silver Spring, Md.

In his article "Reflective Thinking" in "Computers and Automation", April, 1954, Elliot L. Gruenberg gives a definition of "useful" thinking (p. 21):

> "an operation in which present facts suggest other facts and induce belief in the suggested facts on the ground of the real relation in the things themselves".

Irving Rosenthal, in his forum discussion in "Computers and Automation", October 1954, (p. 28) gives a description of "creative" thinking, saying "the process of solution" begins with "a conclusion which is not logically justified by the premises and facts which have been accepted up to that point" and is followed up by recognition of logical discontinuity, re-examination, and modification to make premises and conclusions logically compatible with each other while still in agreement with relevant empirical evidence, etc.

This is a remarkable disagreement; and I for one just cannot allow Mr. Rosenthal's assertions to go unanswered.

We must concede that what Rosenthal describes is an accurate picture of the way in which many human brains have functioned in the past, and it is easy to agree that this approach to creative thought is unsuitable for a machine. But we can carry the argument further -- this method of thinking is also unsuitable for humans. Rather than being a necessary part of the solution of an unsolved problem, it is more generally a handicap. Jumping to illogical conclusions, followed by an effort to justify them, is a method which may succeed on occasion. It is also the method which produced the phlogiston theory and filled space with "ether," not to mention many other such instances.

Indeed, Rosenthal himself indicates quite clearly the handicap of his approach to the problem, as in his third paragraph, where we find an open expression of emotional hostility towards the idea that thinking may be defined so that it is proper to say a machine can think. Again, in his final paragraph, (believe it or not!) it is made to appear that the hypothetical reactions of Soviet propagandists should be a serious factor in reaching a conclusion in a scientific discussion!!

The only other point in Rosenthal's article which needs clarification here is the remark, "It is clear therefore that human emotional interest and energy is required, that without passion and will the painful difficulties of creative thinking could not be overcome." Here it is helpful to refer to Gruenberg's definition again; we note that the operational feature is not "passion and will" but the induction of belief in facts suggested, on grounds subject to logical or empirical verification.

Certainly, if we are to have a machine do creative thinking for us, we must supply the "interest and energy" to state the problem in machine language and turn on the power. The design of the machine then ensures that the problem will be considered. The machine can clearly be induced to "believe" that it has an answer, if the answer can be verified from the data available to it, in which case the answer will appear as output. If the answer cannot be so verified, we can conceive of the machine calling for more information.

Naturally, at this early stage in computer development, no such machine has been designed and built. But if we accept Gruenberg's logical approach, rather than the too-human emotional one, there seems to be no theoretical prohibition of such an ultimate machine.

It must be remembered that at present all so-called thinking done by computers is merely the result of a step-by-step execution of instructions prepared in great detail and with much labor by human programmers. The programmer in offering the machine "choices" between subsequent stages of a program must necessarily detail exactly what must be done following each choice or possible combination of choices. His failure to do this will not result in "freedom" for the machine, but merely a "bug" in the program -- that is, the machine will not produce the desired results, and probably not even anything intelligible.

All this is true because the "mind" of a computer is so rudimentary at present as to be hardly recognizable as such without a little thought. In a human brain the outstanding constructional feature which makes it what it is is the vast interconnecting nerve network between the various brain cells. Thought in a mind formed by such a brain is rich with associations, Subjective experience confirms that an idea, a plan, or a solution, does not arise from nothing, but from the existing associations in the mind. A "guess", or "flash of intuition," may reach the conscious level of the mind suddenly, but it is hardly likely to work out well unless the mind has previously stored much information on the subject.

The computers we have today are in a very different position, since they are constructed on the basis of a single control unit to interpret and carry out instructions. This is the "mind" of the computer -- a very literally single-track affair. There is no mechanical provision for the machine to be aware of what it is doing or why, and there is no associative network whatever -- the machine "control" can only communicate with one memory location at a time. Consequently there is no inherent machine capacity for any kind of associative or self-conscious thought, as the means are lacking. The machine can only carry out the operations of thinking as they have been given to it in the form of commands by the programmer. If due to mechanical failure to any other source of error, the order read into "control" of the computer is not correct, the machine lacks any means of realizing the error and will proceed automatically to execute the incorrect order.

The successful use of computers at present is thus a matter of good engineering, alert maintenance, and skilled programming; and while the machines will certainly carry out logical operations similar to human thinking, they will do so only under specific command. "Thinking" in 1954 computers reduces merely to good programming, and these discussions of machine thought, as Rosenthal correctly observes, have not thus far been of immediate practical use.

But this is not the final answer. It may well prove helpful in the future to have machines capable of creative thought and free from human emotions to consider our various problems. The technical difficulties are great, but theoretically we can already envisage the general nature of such a machine. It will clearly require the existence of numerous "control" stations within the machine, each with independent access to the storage areas, and all or most with associative linkage to the others, allowing each "control" to be informed of what the others are doing. A possible engineering basis might be the operation of a program from a drum via a subsidiary drum-control, with associated and master controls utilizing a bank of electrostatic storage for analysis and correction of the drum program between executions of orders in drum-control. The overall speed of this hypothetical machine would very likely be less than that of our one-control computers of today. But it would serve a different purpose and its operations would more nearly resemble logical human thinking than anything we have now.

The early forms of such a machine would of course still require considerable programming, but would offer the advantage that the machine could be "aware" of what it was doing, "observe" its own operation, and interfere making necessary corrections if for any reason an illogical operation not part of the current process should be introduced into a subsidiary control. Ultimately, the programming burden would be largely taken over by the machine itself. It would be sufficient to supply a more or less brief statement of the problem, with good expectation of getting a logical answer.

The present efforts of many computer groups to build up extensive sub-routine libraries and perfect efficient compiling techniques on our present one-control computers are of course of immediate practical use. But if we are to talk about thinking in machines, admittedly a fascinating topic, it is development along the lines discussed above that appears to offer the most promising prospects.

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NOTICES

(continued from page 13)

should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation, and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words, and payment will be $10 to $50 on publication. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable. No payment will be made for papers. If a manuscript is borderline, it may be returned to the author to be modified to become definitely either an article or a paper.

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ROSTER OF AUTOMATIC COMPUTING SERVICES

(continued from page 20)

University Mathematical Laboratory, Free School Lane, Cambridge, England / D / Edsac / unres

University of Michigan, Willow Run Research Center, Ypsilanti, Mich / D / Midac, etc / unres

Univ of Toronto, Computation Centre, Toronto, Ont, Canada / D / Ferranti / unres

Univ of Wisconsin, 306 North Hall, Madison 6, Wisc / A, D / Philbrick, CPC, punch card / unres

Wayne University, Computation Laboratory, Detroit 1, Mich / A, D / diff anal, Burroughs Unitized Digital Electronic Computer, etc / unres

Westinghouse Electric Corp, Industry Engineering Dept, East Pittsburgh, Pa / A, D / Anacom network anal AC and DC, punch card / unres

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FINDING OUT THAT SOMETHING EXISTS

Neil Macdonald
COMPUTERS AND AUTOMATION

In the November issue of "Computers and Automation" the following remarks appeared in the Editor's Notes:

> Crucial Knowledge -- the Knowledge that Something Exists. Often when one investigates a subject, the crucial knowledge is finding out that something exists or can be done. For instance, if you are investigating from whom to buy an automatic inventory machine, the crucial knowledge is finding out who offers such machines for sale. A man who has never heard that the ABC Company offers automatic inventory machines for sale is hardly in a position to consider buying from them.
>
> To supply this crucial knowledge of existence in the field of computers and automation we have published various kinds of rosters and reference lists; there are now ten kinds. And in this issue over 11 pages have been used to give a cumulative Roster of about 230 organizations in the field of computers and automation.
>
> Yet one reader, whom we shall call J. Moines since that is not his real name, has said to us "You should not publish this valuable information for so little; you should restrict it, give it only to advertisers perhaps, keep it for your own advantage." We don't agree with Mr. Moines. Our purpose as a magazine is to be as useful as we can be; and we believe these rosters and lists help the men in the field. What do you think?

The magazine received an interesting reply to these remarks from Sam C. Black, Jr., office manager of a rubber company in Denver, Colorado. Referring to "the question arising from your difference of opinion with a certain J. Moines", he said:

> "I heartily support your position -- your publication of the information in question has been of extreme value to me and my staff. And I am sure that the same position will be taken by all of your subscribers who have problems similar to ours. ... Early last spring, our management asked us to begin a program of aggressive research aimed at as high a degree of office mechanization as practicable."

We are glad that our reference information is useful. And it has occurred to us on the editorial staff of "Computers and Automation" that, since we now have ten or more kinds of reference information published in the magazine, it would be a help to print a guide to at least some of it. In this way we can make it easier for our readers to find information they may desire.

Organizations

Who are the companies in the field of computers and automation, and what do they make?

The answer to this question is the reason that this magazine is in existence. For we began in September 1951 to issue a purple dittoed list of companies and other organizations (government agencies, university laboratories, etc.) making or developing automatic computing machinery and related items. This has now become the "Roster of Organizations in the Field of Computers and Automation". The definition of the territory now included is "organizations making or developing automatic computing machinery, or systems, or data-handling equipment, or equipment for automatic control or materials handling". But the emphasis continues to be on the computing machinery field, and the list is not as complete as we would like it to be in the related areas.

The last cumulative listing was published in the issue of November 1954, vol. 3, no. 9, pp. 9-19, 30; and it contains over 230 organizations. In each issue of the magazine we bring this Roster up to date, publishing a supplement.

Typical entries may be seen in the Roster in this issue.

Who are the companies or organizations which provide computing services, using at least some kind of automatic computer?

These organizations, so far as we know them, are listed in a "Roster of Automatic Computing Services". If any service organization has an IBM 604 (electronic calculating punch) or any more capacious computing equipment, either analog or digital, we desire to include that organization in this list. Here again we are not yet satisfied with the inclusiveness of the listing. But evidently people read the list, and write us asking that their organization be put in; and this we are glad to do.

The latest cumulative listing of "Roster of Automatic Computer Services" is published in this issue of "Computers and Automation", January 1955, vol. 4, no. 1, and contains 40 organizations. Supplements to the listing are not necessarily published in each issue. Typical entries may be seen in the Roster in this issue.

Computing Machinery and Automation

What are the types of automatic computing machinery? We recently noticed that it is sensible to recognize about 30 different classes of automatic machinery for handling information. They range through accounting-bookkeeping machines, game-playing machines, toll recording equipment, vending machines, etc., not to mention the obvious two classes, analog computers and digital computers. It is desirable to keep in mind how diverse is the new field of automatic machinery for handling information, and so we publish a reference list.

The last cumulative listing "Automatic Computing Machinery — List of Types" appears in the November 1954 issue, vol. 3, no. 9, pp. 24-25, 30. Supplements are not necessarily published in each issue.

A typical entry is:

> Inventory machines, which will store as many as ten thousand totals in an equal number of registers, and which will add into, subtract from, clear, and report the contents of any called-for register (these machines apply to stock control, to railroad and airline reservations, etc.).

How many models of automatic computers are there, and which are they?

There are over 150 automatic computers, nearly all of them constructed since 1944. They range from ABC and Arra to X-RAC and Zuse Model 5. They are listed in "Automatic Computers — List"; and the latest information that we have is contained in:

> "Automatic Computers — List" (cumulative), July 1954, vol. 3, no. 6, pp.18-20, 26, containing brief information about 130 models of automatic computers

> "Automatic Computers — List" (supplement), October 1954, vol. 3, no. 8, pp.15-16, containing information about 54 models of automatic computers.

A typical entry (eliminating the abbreviations is:

> ABC (Automatic Binary Computer) / made by the Air Force Cambridge Research Center, Cambridge, Mass.; located there / general purpose; electronic digital computer; medium size; quantity, one.

If models of automatic computers are examples of automatic computing machinery, what are similar examples of automation?

This is not nearly so definite a question of course as the last one, but we have tried to answer it by constructing somewhat the same sort of list for automation. The first such cumulative listing was "Automation — List of Outstanding Examples", which appeared in the July 1954 issue, vol. 3, no. 6, p. 13. It contained 16 examples, of which one was:

> Ordnance: shells for explosives / W.F. and John Barnes Co., Rockford, Ill. / Factory makes shells from start to finish without touching by human hands.

Supplements to this listing have been published from time to time in Forum. We expect that another cumulative listing will be published before long.

Words

What are the special terms used in the field of computers and automation, and what do they mean?

This is a question in which we have been much interested ever since the purple ditto list which we first published turned into the photooffset magazine which we now publish. For the meanings of the special terms of a field constitute a most important clue to the important information in that field; they point out the key ideas. Several glossaries, and a number of discussions of problems of glossary-making, have been published in "Computers and Automation".

The last cumulative glossary published in "Computers and Automation" appears in the December issue, vol. 3, no. 10, pp. 8-23, entitled "Glossary of Terms in the Field of Computers and Automation". It contains definitions of over 400 terms and expressions. We expect that supplements will be published from time to time, and that a cumulative glossary may be published perhaps once a year. In these glossaries the editors have not attempted to establish by decree the meanings of terms, but simply report meanings and usage.

Examples of some of the entries in the glossary are:

biquinary notation — Numbers. A scale of notation in which the base is alternately 2 and 5. For example, the number 3671 in decimal notation is 03 11 12 01 in biquinary notation; the first of each pair of digits counts 0 or 1 units of five, and the second counts 0, 1, 2, 3, or 4 units. For comparison, the same number in Roman numerals is MMMDCLXXI. Biquinary notation expresses the representation of numbers by the abacus, and by the two hands and five fingers of man; and has been used in some automatic computers.

cybernetics — 1. The study of control and communication in the animal and the machine. 2. The art of the pilot or steersman. 3. The comparative study of complex information-handling machinery and the nervous systems of the higher animals including man in order to understand better the functioning of brains.

magnetic core — Computers. A form of storage where information is represented as the polarization north-south or south-north of a wire-wound magnetically permeable core, which may be straight, doughnut-shaped, etc.

Information and Publications

What about books, magazines, and other publications in the field of computers and automation?

From time to time we publish a list of books and other publications related to computers and automation with short notes about them. A current example of entries in "Books and Other Publications" appears in this issue January 1955, vol. 4, no. 1. The previous listing appeared in the October issue, vol.3, no. 8, pp. 21-26, and contained 42 entries. The information has not so far been cumulated. Also, some of the articles and papers that we publish contain bibliographies: a notable example appears in the paper by John E. Nolan in this issue.

In every issue from July 1953 to the present one, has appeared "Patents", a listing of patents related to computing machinery, compiled by Hans Schroeder. Examples of entries appear elsewhere in this issue. The information has not so far been cumulated.

We have also printed a "Roster of Magazines Related to Computers and Automation". The last cumulative listing appeared in the September issue, vol. 3, no. 7, pp. 17 and 25. A typical entry eliminating abbreviations is:

Scientific American / monthly / published by Scientific American, Inc., 2 West 45 St., New York 36, N. Y. / emphasis: ideas and developments in all phases of science, reported for educated men in other specialties / directed to technical management; paid-for; annual subscription $5.00 / circulation about 120,000 / contains advertising.
Occasional articles on computers and automation. The September 1952 issue was devoted to "Automatic Control".

People

Who are the people in the computing machinery field, what are they like, what are they interested in, and what do they do?

The answer to this question constitutes the tenth kind of reference information which we have published.

This is a "Who's Who in the Field of Computers and Automation". The first edition of this Who's Who was published in about seven or eight sections from January 1953 to January 1954. A typical entry, eliminating abbreviations, follows:

Summer, Charles / technical engineer, Analog Computation Laboratory, Aircraft Nuclear Propulsion Department, Systems Engineering Group, General Electric Co., Evendale, Ohio / interested in applications, electronics, mathematics, analog computation, simulation systems / born 1921; graduate Ohio State University, Bachelor of Science in physics; entered computing machinery field in 1952; occupation technical engineer.

We have been puzzled about what to do about bringing the Who's Who up to date. We are sure that the Who's Who has been used, and that people have found it useful. But to bring it up to date and include all the names of persons whom we know are in the field is an enormous task, and one that is bound to be expensive. We shall be glad to have comments from our readers on this subject.

As Sam C. Black, Jr., indicates, we, the editors of "Computers and Automation", desire to publish reference information which will be of "extreme value" to our readers, information that can hardly be obtained in any other way. We shall be glad to have comments, suggestions and criticisms from any of our readers for this purpose.

- END -

Forum

AN INSIDE-OUT MAGNETIC DRUM

Neil Macdonald
New York

A new idea in memory for automatic computers has been announced by the Clevite-Brush Development Co. of Cleveland. This development consists of a new combination of three old elements: a drum, a magnetic tape, and a row of magnetic heads.

The row of heads is placed in a new location: inside the drum -- see Figure 1. The tape is put half around the drum.

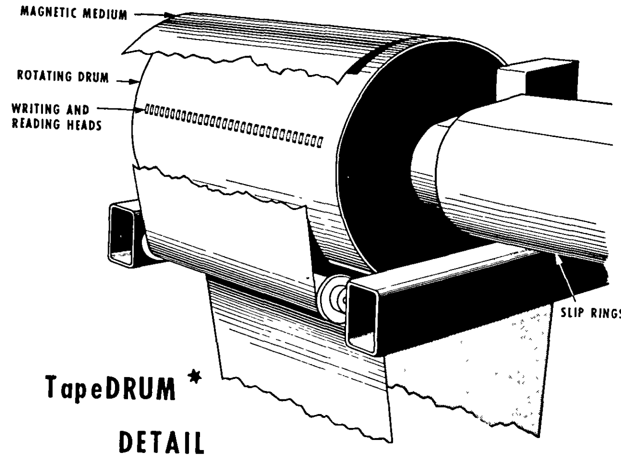
The moving row of heads can write, read, or erase on the inside of a stationary section (call it a "page") of the wide magnetic tape which touches the drum. Because the drum itself rotates rapidly, the heads it contains can read any part of the page in a small fraction of a second. The information passing through the magnetic heads is transferred through slip rings on the shaft of the drum to the rest of the machine. Whenever desired, however, any other "page" on the roll of magnetic tape can be turned to, and that page consulted instead. Between the moving drum and the moving tape there is a film of air so that hardly any wear on the tape results.

With the usual magnetic drums, one has to use additional drums when the information that must be stored exceeds the capacity of the drum; but with Brush's new idea, all that is needed is to move the tape a little. Information is accessible by means of three coordinates: the page (the section of the tape), the column (the channel on the tape), and the line (angular position relative to the drum).

In the model announced, the tape is 14 inches wide, and there are 128 magnetic reading and recording heads in the drum. The section of tape accessible to the heads at any one position of the tape contains 200,000 binary digits, and the average access time to any bit of information on a page is 1/40 of a second. The whole system can store more than 100 million bits of information. Variations, of course, are possible, depending on the width of the drum, the width of the tape, the packing of the pulses, the width of the channels or tracks, and the length of the tape.

Brush calls their device the "Tapedrum" (a trademark).

- END -



* TRADEMARK OF THE CLEVITE-BRUSH DEVELOPMENT COMPANY CLEVELAND 8 OHIO

Forum

AUTOMATIC LITERATURE SEARCHING

U. S. Dept. of Commerce,
Washington, D. C.

According to a release by Secretary of Commerce Weeks, a special advisory committee has been appointed to consider the application of automatic literature searching devices to the operations of the U. S. Patent Office.

The committee is headed by Dr. Vannevar Bush, President of Carnegie Institution, and its members include representatives of the National Bureau of Standards, the Office of Technical Services, the National Research Council, the Library of Congress, the Bureau of the Census, the National Science Foundation, the Rockefeller Foundation, and the Patent Office.

The Secretary of Commerce has invited inquiry and suggestions from organizations interested in the project.

Truer Input Functions in Electronic Analog Computers

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Summary

Functions used as inputs into an electronic analog computer may be introduced by means of a component in the computer called a "function fitter". This component is designed to cause the output voltage of the component to follow an assignable function of the input voltage. It uses an approximation consisting of ten connected line segments, each of which may be independently adjusted both as to slope and length.

Such functions of course are sharp-cornered, and will produce some errors in the quantitative analysis of the equations in the computer. This difficulty may be minimized by using two banks of computer components, the first of which modifies or smoothes out the input curve to a more desirable shape, and the second which uses the output of the first for the purposes of analysis. Furthermore, some functions which cannot be formed on the function fitter may be produced as one of the outputs of a properly arranged spring-mass system. The output displacement, velocity, or acceleration curve may then be used as the input function for the second bank of components if it possesses the desired shape.

Discussion

One of the most important uses for an analog computer is the study of dynamic spring-mass systems regarding displacements, velocities, and accelerations of points within the system. In a great many cases the displacement characteristics of the system are known or can readily be determined by means of a recording oscillograph. Once the displacement pattern of a machine part is determined, its velocity and acceleration curves may be readily obtained by the computer, as well as the effects on these three curves resulting from changing the mass, stiffness, or amount of damping within the system. There is, however, a limitation on the accuracy with which these curves or changes in them may be quantitatively computed if the displacement curve or input function varies from a pure sine wave or pure step wave. The limitation results from the fact that the function fitter-box of the computer must be used in an attempt to duplicate the displacement curve for the purpose of introducing that function into the computer. The function-fitter box is capable of setting up a function incrementally, i.e., it is possible to obtain with it straight lines of various desired slopes running sequentially along the time axis. Naturally, if the desired input function is a continuous curve of changing slope, the product from the function fitter is only an approximation of the true curve, and the resulting velocity and acceleration curves will be quantitatively in error.

The purpose of this paper is to explain briefly and illustrate with examples the method by which input functions can be produced which will more truly represent the desired input curve. There are two general methods of attack which can be used to this end. One is the "Modified Function Fitter" method, and the second is the "Double Spring-Mass System" method. Both of these methods for obtaining the desirable input function embody basically the same principle. The application of this principle differs, however, for the two cases.

The basic principle is very simple and is as follows. Two banks of computer components arranged in series are used instead of one. The purpose of the first bank is to produce an output function which resembles as nearly as possible the desired input function. This output is then merely introduced into the second bank as its input function and the desired effect is obtained.

The first or "Modified Function Fitter" method of approach uses the original input function, that which is created in the function fitter. Referring to Fig. 1, assume that the input function is a displacement x (for example, the displacement curve of a cam), and it is desired to study the displacement, velocity, and acceleration characteristics of a remote machine part which is driven by the cam through a series of linkages. This system may then be introduced into the computer in the manner shown in Fig. 2a.

Referring to Fig. 2a, it can be seen that the equation of motion for this dynamic system is

$$F_{(t)} - M\frac{d^2y}{dt^2} - C\frac{d\ y}{dt} - Ky = 0 \qquad (1)$$

where $F_{(t)}$ is the force as a function of time, M is the mass of the driven or output member, C is the damping coefficient, and K is the spring scale of the system. Referring then to Fig. 2b, it is apparent that $F_{(t)}$ may be represented as

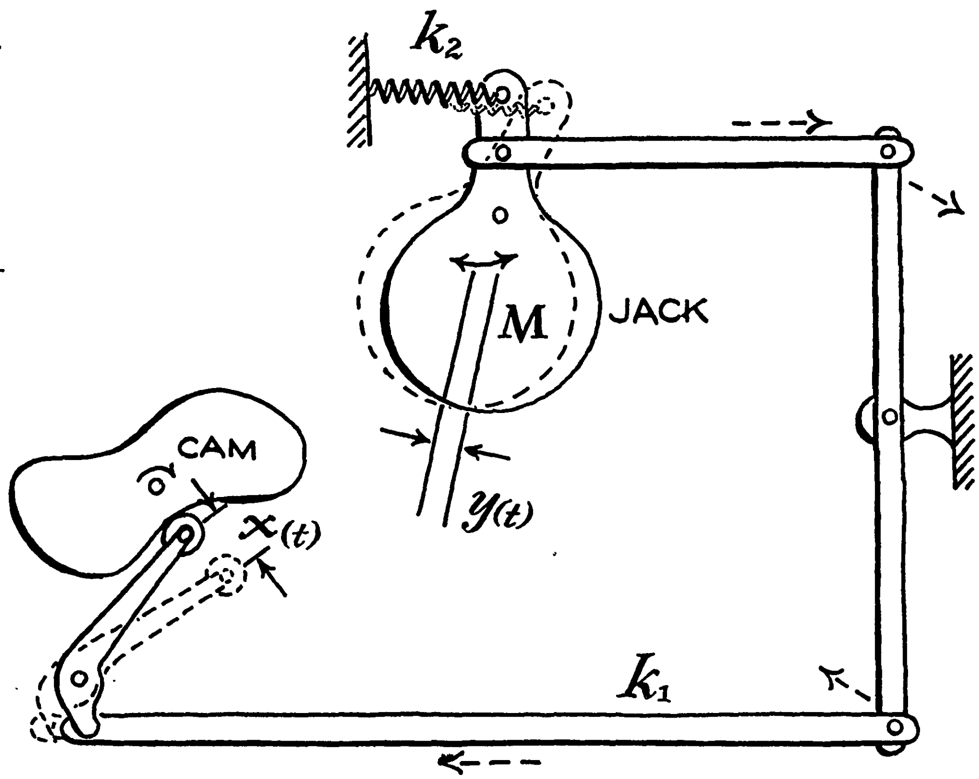
$$F_{(t)} = K_1\ (x-y) \qquad (2)$$

Equation (1) then becomes

$$K_1\ (x-y) - M\frac{d^2y}{dt^2} - C\frac{dy}{dt} - Ky = 0 \qquad (3)$$

Equation (3) may then be fed into the analog computer with x equaling the input from the function fitter and y equaling the output function from the first bank of components. Referring to Fig. 3, it may be seen that the initial conditions are established by a sine wave applied as a stimulus to the function-fitter box. The dials on the function fitter box are then arranged in positions which produce the input function x which matches as closely as possibly can be attained the true shape of the displacement curve. Once the computer is arranged in this manner, it will now be possible to manipulate the mass, spring constants, and damping factor on the C-boxes to produce the

Figure 1 -- Typical cam driven mechanism in a machine suitable for analysis on an analog computer. M = Mass of jack and linkage. $x_{(t)}$ = Cam displacement curve as a function of time. $y_{(t)}$= Jack displacement curve as a function of time. k_1 = Spring scale of linkage. k_2 = Spring scale of back-up spring.



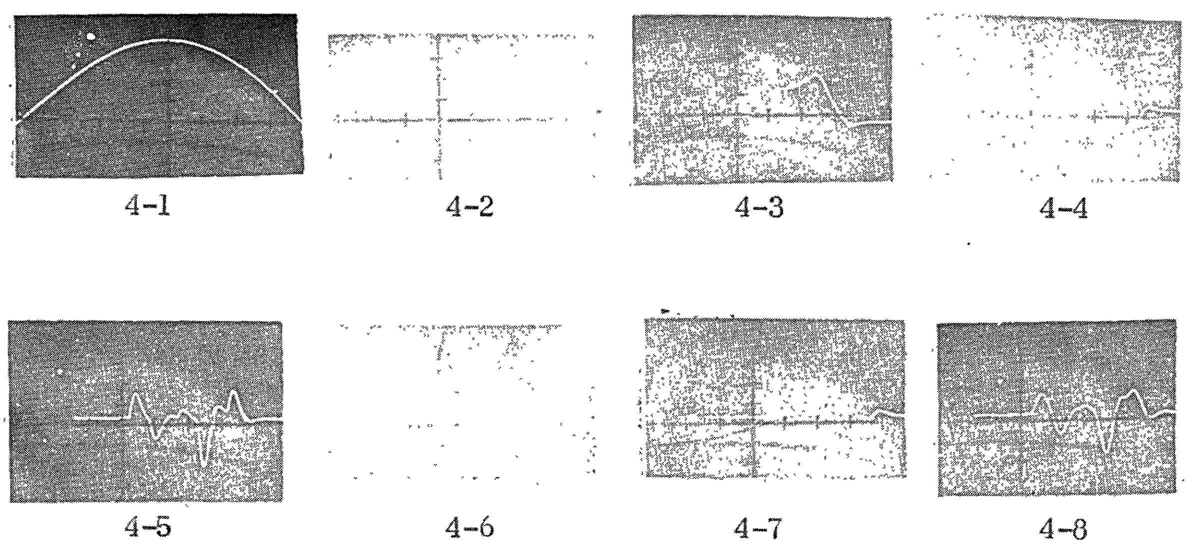


Figure 4 -- Oscilloscope patterns generated by the "modified function fitter" method. 4-1: Sine wave into function fitter. 4-2: Input motion "x" into first bank of components (note sharp corners). 4-3: Output motion "y" from first bank of components x', the input motion into second bank of components. 4-4: Output velocity $\frac{dy}{dt}$ from first bank of components. 4-5: Output acceleration $\frac{d^2y}{dt^2}$ from first bank of components. 4-6: Output motion y' from second bank of components. 4-7: Output velocity $\frac{dy'}{dt}$ from second bank of components. 4-8: Output acceleration $\frac{d^2y}{dt^2}$ from second bank of components.

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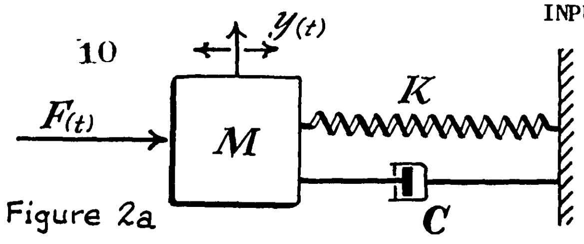


Figure 2a

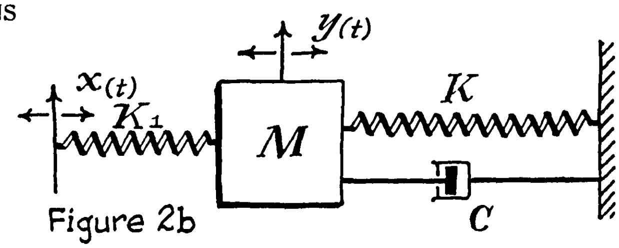
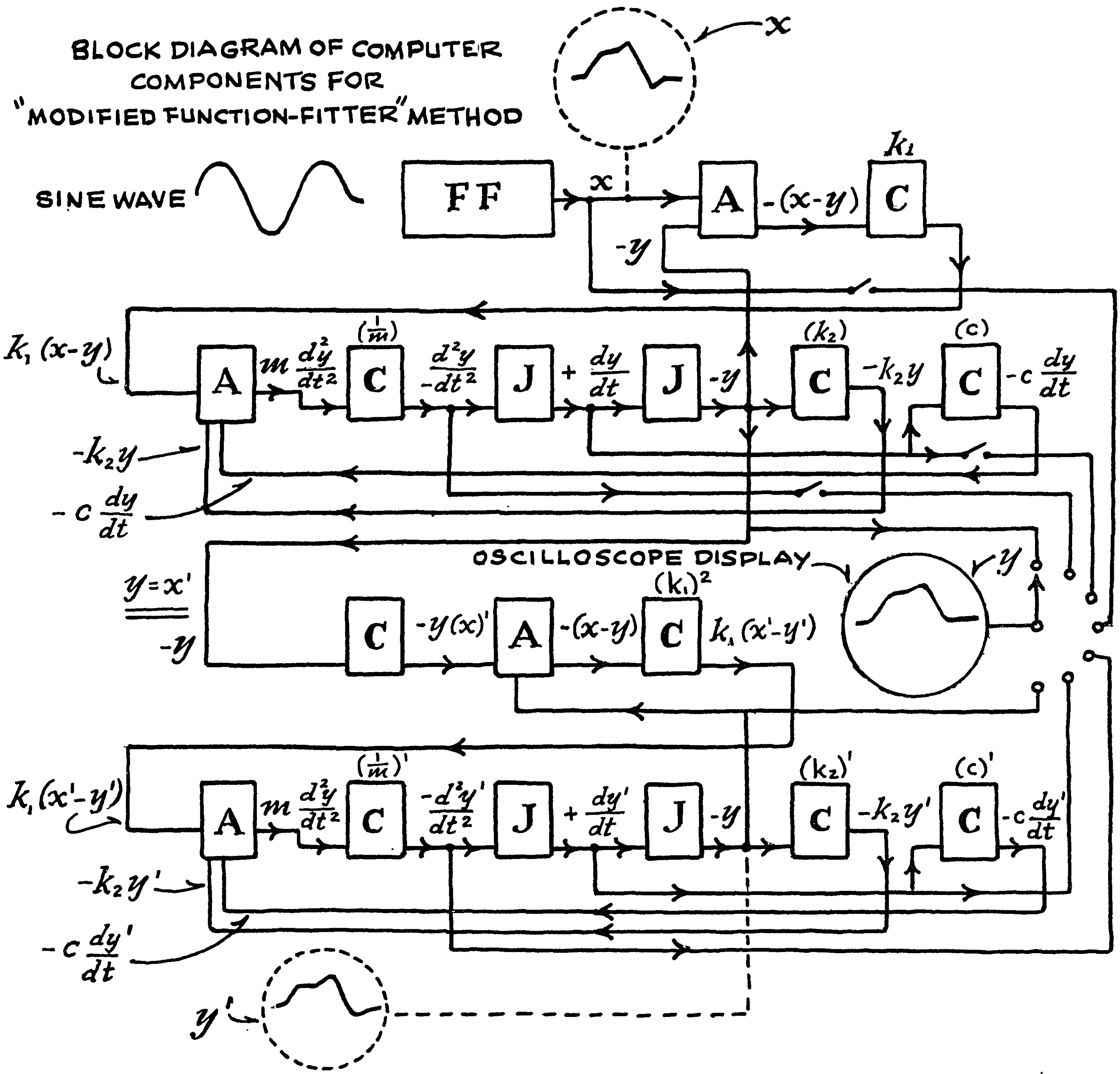


Figure 2b

Figure 3



In Figure 3, A represents an adder; C, multiplication by a constant coefficient; J, an integrator; FF, a function fitter.

output function, y, which will duplicate exactly the original sharp cornered input function. Then by further manipulation the y curve can be smoothed out considerably, in fact, to the point where it appears exactly like the desired input curve. This curve is now used as the input function, x', which is introduced into a second bank of components similar in every way to the first bank. Once the desired shape of the output of the first bank has been obtained and fed to the second bank, the dial settings of the first bank may be forgotten and never changed again. The effects of changing the mass, spring force, or damping may then be observed on the output y', of the second bank. Furthermore, the velocities and accelerations of the jack are much more accurately shown on the oscilloscope than in the case where the input function was taken directly from the function-fitter box. Quantitatively, the errors in the system are reduced to a minimum and could be reduced to zero if the output function of the first bank could be made to exactly reproduce the displacement curve of the cam. This method may then be used for determining velocities and accelerations and changes in them with a maximum of accuracy and a minimum of effort.

In the photographs in Fig. 4, is a comparison of the curves produced by using this method with those produced from using the non-continuous input function.

The "Double Spring-Mass System" method is quite similar to the "Modified Function Fitter" method, and is in some ways more useful. Many functions for some reason or another are difficult to obtain even approximately on the function fitter. In many instances, however, very good approximations of these functions can be obtained by the use of a spring-mass system with close attention being paid to the spring and damping factors as well as the mass. For example, a desired input function may resemble either another displacement or acceleration or velocity function of some spring-mass system which uses as an input, for instance, a single force impulse which is very easy to obtain in a function-fitter box. With such a spring-mass system set up in the first bank of components, skillful manipulation of the parameters in the system can produce hundreds of different curves on the oscilloscope. This fact almost guarantees that one of these curves will closely resemble the desired input function or a portion thereof. This output curve, therefore, whether it is displacement, velocity, or acceleration from the first bank may then be employed as the input to the second bank and the subsequent results may be studied with a considerable amount of accuracy. Naturally, in every instance the accuracy gained in the end is merely a function of how closely the output curve from the first system may be made to resemble the desired input. Furthermore, the process of adding banks of components need not stop with two. If the component boxes are available, as many banks as are needed may be used until the desired degree of accuracy is obtained. Also, if the input function is constantly changing in shape for a long period on the abscissa, portions of it may be taken at one time and studied on the computer. The results for the whole curve are merely obtained by putting the pieces together.

- END -

Analog Computers and their Application to Heat Transfer and Fluid Flow—Part 3 (Concluding Part)

(Parts 1 and 2 were published in the November and December issues.)

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F. Fluid Flow Analogs

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(continued on page 37)

Roster of Organizations in the Field of Computers and Automation

(Supplement, information as of December 3, 1954)

The purpose of this Roster is to report organizations (all that are known to us) making or developing computing machinery, or systems, or data-handling equipment, or equipment for automatic control and materials handling. In addition, some organizations making components may be included in some issues of the Roster. Each Roster entry when it becomes complete contains: name of the organization, its address and telephone number, nature of its interest in the field, kinds of activity it engages in, main products in the field, approximate number of employees, year established, and a few comments and current news items. When we do not have complete information, we put down what we have.

We seek to make this Roster as useful and informative as possible, and plan to keep it up to date in each issue. We shall be grateful for any more information, or additions or corrections that any reader is able to send us.

Although we have tried to make the Roster complete and accurate, we assume no liability for any statements expressed or implied.

This listing is a supplement to: the cumulative listing containing over 230 organizations published in the November issue of "Computers and Automation", vol. 3, no. 9, pp 9 to 19 and 30; and the supplement in the December issue, vol. 3, no. 10. This listing contains only additions or corrections as compared with previous listings.

Abbreviations

The key to the abbreviations follows:

Size

- Ls Large size, over 500 employees
- Ms Medium size, 50 to 500 employees
- Ss Small size, under 50 employees (no. in parentheses is approx. no. of employees)

When Established

- Le Long established organization (1922 or earlier)
- Me Organization established a "medium" time ago (1923 to 1941)
- Se Organization established a short time ago (1942 or later) (no. in parentheses is year of establishment)

Interest in Computers and Automation

- Dc Digital computing machinery
- Ac Analog computing machinery
- Ic Incidental interests in computing machinery
- Sc Servomechanisms
- Cc Automatic control machinery
- Mc Automatic materials handling machinery

Activities

- Ma Manufacturing activity
- Sa Selling activity
- Ra Research and development
- Ca Consulting
- Ga Government acticity
- Pa Problem-solving
- Ba Buying activity

(Used also in combinations, as in RMSa "research, manufacturing and selling activity")

*C This organization has kindly furnished us with information expressly for the purposes of the Roster and therefore our report is likely to be more complete and accurate than otherwise might be the case. (C for Checking)

ROSTER

Argonne National Laboratory, Box 299, Lemont, Ill. / Lemont 800
Maker of Avidac and Oracle automatic digital computers and other computers, for own use and other government agencies. ?s ?e DAIc RMGPC a

Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y. / Plaza 3-0973
Magnetic tape guaranteed defect-free. ?s ?e Ic RMSa

Bendix Aviation Corporation, Eclipse-Pioneer Division, Teterboro, N. J. / Hasbrouck Heights 8 - 2000
Some computing equipment and components. ?s ?e Dc RMSa

Edmund C. Berkeley and Associates, 815 Washington St., Newtonville 60, Mass. / Decatur 2-5453 or 2-3928
Courses by mail in automatic computing machinery and other scientific subjects. Ss(3) Se(1948) Dc Ca Affiliated with Berkeley Enterprises, Inc.

Berkeley Enterprises, Inc., 36 West 11 St., New York 11, N. Y. / Algonquin 4-7675 / and 815 Washington St., Newtonville 60, Mass. / Decatur 2-5453 or 2-3928 / *C
Small robots, etc. Logical design, applications, marketing, etc. of automatic information handling machinery. Publisher of "Computers and Automation" and other publications. Ss(8) Se(1954) Dc RCMSa Affiliated with Edmund C. Berkeley and Associates.

Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia, Pa. / Locust 7-1401
Electronic computing equipment: large automatic digital computer, UDEC; small automatic digital computer, E101. ?s ?e Dc MSa

Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass. / Commonwealth 6-3228
Magnetic shift registers, transistors, delay lines, and other components for computers, systems, automatic control, etc. Ss(20) Se(1954) DIc RMSCa

K C S Data Control, Ltd., Box 38, Postal Station J, Toronto 6, Ont., Canada
Consulting, engineering, and programming in

(continued on page 37)

ANALOG COMPUTERS
(continued from page 35)

ican Society of Civil Engineers, LXXVIII, Separate No. 139 (July 1952).

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- END -

ROSTER OF ORGANIZATIONS
(continued from page 36)

the digital computer field. Ss (3) Se (1954) Dc RCPa

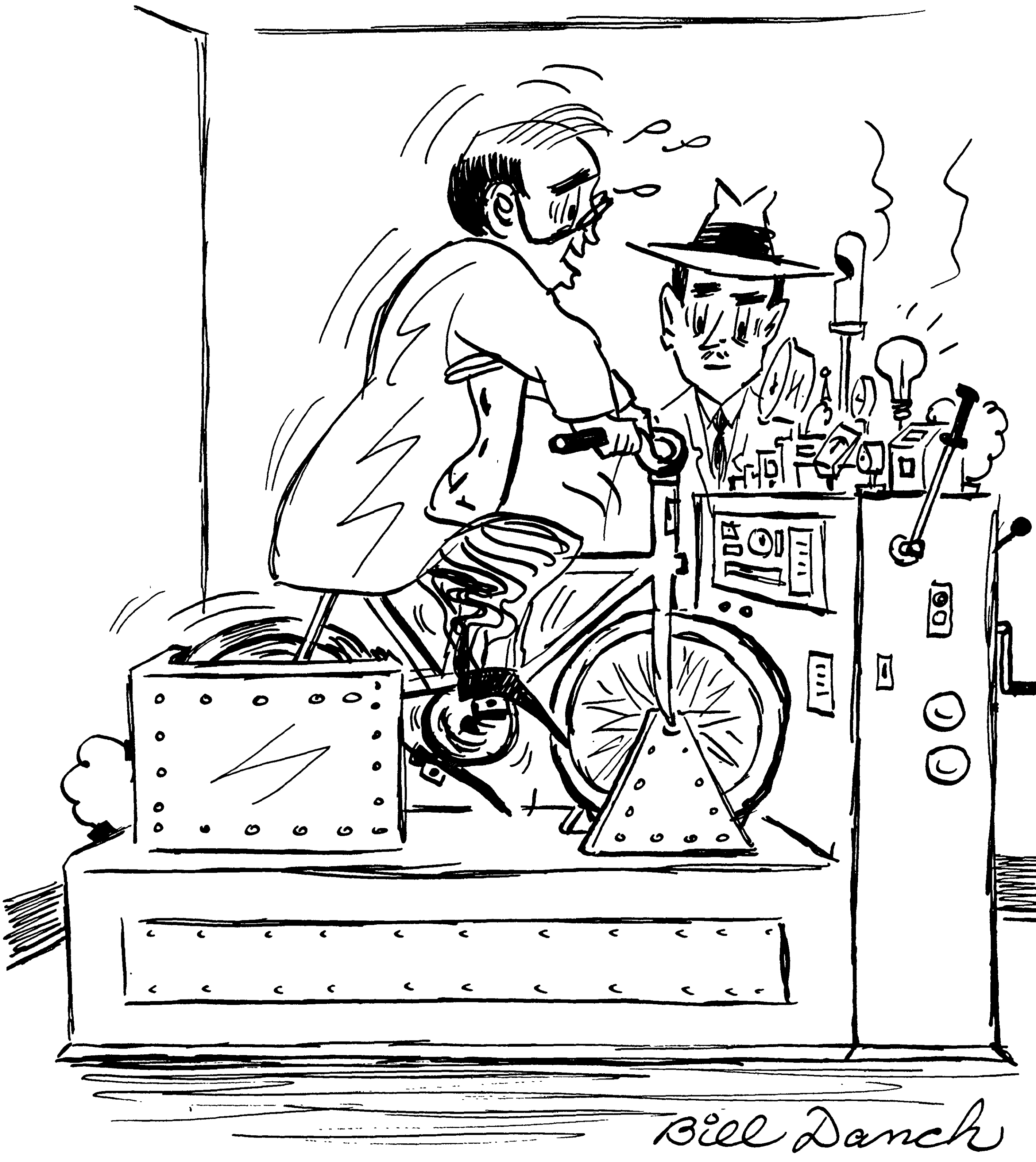
Litton Industries, Beverly Hills, Calif.
Purchaser of Digital Control Systems, Inc. Radar systems with monopulse techniques, electronic countermeasures equipment, automatic flight controls, airborne radar magnetrons, etc. Some digital computer products. Ls (650) Se (1954) DAIc RMSa

Norden-Ketay Corporation, 555 Broadway, New York 12, N. Y. / Digby 9-2717 / and elsewhere
Planned new name of Ketay Instrument Corporation, referring to merger of Ketay Instrument Corp. (see Nov. 1954 listing) and Norden Laboratories of Milford, Conn., and White Plains, N. Y.

- END -

DECIMAL PLACES

Bill Danch
Woodstock, N.Y.



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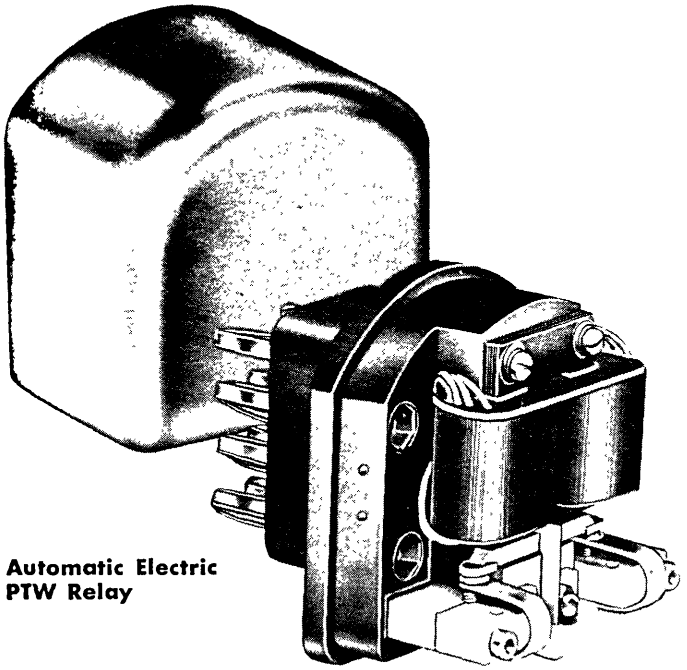

Automatic Electric PTW Relay

Here's a new polar relay that will soon be setting records for long service life! Its sensitivity gives peak performance for high-speed polarized pulse repeating, or for applications where low current is transmitted over long lines. The Series PTW Relay is also recommended for line-current direction indication or as a differential relay in the "Wheatstone Bridge" type of control. Advanced features include:

simplified design and long service life

New design eliminates many parts and adjustments formerly required. Relay gives *billions* of operations without re-adjustment.

extreme sensitivity

Unit operates on currents as low as 2 to 12 milliamperes, depending upon number and combination of windings used. Signals as low as 10 milliwatts through the two line-windings will "trigger" the relay.

reduced bounce and wear

A new method of armature support limits longitudinal movement. There are no bearings to wear . . . the usual rocking motion in contact make-and-break is reduced. Armature bounce is virtually eliminated; contacts last longer.

improved characteristics in smaller size

Because of increased magnetic efficiency, the coils take less space and need fewer turns. The lower coil impedance of this compact unit gives improved characteristics.

fast response

Travel time is as low as .9 milliseconds, depending upon contact gap and windings used.

send for circular

For a small, fast, sensitive polar relay that out-performs and outlasts all others, specify this new Automatic Electric Series PTW Relay. For details ask for Circular 1821. Write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. Offices in principal cities.

helpful technical data

Make and Break—75% total "make" on both contacts at 60 cycles per second with .006" contact gap and 23 milliamperes of sine wave ac. Simple, easy re-adjustment can be made in the field.

Windings—Four windings: two line-windings, each 139 ohms resistance and only .5 henry inductance; other two windings, each 101 ohms and .125 henry. The number of coil turns to be placed in series aiding can vary from 1400 to 8400.

Cover—Snap-on cover easily removed for inspection and adjustment of relay.

Mounting—Jack mountings, available for flush or surface mounting.

Size—2¼" wide, 2½" deep and 2¹¹⁄₁₆" high (plus ⅝" projection of banana plugs).

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BOOKS AND OTHER PUBLICATIONS

(List 10, Computers and Automation, vol. 4, no. 1, Jan. 1955)

This is a list of books, articles, periodicals, and other publications which have a significant relation to computers or automation, and which have come to our attention. We shall be glad to report other information in future lists, if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / a few comments. If you write to a publisher or issuer, we would appreciate your mentioning the listing in COMPUTERS AND AUTOMATION.

Groelinger, Herbert J. / Inventory Control Under the Program-Usage-Replenishment System Defined for Electronic Processing; NBS Report 3651 / National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D.C. / 1954, photooffset, 164 pp, price?

The problem leading to this report is the problem of the Naval Aviation Supply Office in Philadelphia in calculating the anticipated inventory requirements necessary for the support of aircraft operations throughout the Navy. The report was written in order to prepare to use a large scale general purpose electronic digital computer for performing that calculation. The report contains a careful and elaborate description, or "definition", of the work to be done. It also contains a glossary and to some extent explains the inventory philosophy being used, but mostly it is a technical flow-chart "definition" of the work to be done.

Shea, Richard F., and others (Electronics Laboratory, General Electric Co.) / Principles of Transistor Circuits / John Wiley & Sons, 440 4th Ave., New York 16, N.Y. / 1953, printed, 535 pp, $11.00

A basic text: 22 chapters; 14 pages of definitions of symbols; 8 pages of bibliography. Covers subjects such as semiconductor principles, types and characteristics of transistors, design of amplifiers, high-frequency circuit design, matrix methods of circuit analysis, noise in transistors, etc. Chapter 19 is entitled "Computer Circuits".

Thrall, R. M., and others / Decision Processes / John Wiley and Sons, 440 4th Ave., New York 16, N.Y. / 1954, photooffset, hard cover, 332 pp, $5.00

Contains an introduction and 18 papers presented at, or developing from, the Univ. of Michigan and Ford Foundation seminar on "The Design of Experiments in Decision Processes" held in 1952 at Santa Monica, Calif. Subjects include mathematical models, games against nature, multiple-choice situations, an economic theory of organization and information, etc. Some papers are pure mathematics, others are reports of empirical studies.

Ver Planck, D. W., and B. R. Teare, Jr. / Engineering Analysis / John Wiley and Sons, 440 4th Ave., New York 16, N.Y. / 1954, printed, 344 pp, price?

A case method presentation of the philosophy and procedures in "engineering analysis", a technique for developing a student's capacity to analyze problems from an experienced engineer's point of view. Many examples and frequent exercises are given. There are 51 pages of applied problems for "case study". The authors are at Carnegie Inst. of Technology.

Alden, William L, and six more / The Automatic Office: A Study of the Application of Electronic Digital Computer Principles to the Automatization of Clerical and Accounting Routines / William L. Alden, Alden Systems Co., Alden Research Center, Westboro, Mass. / 6th printing, Sept. 1954, photooffset, 48 pp, $5.00

This is a report by a group of seven students in the Harvard Graduate School of Business Administration, first printed Feb. 1952. Chapters cover: history of calculating machinery, how electronic computers work, design requirements for a business computer, factors affecting the adoption of business computers, etc.

Davis, M. E. / Some Current Thoughts on the Possible Use of Magnetic Tape Policy Files in a Life Insurance Office / Metropolitan Life Insurance Co., One Madison Ave. New York 10, N. Y. / October, 1954, photooffset, 17 pp, free

A brief but thorough report made to the Society of Actuaries about studies, considerations and factors in connection with the use of an electronic data processing machine in the life insurance business.

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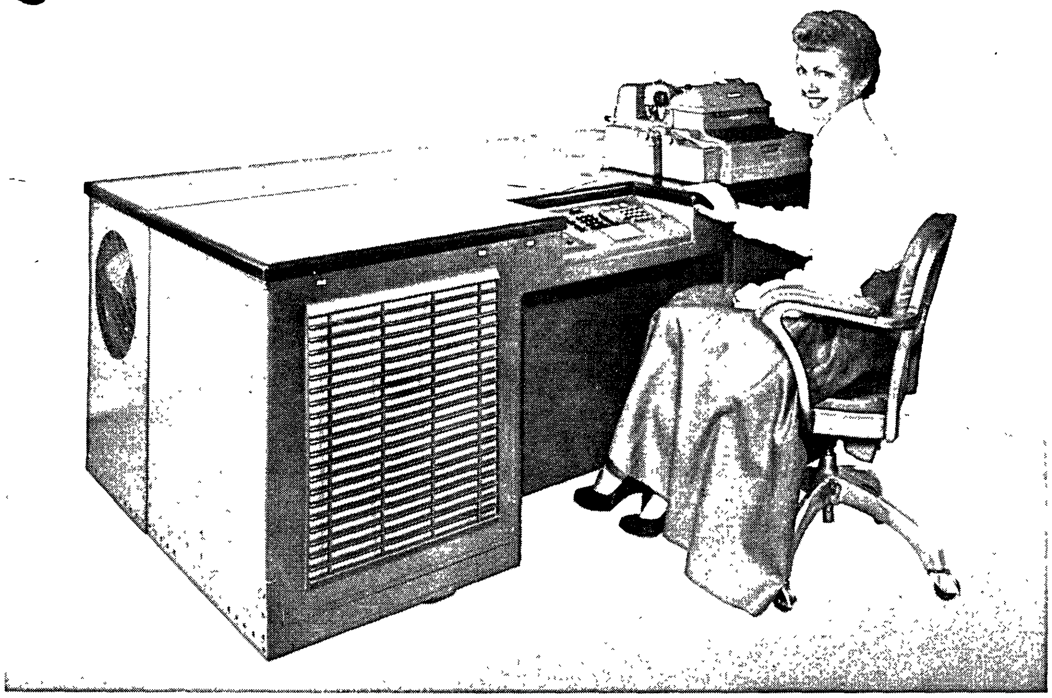

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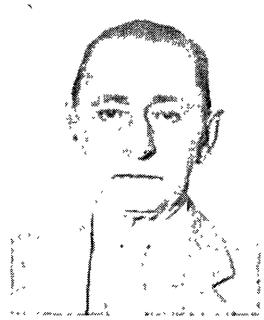

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Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N.Y.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles and reference information related to computing machinery, robots, automatic controllers, cybernetics, automation, etc. One important piece of reference information published is the "Roster of Organizations in the Field of Computers and Automation". The basic subscription rate is $4.50 a year in the United States. Single copies are $1.25. The magazine was published monthly except June and August between March, 1953, and September, 1954; prior to March 1953 it was called "The Computing Machinery Field" and published less often than ten times a year.

2. What is the circulation? The circulation includes 1300 subscribers (as of Dec. 15); over 300 purchasers of individual back copies; and an estimated 1500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are some 3500 or 4000 people concerned with the field of computers and automation. These include a great number of people who will make recommendations to their organizations about purchasing computing machinery, similar machinery, and components, and whose decisions may involve very substantial figures. The print order for the Dec. issue was 2100 copies. The overrun is largely held for eventual sale as back copies, and in the case of several issues the overrun has been exhausted through such sale. A mailing to some 2000 nonsubscribers in December, 1953 (with 173 responses up to March, 1954) indicated that two-thirds of them saw the magazine (library, circulation, or friend's copy) and of these two-thirds over 93% "liked it".

3. What type of advertising does COMPUTERS AND AUTOMATION take? The purpose of the magazine is to be factual and to the point. For this purpose the kind of advertising wanted is the kind that answers questions factually. We recommend for the audience that we reach, that advertising be factual, useful, interesting, understandable, and new from issue to issue.

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8½" x 11" (ad size, 7"x10") and produced by photooffset, except that printed sheet advertising may be inserted and bound in with the magazine in most cases. The closing date for any issue is approximately the 10th of the month preceding. If possible, the company advertising should produce final copy. For photooffset, the copy should be exactly as desired, actual size, and assembled, and may include typing, writing, line drawing, printing, screened half tones, and any other copy that may be put under the photooffset camera without further preparation. Unscreened photographic prints and any other copy requiring additional preparation for photooffset should be furnished separately; it will be prepared, finished, and charged to the advertiser at small additional costs. In the case of printed inserts, a sufficient quantity for the issue should be shipped to our printer, address on request.

Display advertising is sold in units of full pages (ad size 7" by 10", basic rate, $170) and half pages (basic rate, $90); back cover, $330; inside front or back cover, $210. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $290; four-page printed insert (two sheets), $530. Classified advertising is sold by the word (50 cents a word) with a minimum of ten words. We reserve the right not to accept advertising that does not meet our standards.

5. Who are our advertisers? Our advertisers in recent issues have included the following companies, among others:

- The Austin Co.
- Automatic Electric Co.
- Burroughs Corporation
- Federal Telephone and Radio Co.
- Ferranti Electric Co.
- Ferroxcube Corp. of America
- General Ceramics Corp.
- General Electric Co.
- Hughes Research and Development Lab.
- International Business Machines Corp.
- Ketay Manufacturing Co.
- Laboratory for Electronics
- Lockheed Aircraft Corp.
- Logistics Research, Inc.
- Machine Statistics Co.
- Monrobot Corp.
- Potter Instrument Co.
- Raytheon Mfg. Co.
- Reeves Instrument Co.
- Remington Rand, Inc.
- Sprague Electric Co.
- Sylvania Electric Products, Inc.
- Telecomputing Corp.

ADVERTISING INDEX — DECEMBER, 1954

The purpose of COMPUTERS AND AUTOMATION is to be factual, useful, and understandable. For this purpose, the kind of advertising we desire to publish is the kind that answers questions, such as: What are your products? What are your services? And for each product, What is it called? What does it do? How well does it work? What are its main specifications? We reserve the right not to accept advertising that does not meet our standards.

Following is the index and a summary of advertisements. Each item contains: name and address of the advertiser / subject of the advertisement/ page number where it appears / CA number in case of inquiry (see note below).

If you wish more information about any of the products or services mentioned in one or more of these advertisements, you may circle the appropriate CA No.'s on the Reader's Inquiry Form below and send that form to us (we pay postage; see the instructions). We shall then forward your inquiries, and you will hear from the advertisers direct. If you do not wish to tear the magazine, just drop us a line on a postcard.

REPLY FORMS: Who's Who Entry; Reader's Inquiry

Paste label on envelope:↓ Enclose form in evelope:↓

BUSINESS REPLY LABEL

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

4¢ Postage Will Be Paid By --

BERKELEY ENTERPRISES, INC.

36 West 11th Street

New York 11, N. Y.

FIRST CLASS
PERMIT NO 1680
Sec. 34.9, P. L. & R.
NEW YORK, N. Y.

IDENTIFICATION

Name (please print) ....

Address ....

Organization (& address)? ....

Title? ....

Please fill in completely

WHO'S WHO ENTRY FORM

Year of Birth? ....

MAIN INTERESTS:
( ) Design
( ) Construction
( ) Applications
( ) Sales
( ) Electronics
( ) Mathematics
( ) Business
( ) Programming
( ) Other (specify): ....

College or last school? ....

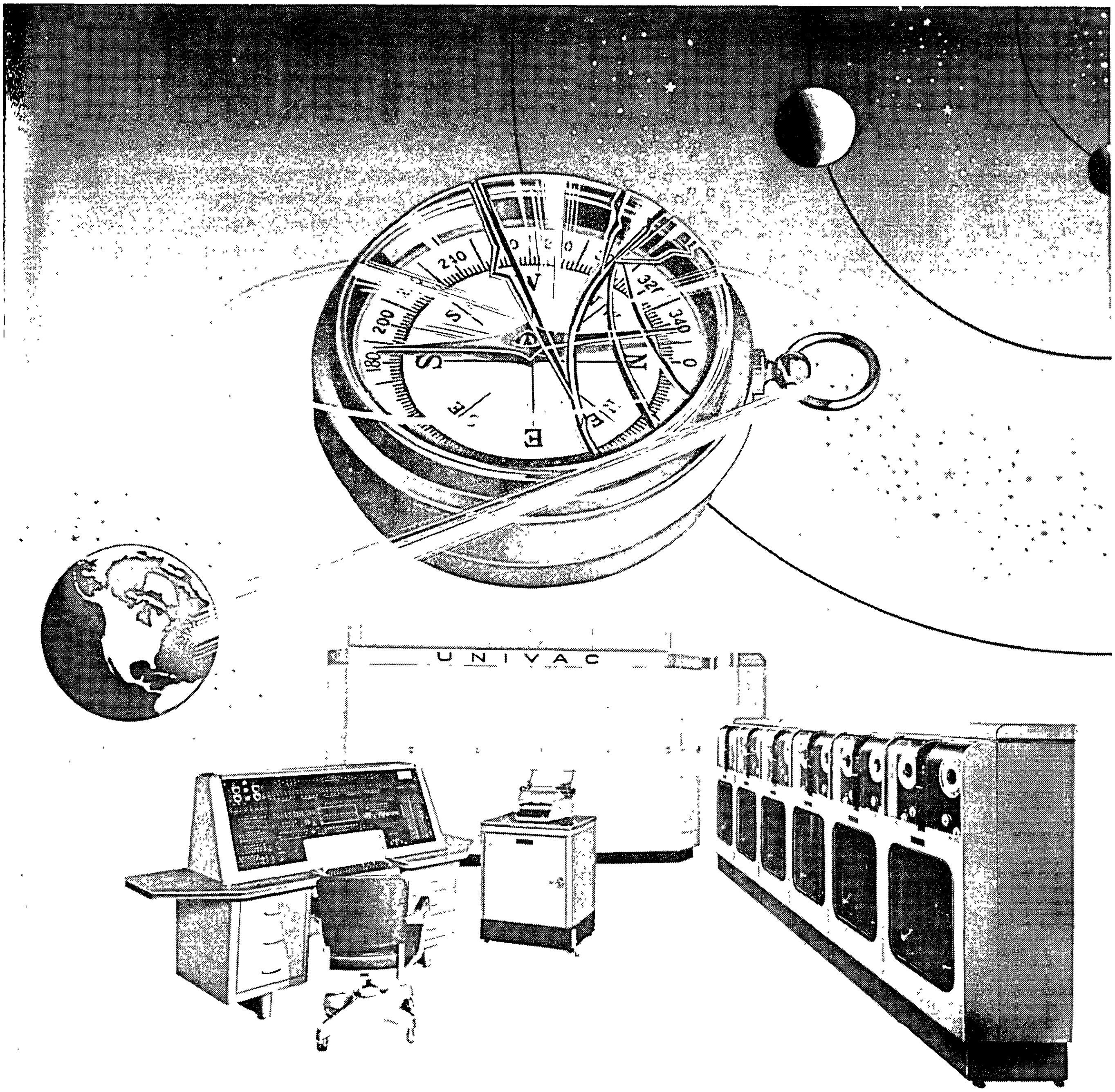
Year of entering the computing machinery field? ....

Occupation? .... (Enclose more information about yourself if you wish — it will help in your listing.)

READER'S INQUIRY FORM

Please send me additional information on the following subjects for which I have circled the CA number:

1 2 3 4 5	26 27 28 29 30	51 52 53 54 55	76 77 78 79 80	101 102 103 104 105	126 127 128 129 130
6 7 8 9 10	31 32 33 34 35	56 57 58 59 60	81 82 83 84 85	106 107 108 109 110	131 132 133 134 135
11 12 13 14 15	36 37 38 39 40	61 62 63 64 65	86 87 88 89 90	111 112 113 114 115	136 137 138 139 140
16 17 18 19 20	41 42 43 44 45	66 67 68 69 70	91 92 93 94 95	116 117 118 119 120	141 142 143 144 145
21 22 23 24 25	46 47 48 49 50	71 72 73 74 75	96 97 98 99 100	121 122 123 124 125	146 147 148 149 150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