COMPUTERS
AND
AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

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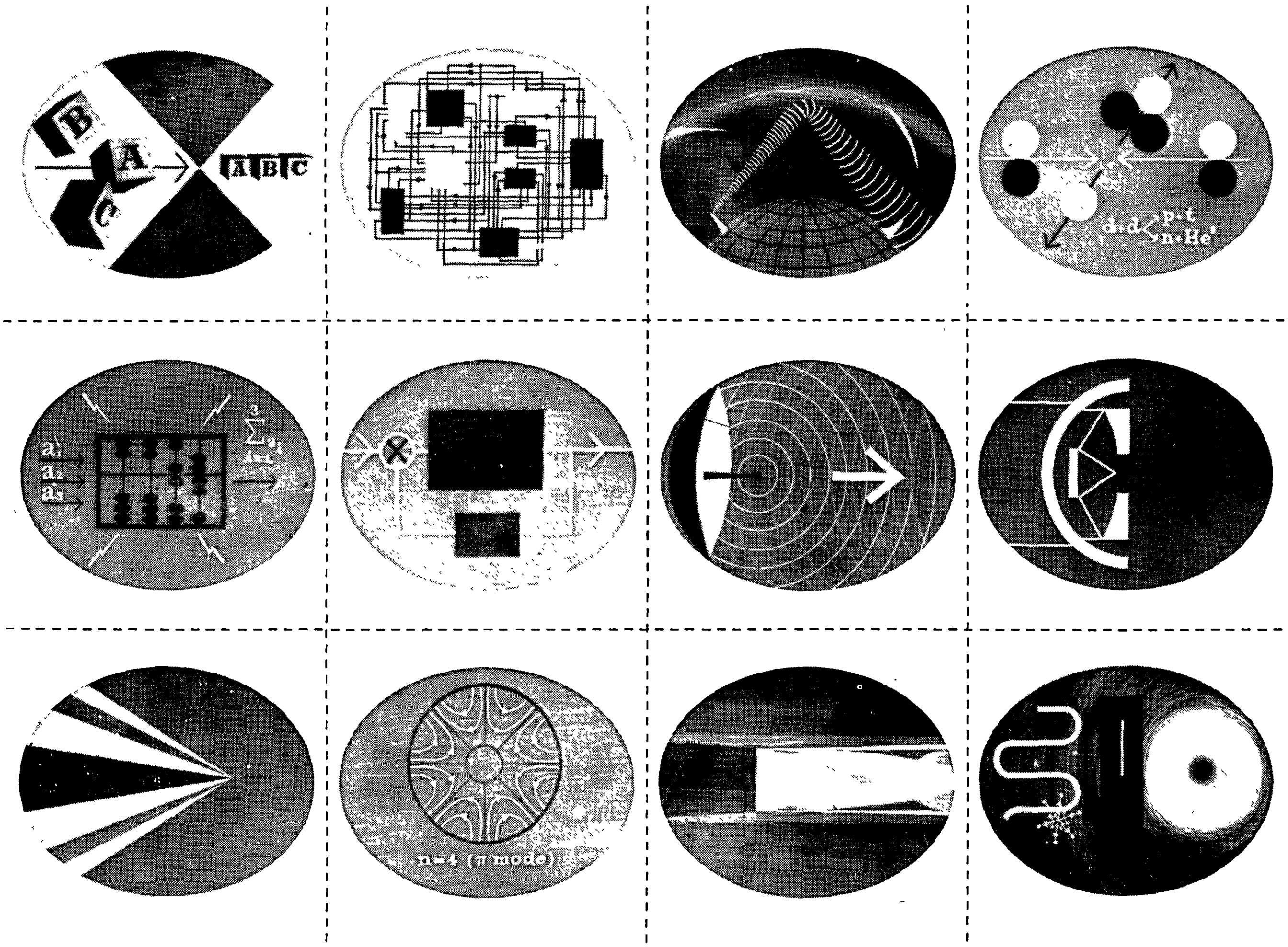

Variety of Technical Fields

These illustrations are symbolic of some of the scientific and engineering fields of endeavor which are essential ingredients in the broad range of technical programs that are in progress at The Ramo-Wooldridge Corporation. Illustrated are: Information Theory, Systems Analysis, Communications, Nuclear Physics, Electronic Computers, Servomechanisms, Electromagnetic Propagation, Infrared, Aerodynamics, Microwaves, Propulsion, and Thermodynamics.

The requirement for technical competence in a wide variety of fields is a significant characteristic of systems engineering work. At R-W this requirement is particularly important because of our emphasis on the development of systems having a high content of scientific and engineering newness.

Our current military contracts support a number of advanced programs in the fields of modern communications, digital computing and data processing, fire control and navigation systems, instrumentation and test equipment. In the guided missile field, Ramo-Wooldridge has technical direction and systems engineering responsibility for the Air Force Intercontinental and Intermediate Range Ballistic Missiles. Our commercial contracts are in the fields of operations research, automation, and data processing. All of this work is strengthened by a supporting program of basic electronic and aeronautical research.

Scientists and engineers whose training and experience are in these or related fields are invited to explore the openings at The Ramo-Wooldridge Corporation.

The Ramo-Wooldridge Corporation

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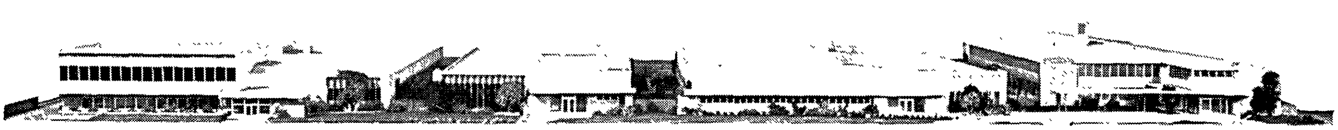

COMPUTERS AND AUTOMATION

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THE EDITOR'S NOTES

INFORMATION ABOUT COMPUTERS AND THEIR APPLICATIONS

It is clear to even a casual observer that information about computers, data processors, cybernetics, robots, automatic control—in short, information about machines that handle information—is mushrooming into a tremendous and continuous explosion. The great quantity of information about computers overstrains the capacity of people in the computer field to find out about it, keep track of it, and get access to it.

For example, there was submitted to us for publication recently a bibliography on automatic programming. We estimated that there were 1400 cards in this bibliography, the first half an index by subjects, the second half an index by authors. We had to reply that we did not think there was room in "Computers and Automation" to publish it —and THIS IS ONLY A BIBLIOGRAPHY!

For another example, at the meeting of the Association for Computing Machinery in Los Angeles in August there were presented 61 papers and addresses. The Association distributed at the meeting three and four page abstracts of 44 of the papers. The remaining 17 (which corresponded with invited papers) had no preprints or summaries. Furthermore, we have been told that the Association has no more copies of the set of preprints, having intended to give them out only to registrants. The Association doubtless has good reasons for these decisions conducing to the unavailability of desired information; but the main underlying reason certainly is that computer people are so busy with actual computers that they are unable to do a good job with information about computers.

We would like to help organize, with the assistance of leading organizations in the computer field, a "Master Library" and "Superintendent of Documents" for the computer field. We would gladly contribute all the books and other information we have; and we are sure there are some more people in the computer field who would eagerly contribute likewise, in return for easily getting copies of whatever they wanted. With suitable support from leading organizations, including support of salaries to librarians and operators of multiple copying machines, it might be possible to set a fine example of a scientific field well-organized from the point of view of access to the information it produces.

WHO'S WHO IN THE COMPUTER FIELD

About October 11 we delivered to the post office, some 15,000 Who's Who Entry Forms, addressed to all persons in the computer field whom we know of. The replies have started streaming in. It begins to look as if we can make the second cumulative "Who's Who in the Computer Field" a useful and helpful book. If you consider yourself really interested in computers, please send us your Who's Who entry form; see the style of entry on page 48. Entries in this Who's Who are free; since this extra issue of "Computers and Automation" is being sold separately at $15, we expect that those who want to use the Who's Who will pay the cost of preparing and publishing it.

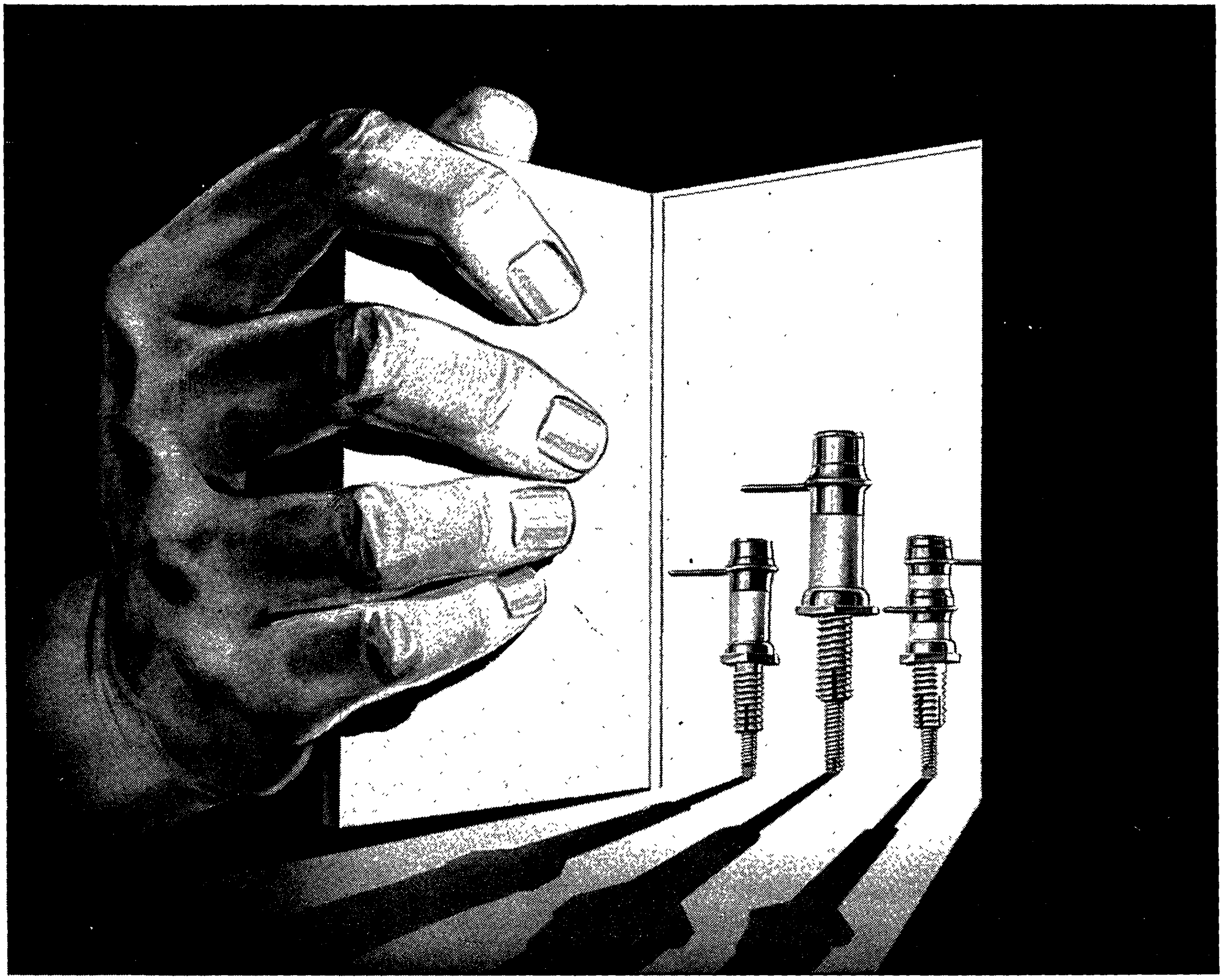
Our plans for this extra issue are as follows: accept entries up to November 25 or November 30; accept orders ($15 per copy, prepaid) until about December 10; go to press, if we are lucky, in December; and mail the Who's Who in January, sending it to those who have already paid for it.

We hope and expect that this second cumulative issue of the Who's Who will contain the names and addresses, and some information, for at least 10,000 people in the computer field. We expect to publish addresses except where the address is confidential.

————————————*

INDEX OF NOTICES

Address Changes: If your address changes, please send us both your new and your old address (torn off from the wrapper if possible, and allow three weeks for the change.



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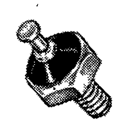

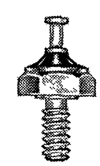

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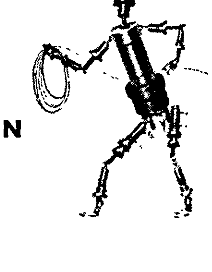

USE OF AUTOMATIC PROGRAMMING

WALTER F. BAUER
Head, Digital Computing Center
The Ramo-Wooldridge Corporation
Los Angeles, Calif.

(Based on a series of lectures given by the author at the Special Summer Session on Digital Computers at the University of Michigan in 1954, 1955 and 1956.)

There are many definitions of the term "automatic programming". One possible definition is as follows: Automatic programming consists of devising and organizing computer programs which will allow the utilization of the computer in the performance of certain tasks which would otherwise need to be done manually by the programmer. Automatic programming can be considered as only the organization of subroutines in the library or it can be regarded as the organization of an appropriate compiler or assembly program together with a comprehensive system for using the compiler to prepare and check out problems.

Motivations and History

There are four principal motivations for automatic programming: the high cost of programming; the shortage of manpower for programming; the desire to cut down the time from presentation to solution of a problem; and the desire and necessity to overcome certain computer shortcomings. The first of these, the high cost of programming, is important for it is estimated that the cost of programming and checking a problem for a high speed electronic digital computer lies somewhere between $2 and $10 per instruction. In view of the fact that a thousand word program is a relatively short program, one sees that this cost is far from trivial. Another commonly accepted statistic applied especially to scientific computation groups, but probably generally applicable, is that the manpower expense (not counting overhead and costs) supporting the computer is as great as the cost of running or renting the computer. Certainly the cost of renting a modern computer is a considerable matter, ranging upwards of $20,000 per month for the more powerful ones.

The programmer manpower shortage has been a serious matter for approximately two years and will continue to plague computer groups. During the year 1956 the amount of computer time available (considering the increased speeds of the modern computers) will probably increase by a factor of at least 4. It is difficult to see how the manpower training problem will keep pace with this expansion rate. The need then is great to make good use of programmer time.

The third item, the elapsed time from problem origination to production of answers, is especially important in a computer laboratory which has, as its main function, the programming of many "one-shot" problems. It is only slightly less important in the case of the business data handling group which continually makes programming changes on its standard bill-of-fare programs. Once the decision has been made as to the logical steps involved, it becomes seriously aggravating to the originator and the programmer alike to accept the long drawn out period until the production state is reached.

The University of Cambridge in England was probably the first group which used automatic programming to any significant degree. The EDSAC computer had a very limited memory size of 256 words and computer word length of 16 binary digits and most problems needed special attention to overcome these difficulties. The clever and imaginative scientists operating the computer built a system of sub-routines and a method for handling them which to this date serves as a model for this type of work. The organization and a description of the computer is contained in a book by Wilkes, Wheeler, and Gill.* Similarly the Whirlwind computer at the Massachusetts Institute of Technology had the limited word length of 16 bits and double precision interpretive programs were required to perform almost all numerical operations. Here again the scientists working with the Whirlwind

* Wilkes, M.V., Wheeler, D.J., Gill, S., The Preparation of Programs for an Electronic Digital Computer, Addison-Wesley Press, Cambridge, Mass., 1951.

computer continued and expanded upon the work of the Cambridge people and developed a comprehensive programming system for the computer. This system involves a complete scheme for programming problems in many forms (e. g. fixed point or floating point) and for debugging the programs and performing the necessary input and output. The automatic programming performed at M. I. T. has probably had more influence on computer use than the activity of any other group in the United States.

Composition of Automatic Programming

There are many items which can be included under the topic "Composition of Automatic Programming". The first of these and the most elemental is subroutines. Subroutines themselves do not warrant considerable discussion here except to remark that the subroutine is the basic building block of automatic programming. Recently, subroutines have been "glorified" by appending to them, certain prelude routines which "particularize" the routine. As a simple example, a prelude routine may particularize the routine for finding X^k to obtain a routine for finding the square root of a number of X. In the same general vein, routines have been prepared which generate subroutines. For example, an output subroutine generating routine would construct a subroutine to provide output in a given format.

Perhaps the most common element of automatic programming is the use of interpretive type programs. These programs take instructions written in extra-machine logic, logic foreign to the internal computer logic, to perform certain desired operations. One of the most frequently used routines of this type is a routine for performing floating point arithmetic operations on a computer which can perform only fixed point arithmetic. Other interpretive programs allow the programmer to write programs in 3-address instruction logic for performance on a single address computer. Still other types can be found such as one programmed for the UNIVAC computer which enables the performance of analytic differentiation automatically by the computer. With the interpretive type program the pseudo instructions to the computer are stored internally and are translated each time the instruction is performed. The ability to perform such a function is the quintessence of the high-speed digital computer.

Currently the point of focus of an automatic programming scheme is the assembly program, alternatively called "compiler" or "executive routine". We shall use the term "assembly program" here for that name emphasizes the central function. By means of such a program, essentially a synthetic machine is created, a machine which is easier to program for and easier to check out prepared programs. As with the interpretive type of program mentioned above, programming is performed in a language foreign to the computer itself; the computer performs the translation into its own language by means of the assembly program. The important difference between the interpretive type program and the compiler is that the translation is done once and for all upon input of the program data. The program information in machine language is then either stored in the computer for immediate computation or it is read out of the computer onto magnetic tape, paper punched tape or punched cards, for later input. The advantage of outputting the data for storage outside the computer is that it may then be placed in a form for read-in into the computer at much higher speeds than the untranslated data. For example, untranslated program data at one instruction per 80-column card is read in at the rate of two instructions per second with the conventional card reader, while "binary cards", cards punched with translated data can be read into the computer at 48 words per second with the 701 and 1103 computers. The fact that the binary card cannot be read and printed with conventional tabulating equipment is of little consequence since the original card is on hand and available. Since the assembly and translation function is performed, once-and-for-all, on input, it is sometimes referred to as an "input translation program".

Some further aspects of the detailed form of the assembly program are discussed below. However, an important over-all aspect should be brought forth. The first assembly programs were such that each instruction to be performed by the computer was explicitly written. In other words, a one-to-one correspondence existed between untranslated and machine instructions. As techniques improved, it was seen to be desirable from many points of view to design a scheme to cause one line of untranslated program data to generate many machine instructions. As an example, one pseudo instruction specifying the merging of two sequences could generate a 50-100 word program. This one-to-many correspondence allowed the programmer to write fewer instructions and, as a consequence, reduced the number of programming errors. However, programming errors became harder to find with such a scheme since the translated machine data held little resemblance to the original. Also, compilers with the one-to-many philosophy often produced programs which ran less economical of machine time than the "hand-tailored" ones, much to the distress of the experienced programmer.

The main functions performed in the assembly operation are as follows:

1. Subroutine inclusion
2. Mnemonic devices
3. Number conversion
4. Standardized automatic data read-in
5. Cursory error analysis

The first of these, subroutine inclusion, implies that the assembly program can alter subroutines, usually routines relative to some fixed address so that they can operate in any chosen spot in the memory. In certain cases the assembly program changes or particularizes the subroutine as mentioned above. The subroutines may be read into the computer in a straightforward fashion from punched cards or punched tapes, or they may be compiled into the program in a more automatic manner from a higher volume storage such as magnetic tape or magnetic drum. The second item, mnemonic devices, implies that the assembly program allows the programmer to write in a language easier to use and easier to remember. For example, the symbol W1 could be used for the address of the cell containing the aircraft weight in the first period, and W2 for the aircraft weight during the second period instead of using the hard to remember numerical notation such as 12968 and 12969. Number conversion refers to some method of converting decimal numbers to binary for fixed point or floating point operations. Standardized data read-in implies that all programs are read in in substantially the same fashion, thus allowing a non-professional machine operator to operate the computer and obviating the necessity of the programmer's presence during program check. Cursory error analysis refers to a "quick look" by the assembly program as it translates to ferret out any obvious errors. An example of this is a scaling error which scales the number so high so as to make it "run out" of the left side of the register. In this case, the computer would indicate the error to the programmer.

Recently, the USE organization (Univac Scientific Exchange), a national organization which exists for cooperative programming among 1103A computer users much the same as the SHARE organization exists for the IBM-704 users, discussed assembly programs at considerable length. The result of this discussion was a list of 17 features of a compiler deemed desirable by the members present. The 17 features, just as they were written in the minutes of that meeting, are included here in an Appendix.

More recently there has been a trend toward the integrated computation system which involves an assembly program only as an important but rather small part. The 5 items mentioned above refer only to the language, that is the means by which the programmer communicates information to the machine on the detailed level of his program data. In the integrated computation system this amount of information communicated is expanded to include items which otherwise would have to be communicated by word of mouth or by written instructions to the machine operator. In the integrated computation system, the following four broad areas are important:

1. The program language
2. Computing mode selection
3. Program alteration
4. Flexible error analyses

As mentioned above, the language refers to the five items of the above paragraph. Computing mode selection refers to the selection of the various possibilities in the computation system which the programmer has at his disposal. He may choose automatically, for example, the fixed point or the floating point computing mode, he may wish to translate his program data and immediately compute, or he may wish to translate and output the translated information for later input. Program alteration is, of course, necessary after mistakes are found, or in case the problem originator wishes to change certain procedures. Program alteration could involve deletions, corrections, or insertions, or, as is usually the case, various combinations of these. Flexible error analysis implies the selection of the means by which the programmer does a detailed analysis to find programming errors. He may, for example, signal the computation system to store the data as it comes into the computer for a later "changed word post mortem" analysis. He may, for example, ask the system to monitor the computation on breakpoints or on each instruction. The important concept here is that all items are integrated together to form one computation system to the exclusion of the use of the machine with isolated subsystems. The integrated computation system almost certainly implies a more economical use of the computer, especially for code check operations which normally require about one-third of the computing time. It allows the programmers to use the computer for short lengths of time and receive the data they need for program check in a very short time. Further, it allows "unattended runs" with the resultant greater flexibility of computer operation and scheduling since the programmer does not have to be present.

Present Systems

One of the most important developments along the lines of automatic programming has been that of the Programming Research Group under Dr. Grace Hopper of Remington Rand. This group produced the A-1 compiler and its successor the A-2 compiler for the Univac computer. The A-2 compiler allows the programmer to communicate with the machine in a language much simpler than the machine language, allows him to generate many machine instructions by a relatively few A-2 instructions, allows automatic segmentation of the problem between the magnetic tapes and high-speed storage of the Univac, and allows a number of computing options such as floating point operation. More recently this group has prepared the B-O compiler which is an extension of the A-2 in two directions: it allows for certain operations which are more frequently used in business or commercial applications, and it is so designed to allow flexibility for future applications, making possible modifications and additions as may be necessary. The philosophy of the B-O compiler is such that it translates various verbs of the imperative mode into computer language and would allow such translations for verbs such as "merge", "collate", "sort", "find the sine of", "find the nth root of", etc.

As another branch of Remington Rand's activities, Dr. Herbert Mitchell's New York group has prepared the BIOR (Business Input-Output Re-run) compiling system. This system, oriented toward commercial applications, provides the means for the programmer to take various blocks of his own coding and move them around and use them conveniently and simply. The design of the BIOR system took cognizance of the fact that the typical commercial problem involves large records of data which are read in from bulk storage such as magnetic tape, processed, and returned to magnetic tape or read out in another fashion.

When the IBM 701 computer appeared on the scene in 1954, a number of so-called "regional programming" schemes were prepared for the computer. These schemes designated certain regions of the computer memory for subroutines, instructions, and data. They involved mnemonic devices at least to the extent that cells belonging to different regions could be distinguished. Usually they allowed for inserting instructions by means of a type of "Dewey Decimal system" which would allow nine instructions, 129.1 to 129.9, to be inserted between instructions numbered 129.0 and 130.0.

About the same time that the regional programming schemes were being developed, the IBM SPEEDCO system was developed by a group at New York under John Backus. It allowed for easy programming since floating point arithmetic was used but suffered from the fact that the resulting interpretive program ran very slowly on the computer. Meanwhile, a number of customers of IBM were preparing interpretive schemes which allowed entrance and exit from the interpretive floating point mode. Los Alamos' DUAL, Douglas' (El Segundo) QUICK, and Lockheed's FLOP are examples of these routines. More recently, John Backus' group at IBM has prepared FORTRAN (FORmula TRANslation) for the IBM-704 computer. FORTRAN will translate into computer language a program written very close the language of the mathematician or scientist. This is an example of the so-called "algebraic coding system" which allows translation of indices, summation signs, parentheses, and arithmetic operation symbols of mathematical language.

In early 1955, a group of IBM 701 users in the Southern California area began the preparation of a compiler called PACT. This assembly program emphasizes index notation for operation on sequences of data and a scheme for simplifying the scale factoring operation. The PACT compiler is being modified to be used with the 704.

The automatic programming developments at M. I. T. and the University of Michigan are notable. Both of these systems include an assembly program or input translation device which uses symbolic notation, free addresses, and pseudo-machine commands. The emphasis, however, remains on the broad scope aspects of the entire system. Both systems place heavy emphasis on unattended computer runs and consequently allow automatic selection of computing modes and error diagnosis devices.

The activities with the integrated computation system at The Ramo-Wooldridge Corporation follow the lines of the M. I. T. and the University of Michigan system. In current use for the 1103 computer is a system which stores all service routines and subroutines (a total of about 8,000 words) on the 16,000-word drum and backed up on magnetic tape in the case of inadvertent destruction of drum data. The assembly program automatically assembles subroutines from the drum into the main program. During program check-out the operator has at his disposal the various service routines (dump routines, input and output routines, etc.) stored on the drum and can call upon them and use them quickly without recourse to any manual operation involving reading the program into the computer. The result is that only programmed data originated by the programmer is stored on punched cards external to the computer. All other routines, service and subroutines, are stored accurately and economically inside the computer where they can be quickly and automatically summoned to use.

Future Systems

Two trends are in evidence in future systems for computer use: the first is the increasing use and development of the automatic, comprehensive computation system referred to above, and the beginning uses of "microprogramming" techniques.

The completely automatic, comprehensive computation system is born of two central motivations: first, the desire to decrease the clerical work of the programmer, up-grade his level of work, and generally increase his effectiveness; and second, the desire to decrease the amount of non-productive computer time. In the face of the development of machines which will be extraordinarily complex and extraordinarily expensive to own and operate by today's standards, this second motivation looms important. This writer believes that the computation system used for most large-scale computers will, within 2-3 years, evolve into one with the following characteristics:

1. The computer will run automatically and without interruption for 3-5 hours, handling many different types of computer runs such as code checks and production computation of many different types.

2. The programmer will handle no computer storage media whatsoever but will deal only with printed pages of programming material he originates or with printed material giving the results of a computer run. He will submit his programming material to a data preparation room and, soon thereafter, receive on his desk the results of a computer run.

3. The computer will be scheduled 4-6 hours in advance by preparing "run tapes", magnetic tapes on which <u>all</u> of the information for running the various problems, in order, is recorded. Deviations from the 4-6 hour schedule to higher priority problems which arise will be possible.

4. Since programmers' run instructions and program alterations will be recorded on tape and handled automatically by the machine, running and checking out the 50-100 current programs of the scientific computer installation will become a file maintenance problem having many of the characteristics of that of the commercial installations today and, in many respects, considerably more difficult.

5. The computation system will find almost all clerical programming errors and, in most cases, will perform the operation the programmer "most likely" meant. In all cases the machine will inform the programmer of errors discovered and interpretations made through print-outs.

6. Machine operators will do nothing but change magnetic tape reels and actuate certain special routines in case of computer error, programmer error in using the computation system, or in exercising options to change the computer schedule to allow interjection of higher priority problems. Essentially, the programmer will operate the computer from his desk.

7. The system will check the operator's actions to a considerable extent. For example, the placing of a wrong tape reel on a tape unit would, in many cases, bring a remark to that effect printed out on the monitor typewriter.

8. Output tape units will be periodically removed from tape reels and placed on high-speed (500-1000 line per minute) printers for outputting information to be returned to the programmer. In many cases, output will be initiated automatically by the computer as needed, with no operator handling necessary.

Certainly much of the onus for the development of such a system such as that described above rests with the computer manufacturer. For the system to operate as described, certain design features must be included into computer systems which have not been included to date. In particular, tape unit operation must become much more flexbile. Independent tape operation (preferably independent tape search) and the operation of many tape units simultaneously will be mandatory. The ability to erase and re-record within a block of previously recorded data will be of great importance. Another item is that all computer switches must be controllable by the internal program. Although no computer at present has these capabilities, the IBM has recently announced changes in IBM-704 along these lines.

In the design of the computation system now in preparation for the 1103A computer to be delivered to The Ramo-Wooldridge Corporation certain steps have been taken toward the "ultimate system". The programmer writes run instructions, program alterations, program error diagnosis procedures, and output instructions on his programming form. This information is transcribed directly to magnetic tape and placed on the computer. The system assembles the program, includes all program changes, runs the program, performs the error analysis, and produces appropriate and complete print-outs for all these occurrences. The programmer submits the instructions for the entire operation in written form and waits until the computer results are returned to him. The file maintenance problem will be avoided during the first design by having an individual tape reel for each program. In a somewhat abridged form, the system will be in operation by the end of 1956.

The next couple of years will see the first uses of a technique in computer design and computer use called "microprogramming". Many computer users have long chafed under the use of instruction logics which were not well suited for their application. Microprogramming would allow the programmer to synthesize his own computer instructions from "microinstructions". Essentially, then, with microprogramming the programmer would "construct" his own control unit, the "construction" taking the form of a plugboard or assimilation at electronic speeds by means of computer program.

As of this date, most work in microprogramming is in the "talking stage". To this writer's knowledge, only one paper on microprogramming has been published, that by Herbert T. Glantz*. In the article Glantz presents a plan for a microprogramming facility which would provide for the computer to leave its normal (conventional) mode and jump to a "Micro Mode". In this mode, the computer would perform instructions made up of microinstructions according to a sequence as indicated in a special magnetic core memory. At the command of the programmer, the computer would jump back to the normal mode, performing arithmetic and logical operations in a conventional fashion.

One of the first meetings on microprogramming was held at Massachusetts Institute of Technology in March, 1956. At this informal meeting Dr. David Wheeler of Cambridge University, England, spoke of Cambridge's activities in the field. The Cambridge group, operating the EDSAC II computer, plans to encode subroutines in a magnetic core control matrix to allow the subroutines to operate at speeds comparable to normal instruction speeds. This technique could be characterized as making certain machine changes which will allow "macroprogramming", the synthesizing of complex instructions from common ones. Their activities along the microprogramming lines apparently will make use of a magnetic core matrix forming the heart of the computer control.

Two university groups in this country are interested in microprogramming and are formulating plans: M. I. T. and University of California at Los Angeles, the Numerical Analysis Research group which operates the SWAC. M. I. T. has ideas which would make available an additional microinstruction on the Whirlwind I computer as part of its regular instruction repertoire. The address part of this instruction would control 120 subcommand lines of the control matrix of the computer. Presumably, the programmer would contrive his own instruction by using the 120 lines as he wishes.

The activity at the University of California at Los Angeles has resulted in the writing of a master's degree-level thesis by Robert Mercer (to be published) under the direction of C. B. Tompkins. If present plans materialize the Numerical Analysis Research group will make extensive studies of the SWAC control system, followed by extensive changes which will probably result in a plugboard to allow the selection of sub-commands. The group hopes to complete the next step which would allow the choice of sub-commands at electronic speeds under stored program control.

The future possibilities of microprogramming are considerable. With microprogramming one visualizes a three-level hierarchy of programming. At the production level programmers would use subroutines performing operations like "find sine of", "merge", etc., probably by means of elaborate compiling routines. At the next level "subroutine programmers" would prepare the subroutines which

(cont'd on page 36)

* Glantz, H. T., "A Note on Microprogramming", Journal of the Association for Computing Machinery, Vol. 3, No. 2, April 1956.

THE POWER OF THE COMPUTER

GEORGE J. HUEBNER, Jr.
Chrysler Corporation
Detroit, Mich.

Presented at the University of Michigan's Conference on Mathematics in Engineering, June 1956; reprinted with permission from "Tooling and Production", September, 1956

No one in engineering could fail to appreciate the honor of speaking to this distinguished gathering,forming, as it does, an integral part of a most important conference. The application of mathematics to engineering surely has never been in doubt; but as engineers wean themselves from the deep-rooted empiricism of the past to the rationalism of the future, the quality and quantity of the necessary mathematical development seems almost overpowering. The work of conferences such as this is of inestimable value in indicating the direction we must go; and I am deeply grateful for the opportunity to become part of it.

Yet what can I say that will be of interest to you? I have before me an audience surfeited with two days of abstruse discussion; and now, replete with food and knowledge, wishing nothing so much as a quiet hour of rumination. It would therefore be indiscreet, even if it were possible, for me to place weighty scientific matter before you; and I hope you will settle back comfortably while I give you a brief history of our experience with electronic computers, and our struggle from humble beginnings to some slight competence in this field.

The accelerated tempo of engineering activity following the war found us suffering from the universal shortage of engineers. Yet our war work had shown very strikingly that "laisse-faire" design procedures could no longer be tolerated, and that the man-hours of engineering on any project must be substantially increased to avoid costly mistakes. One of the first places where the computer came to our rescue was in the design of engine valve gear. Prior to the war the practice had been to design cams to predetermined geometrical profiles — easy to compute and easy to draw. Such cams were perfectly satisfactory for side-valve engines or overhead camshafts, where the design was inherently stiff.

AS VALVE ACTION GETS MORE COMPLEX — SO DOES THE MATH

The pushrod type of valve gear, however, was much less amenable to discipline; and the absorption of an impact by a flexible system proved to be a very sticky problem. It was found necessary to specify the valve accelerations with much greater exactness than before; and by a process of continuous refinement we finally arrived at a six-term polynomial equation which specified acceleration throughout the valve-opening process. Normally we would have got no further; for the computations were quite laborious and it was necessary to survey the entire field to determine the induced vibration amplitude and the selection of suitable coefficients. Fortunately, about this time we were given part-time access to one of our I. B. M. Type 405 accounting machines; and by the process of wiring up a new central panel for each problem our eager beavers reduced the cam problem to practicality.

MACHINE TAUGHT TO PLOT CURVES

Not only did the machine compute the cam profile but it was taught to plot the curve to scale, thus providing a visual check on accuracy. Finally it was found that the transcription of the data on the drawings resulted in numerous errors, to avoid which the computer printed the tabular values which were then transferred to the drawing photographically.

Arising out of this valve gear problem was the determination of energy inputs to the system. This involved a harmonic analysis of the cam profile using 360 ordinates. Our previous efforts with a Runge 72 ordinate schedule, the most extensive then available, had proven laborious and of doubtful accuracy; but the 360 ordinate computer schedule was found both painless and of adequate accuracy for our needs.

The third problem which was fed the computer was the determination of bearing loads in a new series of engines. This problem normally takes about two weeks of combined desk-calculator computation and graphical construction. By skillful use of the facilities available, this time was reduced to four hours, at the end of which neat tables were available giving perpendicular components of the loads of regular intervals, the resultant at each point and the mean value. The accuracy and economy of this procedure has made it possible to investigate many engine types which would normally be neglected; and the ratio of 1/20 for the computer time as compared with previous methods has been equalled or exceeded on every problem investigated.

THE LINE FORMS ON THE RIGHT

By this time news of the bonanza had got around, and work began pouring in from all directions. Torque converter blade shapes, converter performance, structural design problems — everything was thrown at the accounting machine, and ultimately the bank of specially wired control boards gave the poor thing indigestion. By good fortune we were able to get one of the first of the new card-programmed calculators, and things began to look up. Actually the C. P. C. equipment did not come a day too soon; for we were in the midst of our first development of a gas turbine passenger car. On this project the customary back-log of experience did not exist; and the amount of preliminary technical analysis was truly appalling.

Chrysler Corporation was the first to demonstrate the installation of a successful gas turbine in a passenger automobile. By successful we mean that which fulfills the requirement of an automotive application; a power plant which has the flexibility, the control, the safety and above all the efficiency and economy of the highly successful automotive reciprocating engine. We became convinced many years ago that at the present stage of development of materials for turbine power plants, success in an automotive application could only be realized by an almost complete recovery of the exhaust heat. Early in our efforts to solve this problem, however, we detoured from the automobile application to an aircraft propeller type regenerative gas turbine. The heat exchanger involved was quite successful and resulted in a power plant efficiency which was comparable to a reciprocating aircraft engine at 70% potential engine power.

Although this power plant fulfilled the early expectations and accomplished the predicted performance, when we returned to the automotive job we realized that our approach to the heat exchanger problem would have to be radically different.

THE COMPUTER MEETS UP WITH THE GAS TURBINE

We were forced to this realization when our early calculations showed that a heat exchanger using conventional techniques and large enough to make the turbine competitive with the reciprocating engine, at the 25% to 30% normal load factor of an automotive engine, would fill a comfortably sized house trailer. We therefore threw away our preconceived concepts and started out on an entirely new approach. This approach would have been almost impossible without a fast digital computer.

A number of designs were conceived but even the exploration of a single design required the exploration of over 80 combinations of the variables involved in order to obtain the optimum, and in this case the optimum was not just desirable, it was an absolute necessity. Even with the fullest possible utilization of the digital computer the job took nine months and since our usual ratio is 40 to 1 in comparison to longhand and desk calculator methods, we all would have been dead and buried before we could have found out even the direction of the trend by "hand" methods.

DIVIDENDS FROM COMPUTATIONS

An unforeseen but very real dividend from these computations was realized as soon as the first experimental parts designed according to the calculations were put on test. The parts looked good, they had been fabricated with extreme care and the test setup was in accordance with our best practice, but the small sample of heat exchanger so tested was a miserable failure. It was not even as good as the conventional unit on which we had had years of experience. But none of us doubted that the error was either in the fabrication or in the test setup because we knew that the mathematical analysis of the unit had been so completely covered and our basic assumptions were so easily provable, that we turned immediately to improving our fabricating techniques with very successful results.

COMPUTER BREEDS CONFIDENCE

Having gone through similar disappointments many times before, and having turned to find the error in the mathematical work involved, it was a gratifying experience to find that the ability of completely exploring an entire field which had been given to us by the digital computer had made us completely confident of success in the actual component.

A similar story can be told on performance calculations for the gas turbine. By desk calculator methods a change of one variable in the rather complex analysis necessary meant a three-week delay in design progress while the calculation was made and checked. Naturally, many conditions had to be varied both during the design period and in the experimental testing which required the re-evaluation of performance. In addition, turbine wheels were analyzed for different temperature gradients and various constructions and material distributions. We have never had the time to estimate the number of man-hours saved in this one aspect alone but it certainly is very large.

PUTTING THE BRAKES ON THE COMPUTER

Other problems outside the turbine field helped to establish the power of the computer. In our efforts to equalize brake shoe deflection to reduce wear we investigated 5000 designs in each of several sizes — a task so formidable it would never have been thought of in the absence of the computer. Engine test data reduction became a ten-minute task, so that no delays in the test schedule occurred. Algebraic equations of considerable complexity were tossed off in minutes; but here the C. P. C. computer met its Waterloo.

After a honeymoon of nearly two years it became apparent that the speed and memory capacity of the C. P. C. equipment was inadequate for the differential equations we now wanted to handle. The newer Type 650 machine with magnetic drum storage has now been installed, and has greatly increased our capacity to tackle involved problems.

FROM BRAKES TO HYPOIDS

As we have grown in experience with the new computer more difficult problems have been added to our repertory. Naturally, computations which provide drastic time savings are high on our list. A recent important example is the computation of hypoid bevel gears for rear axles. This computation is one of extreme complication and tedium; and the period of several weeks usually required for its completion had acted as an artificial barrier to the selection of optimum axle ratios. We have recently succeeded in programming this computation; and the reduction in time to 3/4 of an hour has resulted in much better coverage of one of our basic problems. Of such apparent trifles is progress constituted.

WRAPPING THE COMPUTER AROUND THE WINDSHIELD

Another recent headache is the compound curvature of windshields. The optical properties of these components introduce problems of serious importance; and we are busily engaged in determining an analytical expression for the curvature of the glass, in the hope that the wearisome ray-tracing computations may be reduced to manageable proportions. This problem has not yet been reduced to submission; but the impact of a solution on the design of aspherical optical components makes the effort well worthwhile.

One of the interesting traits of our computers is the evidence of their universal tastes. They are devoid of prejudice; and never show resentment, as human computers so frequently do at being transferred from their field of special interest. We had reason to observe this recently when the computers were introduced to the nuclear field. The computation of the critical mass of reactors was made with the same dispatch as a routine harmonic analysis, and the problem of reactor flux distribution caused no more disturbance to the equanimity of the machine than the simplest stress problem. With such servants to aid us we shall have little excuse, indeed, if we fail to produce at least some of the miracles expected of us.

UNEXPECTED PROBLEMS

The new magnetic storage facilities have greatly increased the capacity of our computers, but with this increased capacity have come unexpected problems. A set of thirty-two simultaneous equations can now be handled quite readily; but the rounding errors of such a set vitiate the accuracy of the computation to the point where we may well suspect the significance of the answer. Truncation errors are very difficult to fit into the theory of probability; but evidence seems to exist that we lose eight significant figures in solving a fifteenth-degree equation. It is apparent, therefore, that great care must be taken to avoid a sense of false well-being when our more powerful computers pour out a long string of figures. Our own motto is rapidly becoming "Festina lente".

In recent months many computers and their operators have been engaged in extra-curricular activities, authorized and otherwise, since there seems to be a desire on the part of some computer people to prove versatility of their methods in all fields. The result of one of these deliberations attained wide publicity in this part of the country; since it predicted that the Detroit "Tigers" would win the American League pennant. When the audible guffaws had died down there remained in many minds a suspicion that such predictions were eminently feasible.

HOW ABOUT THE DETROIT "TIGERS"?

Our own people became interested in the problem; and from the published statistics for the last six years they have determined regression coefficients for "runs for", "runs against", "earned run average", "team batting average", "total home runs" and "team fielding average". From these data it was found that of the twelve actual pennant winners, nine were statistically entitled to their position; and of the twelve statistical champions every one finished either first or second.

With the foregoing information as a basis it was decided to predict from the first forty games of this year how the teams would finish the season. There is something fatalistic in the make-up of anyone who makes sports predictions; and the fact that his ears will inevitably be pinned back never seems to deter him. Therefore, for the benefit of our public among the baseball fans we must publish our findings. If our computer knows its business the American League results will be as follows: New York, Cleveland, Detroit, Boston, Chicago, Baltimore, Kansas City and Washington. In the National League the teams will finish: Milwaukee, St. Louis, Pittsburgh, Brooklyn, Cincinnati, New York, Philadelphia and Chicago.

CHARLEY-HORSES UNPREDICTABLE

Now the last 100 games of this hypothetical schedule were played in a six-dimensional continuum of the computer's own choosing; and whether the results bear any relation to what will happen at Briggs Stadium or Ebbetts Field only time will tell. After all, any computer has its limitations. It cannot, for instance, predict a late-season epidemic of charley-horses, or that the star shortstop will start indulging too heavily in the variety of blood plasma which comes bottled in bond. Nevertheless it is apparent that, if it were worthwhile, these procedures could be refined to the point where they could predict with the necessary accuracy baseball results or any other events of interest.

It is no secret to this audience that eighteenth-century gambles subsidized quite heavily the foundations of the theory of probability. Who knows but that their twentieth-century counterparts won't become ardent patrons of our computer laboratories.

The attainment of a usable answer is not the only benefit from the introduction of a problem to the computer. Frequently this procedure provides heuristic clarification of a principle previously obscure. We recently had occasion to investigate a diffusion problem over a wide range of two of the parameters involved. In this process functions were required which had not previously been set up for the machine, and considerable time was expended in programming before we were assured that the computer had been given accurate and adequate instruction. The first analysis of the ensuing data was made by a man not previously acquainted with the problem, who immediately realized that the work could be reformulated into a much simpler type of computation capable of accomplishment in a few minutes on a desk calculator.

TANGLED JUNGLE vs DIRECT PATH

Thus, constant vigilance must be used to avoid letting the power and capacity of the computer lead one through tangled jungles of computation, when a direct path may be available at the price of a little searching. The necessary catalyst in all this work is the brain of man, forever searching to escape from work, or the easiest way to do it, if escape is impossible. Castigliano is given the credit for formulating the Principle of Least Work; but man has used this principle instinctively since he first appeared on this earth.

So far we have discussed our experience with digital computers when engaged in the point-by-point computations so typical of numerical analysis. However, we are being forced by circumstances into a more active utilization of non-linear mechanics. For this type of problem we feel that the analogue computer has definite possibilities; and at the moment we are trying to assess its proper sphere of influence.

In general, there are two types of problems for which the analog computer is ideally suited. One is the problem involving complex differential equations which cannot be rationally solved by long-hand methods even when the equations are linear. The other is the type of problem which is readily solved by long-hand when the equations are linear but becomes impossible to handle rigorously when non-linear elements are introduced.

Unfortunately, most real situations involve non-linear elements, and the use of assumptions to obtain linear equations capable of long-hand solution can readily invalidate the results. Therefore, the ability of the analog computers to simulate any real relationship between variables is one of its greatest attributes.

LONG-HAND NOT FOR VIBRATIONS

If we take as an example a simple vibrating system of one degree of freedom, we know that it is readily solved long-hand as long as viscous damping is assumed. This gives us a convenient linear differential equation. Actually, very few practical vibrating systems even of an elementary type involve pure viscous damping. The fluid damping if present is not truly viscous and additional damping elements of the complex or coulomb type are quite often present. Any attempt to introduce these real damping factors immediately leads to an equation which can no longer be rigorously solved long-hand. In contrast, these real conditions can be readily simulated on an operational analog computer and answers obtained in one day, including the setup time.

To extend the illustration, let us consider one of the complex problems that we face today, namely, to obtain a complete understanding of the dynamics of a road vehicle as it affects the motion of the passengers. It is possible to simplify the problem to the extent of considering only vertical and angular motions in one plane but even the complete system involves eight degrees of freedom when the sprung and unsprung masses and passenger masses are taken into account. The eight simultaneous differential equations are quite readily written but without the analog computer we can see no way of making reasonable progress toward their solution.

As I just pointed out, it is vital that the real characteristics of the elastic elements and damping elements be accurately simulated and these are all invariably non-linear. Yet this complete problem can readily be handled on an operational analog computer of moderate size requiring no more than 40 or 50 amplifiers, depending on the amount of auxiliary equipment available to generate non-linear functions.

TAKING THE BUMPS OUT OF THE ROAD

Many of you are familiar with the process that is used in the automotive industry to achieve a satisfactory riding automobile. It has been the subject of many technical papers and many learned professional treatises, so that it would be inappropriate if not impossible to completely review the method here. There are so many variables in the ride alone, and so much extensive instrumentation is required that the development of even a single model becomes a very lengthy and expensive procedure.

To the ride problem may be added sway control, roll control, transverse, longitudinal and vertical shake, and the overall steering, handling and control response of the vehicle, all of which affect the safety and comfort of the driver and his passengers. This problem becomes more and more complex every year due to higher and higher standards of performance and due to the steady progress of the mechanical components involved.

Consequently, the development of a safe and comfortable riding vehicle has become a combination of high scientific effort and the application of what can only be called the highest type of artistry. It is in the field of the "art" in which the computer can make such tremendous contributions.

Very definite progress has been made at Chrysler in placing this problem in a mathematical framework. Certainly we have been aware of it for many years and our first ride analysis analog computer was built in 1938 and 1939. It represented at that time an oversimplification of the problem, but it nevertheless indicated the course we wished to follow and it was of very real assistance in the solution of the immediate problem then facing us.

We felt then, however, and do now that the development of computation equipment, although of scientific interest to us, is not our job. Others have developed competence in this field for good, sound commercial reasons and pure scientific progress is likewise assured. Therefore, we stand ready to utilize this progress as one of the most valuable tools that we have ever had in the scientific progress of personal transportation.

One of the most convincing demonstrations of the ability of an analog computer to simulate ride motion of an automobile was made some time ago by the University of Michigan research group. They found it essential to prove that the analog computer predictions are completely valid and truly simulate the action of a vehicle on the road. They invited our cooperation, which we were very happy to give them, since we were equally desirous of seeing such a demonstration performed.

Accordingly, we submitted to Willow Run the complete set of pertinent specifications of a given automobile for which road test accelerometer recordings were available. In order to simplify the problem to some extent, the records we furnished were those taken with the passengers on solid wooden seats, which eliminated the four degrees of freedom associated with the vertical and angular vibrations of the front and rear passengers on the normal elastic cushions. Recordings had been taken on a series of rough street intersections, each consisting of two severe waves of 4 inch amplitude and 20 feet wave length, at a speed close to the critical value.

To make the simulation complete, some members of the University staff photographically recorded the contour of one of these intersections one dark night by rolling a wheel with an illuminated hub over the intersection. This contour was then reproduced by means of an input function generator, and fed into the computer to excite the system.

PROVING THE PREDICTION

The results showed that the analog traces and the measured accelerations agreed both in vertical motion and in longitudinal motion taken at passenger shoulder level on the car body. Moreover, slight departures that did exist between the two are not the fault of the computer but the probable effects of known factors which were deliberately neglected in the analog simulation to save time. These include a relatively small amount of friction and minor variations in deflection rates in the actual car suspension.

Thus we see that the operational analog computer not only extends the analytical approach into entirely new areas but can get results in a short enough time to be of practical usefulness. As compared with the customary experimental approach in exploring new mechanical systems, the analog computer can obviously save a tremendous amount of time and money. But, what we feel is even more important, it provides a reasonable expectation of finding the optimum combination of parameters. This is true because of the rapidity with which a full range of parameters can be explored in all their combinations and permutations.

To carry out the same process experimentally would be prohibitive in the expenditure of time and money. Consequently, it is only by happy accident that anything approaching the optimum design of a complex system is ever achieved by exclusively experimental methods.

PIN-POINTING THE EXPERIMENTAL

However, after the computer has indicated the probable optimum area, experimental work can readily be pin-pointed to achieve the practical optimum. Something should be said also for the great advantage gained by the use of the analog computer in being able to visualize directly the effects of parameter changes accomplished by the mere turning of dial controls.

Our present analog computer has been with us for less than a year, and much of this time has been spent in getting acquainted with the machine and learning its capabilities. However, it has had time to analyze the suspension of an eight-wheel ordnance vehicle with complete independent suspension and compare it — favorably, of course — with the standard eight-wheel bogie construction. The flow of air between tanks of an air-suspension system has been investigated, as well as the effect of shock absorbers with non-linear systems. Servo-control for a complete suspension system has been analyzed and found to show great promise. After five years of quiet the valve-gear problem has come up for further study; and it is our hope that the analogue computer may contribute substantially to an enduring solution.

NO PROBLEM IMPOSSIBLE

The revolution brought about by powerful computers is so new that the full implications are not yet realized. The speed of these devices changes our entire approach to problems; and whether it is the randomizing of 1000 samples for use on a coast-to-coast test or the tabulation of synthetic names for non-existent drugs we no longer consider any problem impossible. The science fiction writers have got to the point of permitting two giant computers to fight a war with each other, and take control away from their operators when the latter

(cont'd on page 48)

DATA PROBLEMS OF A GROCERY CHAIN

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Safeway Stores, Oakland, Calif.

Presented at 11th National Meeting Association for Computing Machinery
University of California at Los Angeles
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SAFEWAY ORGANIZATION

Our organization is a far flung one in its operations and for that reason, we must be highly decentralized for efficient control.

In order to avoid unnecessary details of our company-wide structure, I will only discuss our Retail Zone Organization which is the unit of our organization to which my talk is confined.

So that you may have a better understanding of this operating unit, you will find here a copy of our Retail Zone Organization Chart (Figure 1).

You will note that this is headed up by the Zone Manager and is broken down by the following groups:

1. Accounting
2. Other Service Departments
3. Warehousing and Trucking

Actually all three of the above groups are area Service Departments for the Zone operating unit's retail stores.

My discussion will be confined to the function of each Zone's accounting office and its relation to the other departments shown on the Organization Chart.

The office performs the following functions:

1. Maintains a General Ledger for all operations.
2. Bills all merchandise to stores which they receive from our various warehouses within the Zone. These billings from the warehouses represent warehouse sales, and the receipts by the stores are treated as store purchases.
3. As a by-product, the billings keep the Supply Managers informed as to the inventory position of the commodities for which they are responsible as buyers, and as to the sales trends of these commodities.
4. Keeps detailed records by individual stores as to their sales, purchases, and expenses.

The store purchases are made up of three different categories, as follows:

1. Purchases received from our own warehouses.
2. Purchases of merchandise delivered directly to stores by vendors and consisting of soft drinks, bakery goods, magazines and newspapers, drugs, housewares, as well as various food items. This comprises our second biggest paper handling job inasmuch as the average Zone will run between 5,000 to 8,000 invoice tags per week, which involve payment of between 200 to 300 individual vendors weekly.
3. Cash purchases which are disbursements made out of current store receipts.

In addition, it is necessary to handle all of the other store expenses in detail, which consist of the following items:

1. Salaries, which are mechanized and handled on tabulating equipment.
2. Such items as store supplies, rent, light, power, etc., for which it is necessary to pay the individual vendors and charge the appropriate stores. These items are handled manually.

I think you will begin to see that we have

RETAIL ZONE ORGANIZATION CHART

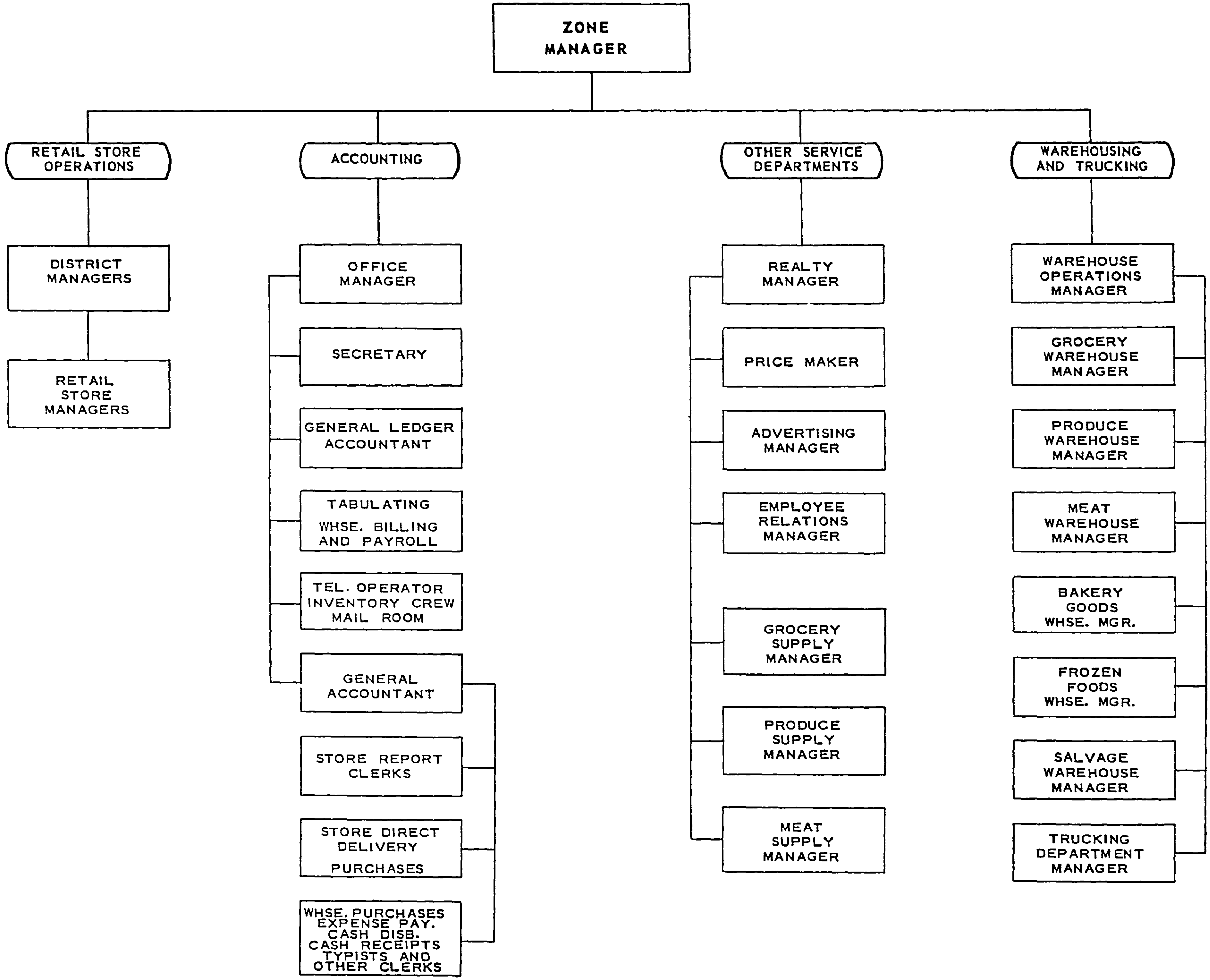


Figure 1

quite a problem in that a certain part of our paper handling lends itself to mechanization, whereas the balance has to be handled manually.

Warehouse Billing to Retail Locations

There are three methods of billing that can be employed. They are as follows:

1. Prebilling. Prebilling, which means that a source document or a store order is received from the store in code order sequence. From this document, we can follow either of two methods: (1) Pull cards from a tubfile, which cards are completely extended for one unit of merchandise and by pulling multiple cards for one commodity, we are able to complete the store's wants for one particular commodity. The pulled cards can then be run through the tabulator from which a selection list for the warehouse is made. Or, (2) under batch billing methods, instead of pulling cards, we can punch the code number and quantity into a basic card, and from there on, perform the various sorting and computing operations before we are able to tabulate the store charge and obtain a selection list for the warehouse.

2. Prelist Method. This method is employed where we are using a private line teletype communication system for relaying the information from the store to the warehouse involved. This prelist is printed on a teletypewriter showing the code number and quantity which the warehouse uses for a selection list to fill the store order. At the same time this prelist is being printed on the warehouse teletypewriter, an interpreted five-channel tape is being produced at the tabulating billing center, which is later run through a tape-to-card converter to create cards for each store order.

3. Postbilling Method. This method employs a source document originating at the store which is routed directly to the warehouse where it becomes also a selection list for filling orders of merchandise.

See Figure 2, a flow chart outlining nine different steps that are required under this postbilling plan of operation and, for the purpose of this discussion, let's say that this is the billing procedure that, for other considerations, is used by the Grocery Warehouse which stocks the largest number of commodities of any of our warehouse operations. The postbilling steps are as follows:

Step 1. A master deck of cards is maintained for approximately 3,000 individual commodities. This master deck contains information on each card as to the code number, units on hand, unit shipments to date, cost and sell values to date in dollars, unit weight, cost and sell price. From this deck we reproduce each day a new deck of cards to be used as a trailer card in the operation, which card shows the code number, unit weight, cost and sell. The other information has been locked out from the previous balance forward card.

Step 2. After the store orders have been received from the warehouse, we manually add on a comptometer the units that the warehouse has shipped, in order to have a control figure to balance to. Any items that were not shipped have been circled out by the warehouse.

Step 3. After the above addition has been made, we have as many as twenty to thirty pages representing one store order. Then, to get an even flow through the Tabulating Department, we manually sort this paper into sequence by blocks of 1,000 code numbers. For example, the first 1,000 code numbers for all stores to be billed for any one day, would be set up in one pile, the second thousand numbers in another pile, and so forth. The reason for doing this is that by maintaining the master deck (from which we obtain the price information for extension) in strictly code order sequence, the cards coming off the key punches can then be processed through the machines in blocks of 1,000 after first sorting and merging with the master cards by a three-digit sort.

Step 4. Detail cards are punched, and each shows the date of order and store number (which information repeat punches in each card), and manually we punch the code number and quantity ordered. At the same time that the cards are being punched, the key punch which is directly connected to a solenoid driven adding machine, is preparing a proof list so that when we come to the total of the store order, that total can be compared with the predetermined total obtained in Step 2.

Step 5. After the first 1,000 code numbers for all stores have been key punched, they are merged on a sorter along with the receiving and adjustment cards, old balance forward cards and new balance forward cards.

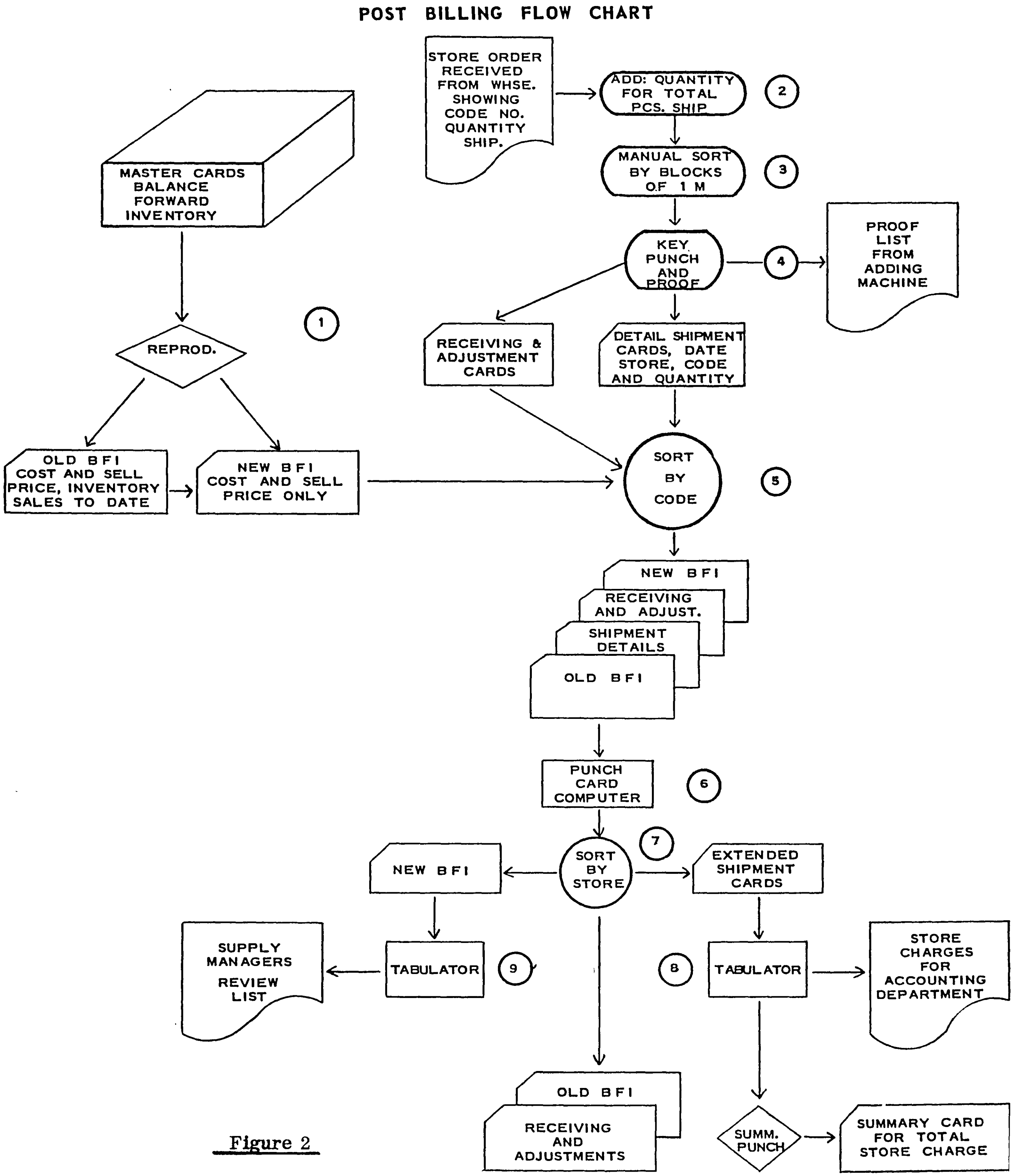

POST BILLING FLOW CHART
STORE ORDER RECEIVED FROM WHSE. SHOWING CODE NO. QUANTITY SHIP.
ADD: QUANTITY FOR TOTAL PCS. SHIP
2
MANUAL SORT BY BLOCKS OF 1 M
3
MASTER CARDS BALANCE FORWARD INVENTORY
KEY PUNCH AND PROOF
4
PROOF LIST FROM ADDING MACHINE
1
REPROD.
RECEIVING & ADJUSTMENT CARDS
DETAIL SHIPMENT CARDS, DATE STORE, CODE AND QUANTITY
OLD BFI COST AND SELL PRICE, INVENTORY SALES TO DATE
NEW BFI COST AND SELL PRICE ONLY
SORT BY CODE
5
NEW BFI
RECEIVING AND ADJUST.
SHIPMENT DETAILS
OLD BFI
PUNCH CARD COMPUTER
6
7
NEW BFI
SORT BY STORE
EXTENDED SHIPMENT CARDS
SUPPLY MANAGERS REVIEW LIST
TABULATOR
9
8
TABULATOR
STORE CHARGES FOR ACCOUNTING DEPARTMENT
OLD BFI
RECEIVING AND ADJUSTMENTS
SUMM. PUNCH
SUMMARY CARD FOR TOTAL STORE CHARGE

Figure 2

Step 6. After the cards have been sorted in the above outlined manner, they are run through the computer which stores certain information for making calculations as follows:

1. Extends each receiving card as to dollar cost for the quantity received.
2. Extends each detail store card as to weight, cost and sell.
3. Reduces inventory on hand.
4. Increases units shipped to date and dollar cost and sell to date.

Step 7. Next the cards are run through the sorter, sorting on store number, from which we obtain the extended store shipment cards and segregate the new B. F. I. card, the old B. F. I. card, and the receiving and adjustment cards.

Step 8. These extended store shipment cards are run through the tabulator to obtain store charges for the Accounting Department and, at the same time, creating a summary card for the total store charge.

Step 9. The segregated, new B. F. I. cards are run through the tabulator to obtain a review list to be used by the Supply Manager for buying purposes.

Mechanization of our Manual Operations

We could not obtain equipment on the market which would take care of all the input problems for our accounting. Present punch card equipment and proposed large scale computing equipment do not provide special input devices which are required to do a completely integrated accounting job.

In some cases, therefore, we worked with equipment manufacturers and, in other cases, had equipment developed on our own — in order to solve the missing link in our accounting problems. These machines are as follows:

1. Cal-Ke Punch
2. Key Punch Proof Machine
3. Store Ordering Machine
4. Adding Machines (now on the market) that create a 5-channel tape.

CAL-KE PUNCH This machine was developed for the purpose of handling our Accounts Payable in connection with retail store accounting. As was previously mentioned, the second largest portion of our office work is accounting for store purchases delivered directly to our stores by the many vendors of food and household items.

This machine enables us, as a by-product of checking the vendors' invoices, to automatically write the answers into 5-channel tape for further conversion into punch cards. These punch cards can then be completely integrated with the store purchases produced by the warehouse tabulating billing equipment. Formerly this work was strictly manual, which meant that after the extensions were checked, the invoices had to be summarized by comptometers and posted manually to store ledgers; then, by a sorting operation, the invoices had to be arranged into vendor order and summarized to obtain how much we owed each vendor. See Figure 3, the above-mentioned machine with an additional attachment explaining its various components.

KEY PUNCH PROOF MACHINE This device was developed in cooperation with one of the calculating machine manufacturers to be used in conjunction with our postbilling operations. Formerly our postbilling procedure required that after the cards had been key punched, they had to be run through a tabulator in order to obtain the page totals for each store to determine whether they were in agreement with the source document from which the cards were punched. If they agreed with this tabulated list, no further checking was necessary but, if they did not, it was necessary for clerical personnel to check in detail to reach such agreement. This required additional tabulation time, increasing the number of tabulators at each Zone operation and adding to its clerical staff.

This machine is a solenoid-driven machine which is directly connected to the key punch, so that the operator by punching the cards also causes this machine to add up the quantities at the same time. Now when the operator comes to the end of a store order, she depresses a remote control key (which is an extra attachment to the key punch) causing the adding machine to print a total to be compared with the original source document.

STORE ORDERING MACHINE A prototype of this machine is being made by ourselves, which we intend to use in conjunction with a private line teletype system for store ordering, which has been installed at one of our Zones. At present each store in this test Zone has a Type 15 teletypewriter to transmit perishable warehouse orders consisting of 30 to 40 items each.

In order to extend the system to grocery ordering (inasmuch as the average grocery order runs between 800 to 1,000 items), it would be economically necessary to install Type 19 equipment at the store level so that the transmission of this order could be speeded up to 60 or 75 words per minute.

That is the purpose of this machine, to create a 5-channel tape as a transmission link for the teletype equipment.

You might say, why not use the existing adding machine equipment which is presently on the market. The trouble with this equipment is, it is not foolproof enough to protect against store personnel making errors in code numbers and quantities. Our machine will automatically read back the code number and the quantity of each order by merely depressing the read key on the machine. (See Figure 4.)

ADDING MACHINE THAT CREATES 5-CHANNEL TAPE At present we are experimenting with adding machines of this type for transmission by leased lines from our 27 Zone office points to our Central Accounting Department in San Francisco for drafts issued by these offices but drawn on our Treasurer in San Francisco.

As a by-product of transmitting such a printed draft list, the receiver at our San Francisco office at the same time can create a 5-channel tape which will replace the manual key punch operation now necessary to create these draft cards by punching them automatically.

We have been running this equipment for several weeks, and it is working satisfactorily.

We plan to use this equipment for other accounting information to be transmitted by these scattered Zone offices to the Central Accounting Department for the incorporation of other reports which they produce into organization-wide presentations.

PRIVATE LINE COMMUNICATIONS LINKED UP WITH COMPUTERS We believe that, through the media of teletype communications, it may be possible to set up regional accounting offices which pertain to certain geographic areas. The type of computers that we have in mind would be medium-sized, having large storage capacities. We do not now believe that we have any place in our business for large scale computers which are now on the market with fast access working storage primarily used for programming and problems in arithmetic and logic, and mass storage of data on magnetic tape.

We prefer a computer which would have large drum storage as we feel that this type of storage would be much better than magnetic tape storage for our particular work because a large part of the information that we receive over our teletype equipment probably would be in random access order.

There remain certain problems of linking up the computer with a communication system. By that I mean for our system, it would be preferable to use, as a means of input, five-channel tape which would terminate at the regional office computing center. Most five-channel tape, however, is of the chadless type. This type of tape, in order to be read into the computer, makes necessary the use of slow pin-sensing readers instead of being able to use highspeed paper tape readers which are on the market, operating with photoelectric sensing. It is necessary in a communications system to have interpreted tape coming into the relay center and, further, it is useful to have such interpreted tape at the regional accounting centers for proper identification. Chad tape does not give us the interpretation, but it does lend itself for high-speed readers. It would, therefore, be helpful to us if the communications people develop a chad-type tape which is fully interpreted. I understand one of the companies already has done something on this, although I have not had an opportunity to investigate the results.

We, however, would not consider attempting to eliminate all of the accounting functions that go on in a Zone office. Because, as I explained at the outset, ours is a far-flung organization requiring highly decentralized local area management for efficient operations. It is necessary for the Zone offices to handle the following mass detail information on a decentralized basis:

1. The billing of our own warehouse merchandise to the stores. The Supply Manager needs this information readily available at his finger tips, instead of having to obtain it in a necessary standardized form via communications from a remote regional point.
2. The checking and paying of Accounts Payable invoices pertaining to each Zone's own operations could best be done at the source.
3. The keeping of detailed information of individual store operations — consisting of sales, purchases, and expenses — we feel would be better handled on a more flexible decentralized basis.

It is, however, apparent that we would be able to eliminate the problem of keeping a general ledger locally. After the information is developed by the

Zone, relayed to the regional or central computing office, the functional values of Profit and Loss statements (consisting of the total store operations, warehouse operations, trucking operations, general administrative expense details, etc.) are of greater importance to central management than the separate significance of each Zone's breakdown is to local operators before inclusion of central expenses, etc.

CAN WE AFFORD A MEDIUM-SIZED COMPUTER HAVING A LARGE STORAGE CAPACITY?

Since punch card computers were placed on the market, we have been able to install batch billing in lieu of previous tubfile methods at our Zone offices for billing and inventory control and we have been able to achieve some major efficiencies. Time has premium value to a fast-moving business like food retailing beyond the importance, even, of the labor economies.

If we installed medium-sized computers to do our billing, it is true that we would be able to eliminate certain sorting, collating and other machine operations necessary to a batch billing punch card method. However, it is doubtful as to whether sufficient efficiency would result to warrant the loss in personnel services.

For example: Let us assume that we have an installation that now requires a peak staff of six people in the machine room to perform the card handling routine. We know that if we put in a medium-sized computer, we are not going to free the time of all of these people. And the people creating the input to the equipment cannot be considered because it does not matter which equipment is used, some source of input is necessary. We cannot afford to pay any more rental for this equipment than the time it saves unless some additional efficiencies, not now apparent, are gained.

It is, therefore, evident that before we can consider using this type of equipment for our Zone billing that the people building it will have to come up with more realistic purchase or rental adaptations for our decentralized retail industry.

DESCRIPTION OF THE CAL-KE PUNCH

The Cal-Ke Punch consisting of the following components:

Upper Console

1. Switch to control the homing position of the neon light stepping switch. This switch has 15 positions. The specification is to vary the homing position for card columns 1 to 15, inclusive, based on the length of the number of columns to be stored for repetitive punching into 5-channel tape. For example: let us assume that we wish to store the date, which requires 4 columns, and the vendor number, which requires 4 columns. The switch indicator is set on 8 and when the "Intermediate Trip Key" on the auxiliary keyboard is depressed it returns the neon light indicator to column 8 as a starting point rather than to the homing position, or zero column.

2. There are a group of 45 neon lights in addition to the 2 neon lights in the zero column position on the extreme left. Of these two, the upper one designates the upper 45 columns of the card, and the lower designates the lower 45 columns of the card. As the control keys on the auxiliary keyboard are depressed, the neon lights turn on and off and stop at the respective card column for which the program has progressed.

3. Immediately above the neon lights a moulding is provided so that a paper form can be inserted showing columns 1 to 45 and columns 46 to 90 for programming to punch card columns. (In the case of I. B. M. equipment this form shown 1 to 40 and 41 to 80.) The numbers printed on this form appear immediately above the 45 neon lights. The purpose of this paper form is for the programming of the machine as lines can be drawn on the form and headings indicated, referring to the respective card fields that will be punched.

Auxiliary Keyboard

On the right-hand side of the machine an auxiliary keyboard is provided which consists of the following:

1. A 10-key keyboard having digits 1 to 9 and a zero key.

2. Key captioned "Read" which causes machine to read any information stored in the calculator and punch results into the tape.

3. Key captioned "Error" which causes machine to punch an error code in the tape.

4. Key captioned "Space" which causes machine to punch space code in the tape.

5. Key captioned "Carriage Return" which causes machine to home neon light indicator to zero position on the program console and

to turn on the lower neon, indicating the machine is set to punch in the lower 45 columns of the card.

6. Key captioned "Intermediate Trip" which causes machine to return the neon light indicator to a fixed position based on the setting of the control switch on the upper console which was previously explained in my description of the Cal-Ke punch.

7. Key captioned "Card Eject" which causes machine to home neon light indicator to the zero column, indicating by the upper neon light that punch is set for upper 45 columns of the card.

Calculator Keyboard

This is a standard comptometer which is electrically wired to read from the machine any information stored in the numerical dials of the machine when the "Read Key" of the auxiliary keyboard is depressed.

The comptometer is a 10-column machine and in order to control the readout of any particular column there is mounted on the upper console ten toggle switches and ten neon light indicators. If all the columns are to be read the switches are placed in the "on" position, indicating that the columns are on and the 10 neons show a light immediately above each switch. The purpose of these switches is to control the digit length for the money or quantity fields of the card form.

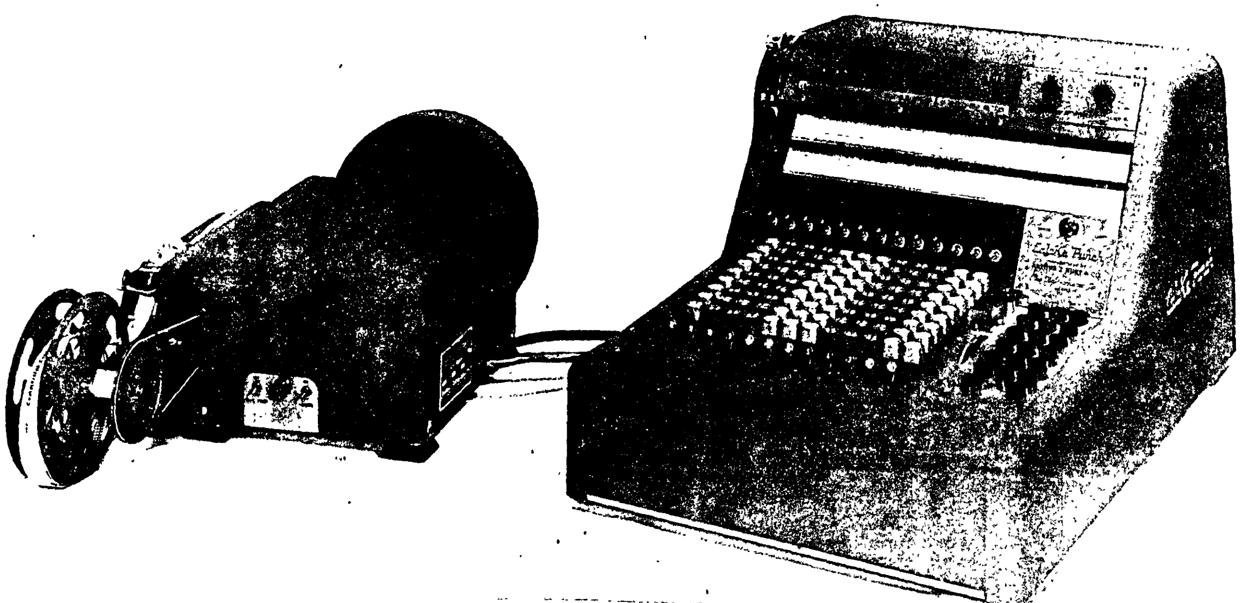


Figure 3 - CAL-KE PUNCH

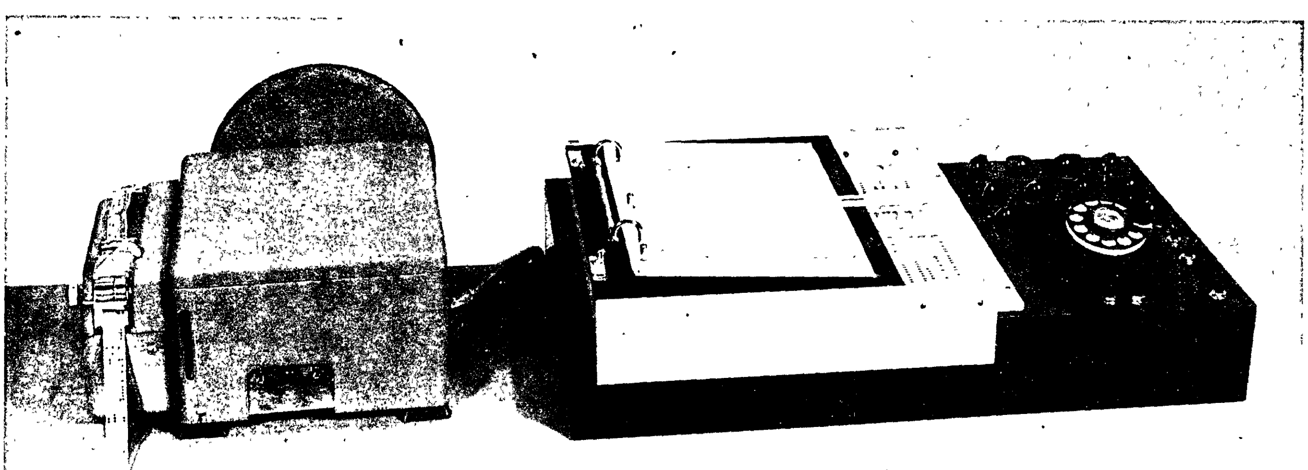


Figure 4 - STORE ORDERING MACHINE

-END-

AN AUTOMATIC MICRO-IMAGE FILE

National Bureau of Standards
Washington 25, D.C.

A micro-image data storage and retrieval device recently developed at the National Bureau of Standards provides rapid access to any one of 10,000 information-containing frames recorded in miniature on a 10-in. square sheet of microfilm. The instrument operates on a continuous basis; it automatically searches the microfilm and photographically prints out one frame every 2 seconds. Designed and built by M. L. Kuder of the Bureau's electronic instrumentation laboratory, the device is intended for use in other Government agencies.

The machine is particularly applicable where large volumes of data must be assembled in a predetermined sequence from a master random file. Information may be in the form of pictures, drawings, fingerprints, sets of numbers, letters, or other symbols, or even single stages of electronic circuit diagrams. Quantity and kind of data is limited only by the size of the individual frame (1/10-in. square) and the photographic resolution of the film emulsion. Although the basic storage capacity of the machine is for a 10, 000 frame matrix, the matrix can be interchanged with others from a static file.

Input to the machine is from a perforated teletype tape containing the coded locations of the desired frames in the order in which they are to be printed out. The assembled data produced by the machine comes out on a 10-in. wide strip of photosensitive paper of any required length. Individual frames are enlarged to 1/2-in. squares. Commercial automatic developing equipment processes the photographic paper.

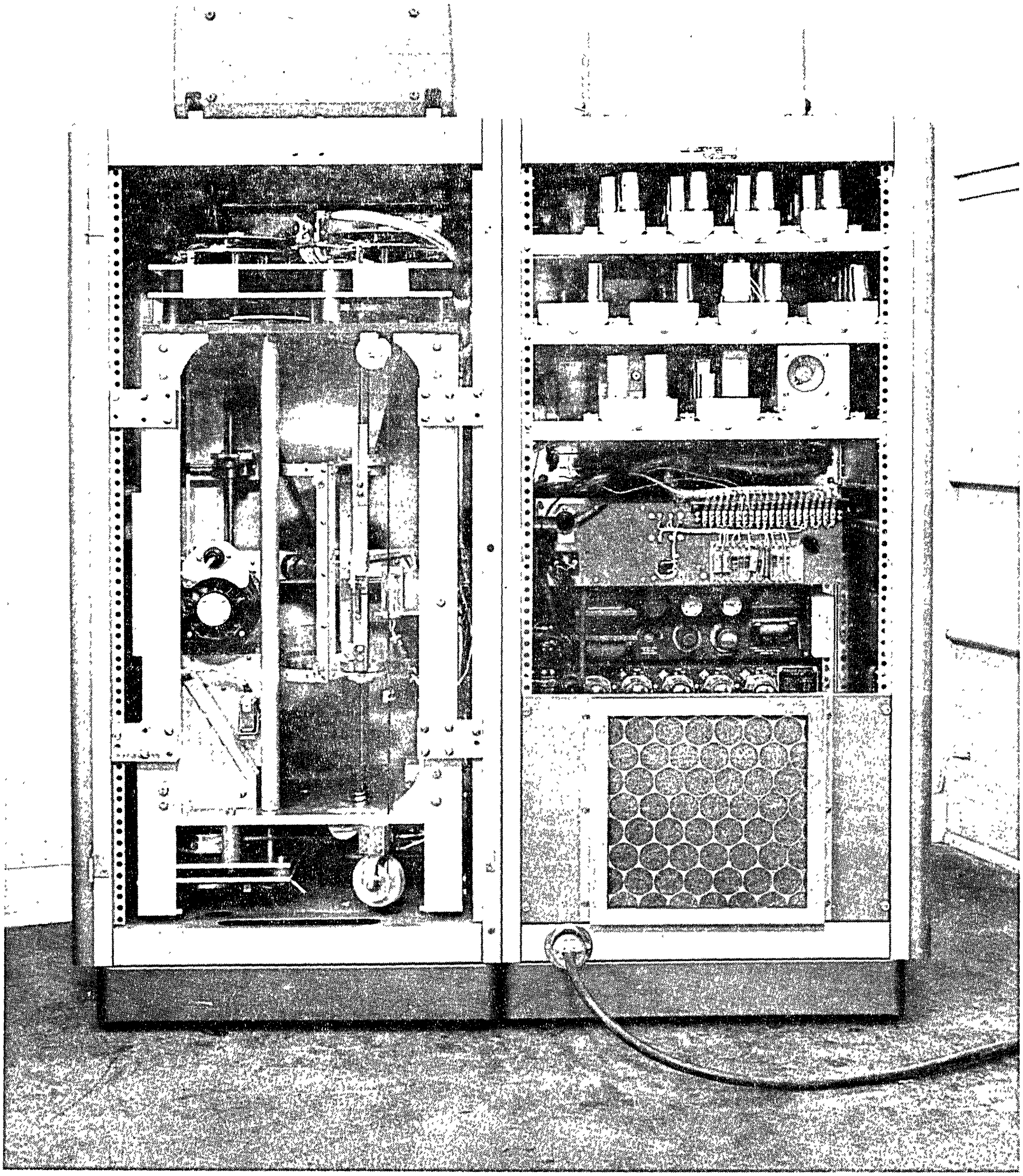
The instrument is essentially a combination of digital computer electronic circuitry and a pair of precision servomechanisms that search X and Y axes of the matrix. The location of the desired frame is fed into a 20-bit (binary digit) register from the teletype tape. The register consists of a capacitor memory and coincidence identification circuitry. The first 10 bits recorded in the register control the Y position selection while the second 10 bits control the X position.

The matrix is supported on a drum 10 inches in diameter and is fastened at one edge with dowel pins to insure its accurate location on the drum. The drum is servocontrolled in both linear and rotary axes of motion, corresponding to the X and Y axes of the matrix. The servos that shift the matrix to the chosen coordinates are mechanically coupled with precision gearing to two code commutators.

The code commutators, one associated with each axis, control the coordinate positions to which the matrix is located. These commutators are photo-etched with 100 ten-bit numbers corresponding to the standard teletype binary bit code. The two particular positions on the commutators are selected by a serial mechanical search with contacting brushes until a code combination is found that matches the binary bits recorded in the 20-bit register. Magnetic clutches and brakes provide rapid starting and stopping of the drum with uniform over-travel in locating every position on the matrix. A single induction motor supplies all motive power to the machine.

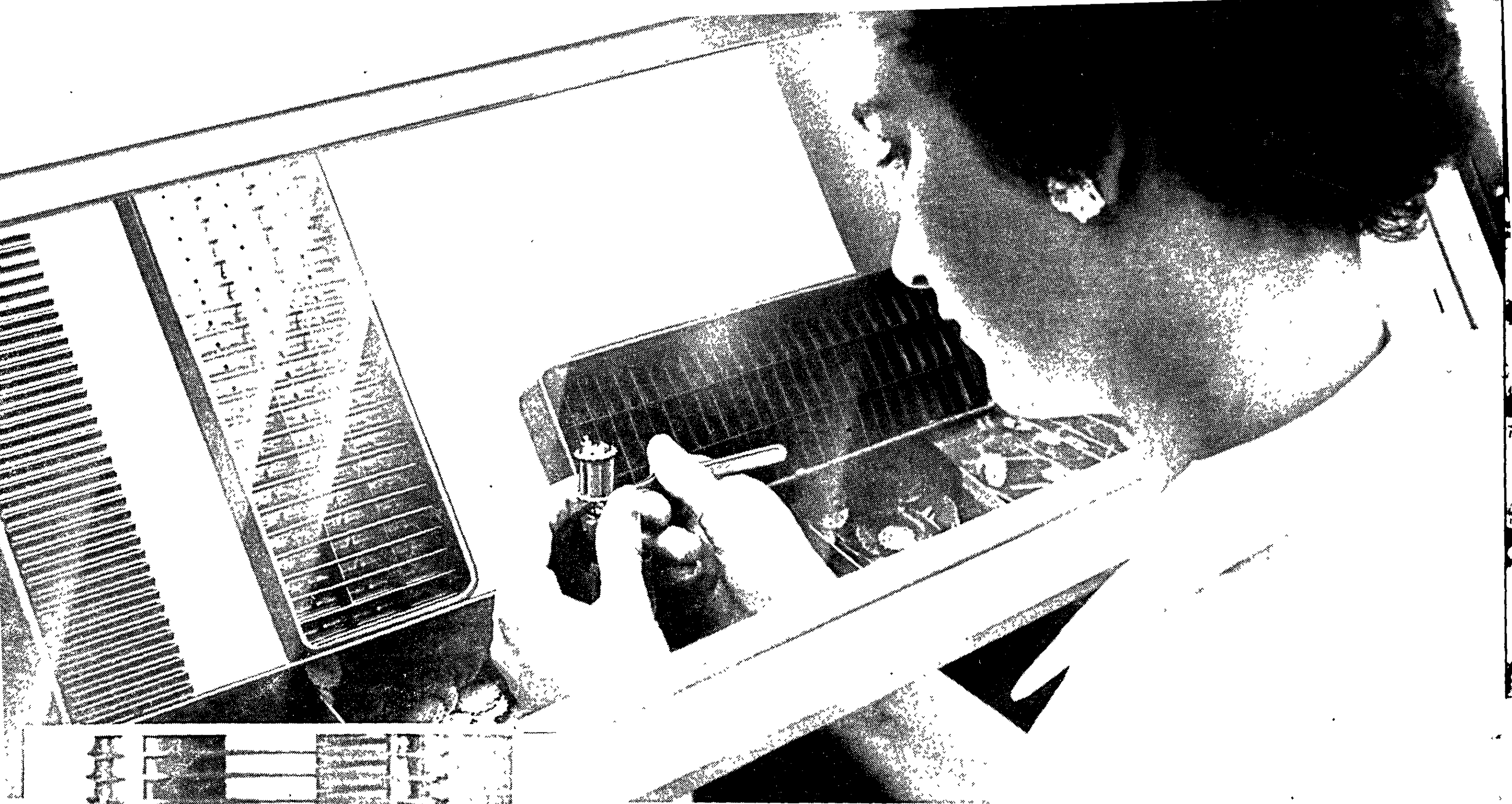
At the beginning of the cycle of operation, a teletype tape reader reads a 4-decimal-digit number into the 20-bit register in terms of a binary-digit code. A space symbol is customarily inserted in the teletype tape following each 4-digit number. On detecting this space symbol, the machine's program control stops the tape reader, engages the magnetic clutches on the X and Y servos, and looks for the compatible code on the two coordinate axes. When the compatible code is found, the clutches disengage and magnetic brakes stop the drum. A print lamp is briefly turned on to make a photographic exposure of the selected microfilm frame on the photosensitive paper. When the exposure is completed, the teletype tape advances to the next instruction, the drum returns to its zero position, and the machine proceeds with the next search cycle.

Fifteen successive frames are printed in a row across the 10-in. width of the print paper by means of a step positioning mirror. This mirror

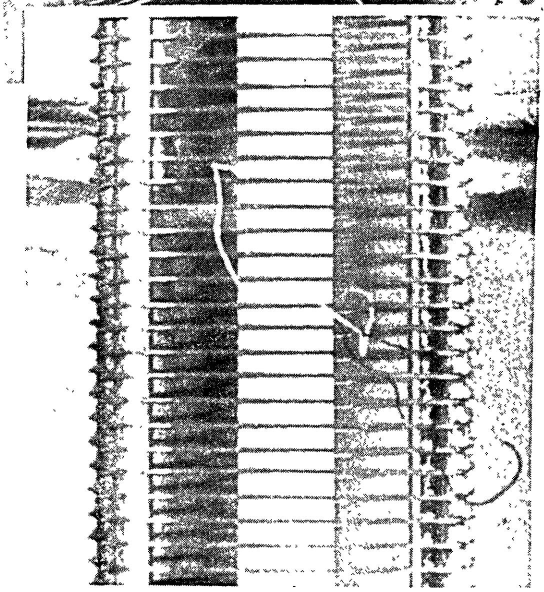


Automatic Micro-Image File

(cont'd on page 50)



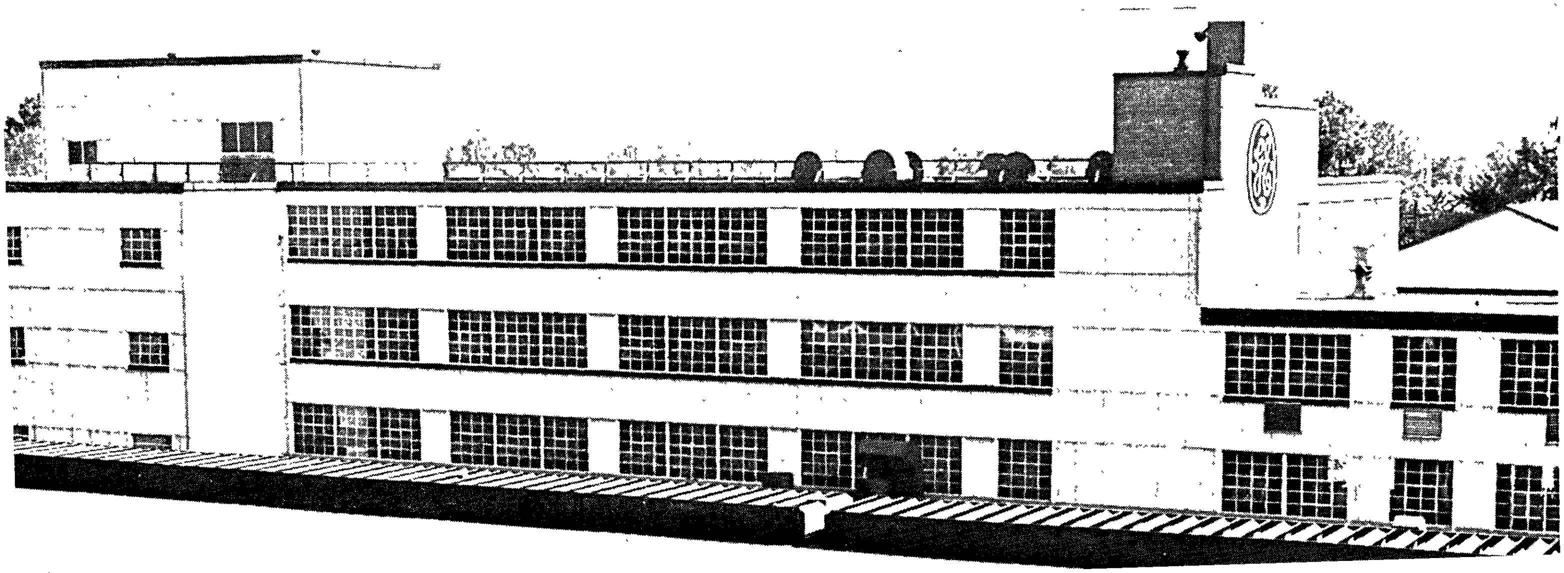
▲ **MANUFACTURED "UNDER GLASS"!** For optimum cleanliness, 6829's are assembled under glass-paneled protective hoods. All G-E employees who build 5-Star Tubes wear rubber finger cots, and their uniforms are lint-free Nylon and Dacron. These precautions are taken to ward off lint and dust, most frequent causes of intermittent tube "shorts".

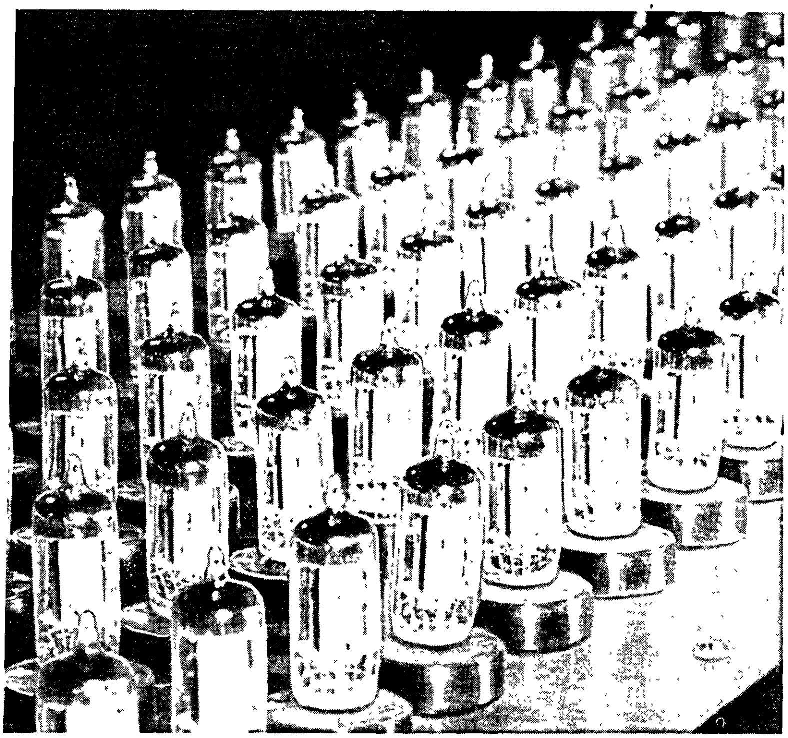


▲ **LINT IS A TROUBLE-MAKER!** The unretouched microphoto above shows a strand of lint which easily can cause an inter-electrode short-circuit. Dust particles within a tube have the same harmful effect.

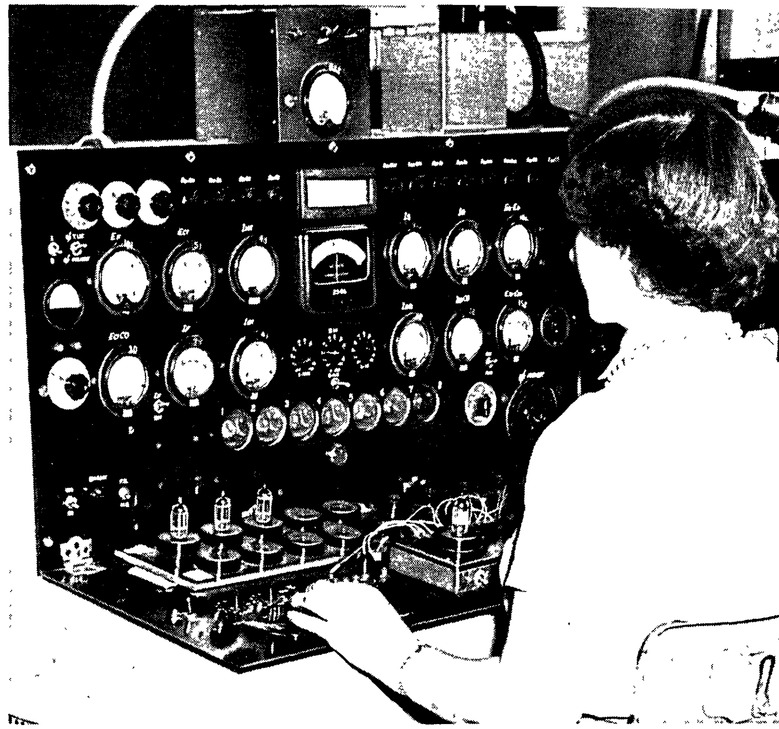
FIRST GENERAL ELECTRIC HAS LINT-FREE

▼ **1200 WORKERS ASSEMBLE 6829's AND OTHER HIGH-RELIABILITY TUBES** in this 5-Star building, located apart from the rest of G.E.'s Owensboro, Ky., tube factory. Because of the special white lintless uniforms, plus immaculately clean working conditions, "Operation Snow White" is aptly used to describe G-E 5-Star Tube manufacture. The entire assembly and inspection area is pressurized, with air that has been filtered, dehumidified and cooled.





▲ **SPECIALLY TESTED . . . BIASED TO CUT-OFF FOR LONG INTERVALS!** Life tests of G-E computer tubes under cut-off conditions, are made in order to be sure no "sleeping sickness", or failure to respond to grid input pulses, develops during inactivity. This is determined by means of periodic interface checks.



▲ **CHECKED FOR COMPUTER-SERVICE CHARACTERISTICS!** G-E computer tubes are specifically tested for those electrical qualities that closely affect tube operation in computer circuits. Among the characteristics checked are zero-bias plate current . . . cut-off performance . . . difference in cut-off between both triode sections.

5-STAR COMPUTER TUBE MANUFACTURE FOR ADDED RELIABILITY

Shock-resistant design—comprehensive cut-off tests—further establish Type 6829 as the most trustworthy tube you can apply in military computers!

General Electric, first to design and build a new line of tubes for computers, now pioneers the first 5-Star high-reliability tube for computer circuits —analog and binary—where airborne, gunnery, or field-transport conditions call for resistance to mechanical shock and vibration.

Type 6829 has the many 5-Star design features that give added strength, such as a compact, sturdy tube cage . . . double mica spacers . . . a double-staked getter. In addition, tube assembly is carried on in immaculate surroundings free from lint and dust, while special tests assure those electrical qualities that are essential in achieving computer dependability.

A 9-pin miniature, the 5-Star 6829 has similar characteristics to standard computer Type 5965. The new tube is designed for high-speed circuits—has high perveance, balanced, sharp cut-off qualities, and low heater power requirement (.45 amp).

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Association for Computing Machinery, 11th National Meeting, Los Angeles, August 27 to 29, 1956, — Program, Titles of Papers, and Abstracts — Part 2

(continued from October issue)

20. ON THE OVERALL STABILITY AND CONVERGENCE OF SINGLE-STEP INTEGRATION SCHEMES FOR ORDINARY DIFFERENTIAL EQUATIONS

JOHN W. CARR, III

Formulae are derived for use in the integration of the equation

$$\frac{dy}{dx} = f(x,y)$$

by means of the single-step methods of the Kutta type, to guarantee both convergence and stability of the numerical solution of the equation in the case where the differential equation itself is stable (that is where $f_y\ (x,y) < 0$). Error bounds for overall propagated error due to round-off and truncation error are given for Kutta's fourth-order process for the cases where the original differential equation is both stable and unstable. A value for the step-size to keep overall error within a given bound for the stable case is also given.

21. GENERATED ERROR IN THE SOLUTION OF CERTAIN LINEAR DIFFERENCE EQUATIONS

ALSTON S. HOUSEHOLDER

Let the elements of a vector x represent the values of the dependent variable at the grid points in a finite difference representation of a linear differential equation. In matrix form the difference equations are

$$Ax = b$$

Let x^* be a computed solution, $(Ax^*)^*$ the machine product of A by x^*, and

$$d = [b - (Ax^*)^*] + [(Ax^*)^* - Ax^*]$$

Then the generated error is

$$x - x^* = A^{-1}\, d\,,$$

and for any consistent matrix and vector norms

$$\|x - x^*\| \leqslant \|A^{-1}\| \quad \|d\|$$

In some cases $\|A^{-1}\|$ can be directly estimated. Illustration is made to the equation of reactor criticality.

22. EVALUATION OF INCOMPLETE ELLIPTIC INTEGRALS BY GAUSSIAN INTEGRATION

JOHN G. HAYNES

Expressions containing Incomplete Elliptic Integrals of the First and Second Kinds pose serious speed and storage problems in medium sized computers. A further complication arises if the expressions in which the elliptic integrals occur are themselves integrals. A method based on Gaussian integration is presented for evaluation of the incomplete elliptic integrals alone, or of the integrals in which they appear. For a specified accuracy, the method gives a near optimum compromise among such program characteristics as storage requirements, speed, complexity, and general applicability.

23. PROGRAMMING OF THE METHOD OF CHARACTERISTICS FOR AXISYMMETRIC FLOW

D. C. LEIGH AND C. R. EUBANK

An extensive project is in use on the IBM 701 at Convair, Fort Worth, and many applications of the method have been made to aerodynamics problems. The equations and computing procedure are described briefly. A large library of subroutines for the method has been developed which gives flexibility in applications and modifications, and in the use of coding personnel. The subroutines are divided into basic groups each of which is defined. Some subroutines in each group are described in detail. Boundary data input, mesh size, and a mathematical check are discussed briefly.

24. A METHOD OF COMPUTING SHOCK WAVES

D. C. LEIGH

The subject of this paper is a numerical procedure for the computation of the variables of axisymmetric flow at a shock wave in a flow field computed by the method of characteristics. There is a preliminary discussion of the determination of the mesh size of the characteristic grid at a shock. The author's method of solution is then described in detail as well as a method by Ferri and a comparison is made.

25. A VARIATIONAL APPROXIMATION FOR STURM-LIOUVILLE PROBLEMS

C. C. FARRINGTON, JR.

A method of obtaining approximate eigenvalues and eigenfunctions of the Sturm-Liouville problem,

(1) $(py')' + qy + \lambda ry = 0$

with boundary conditions $y(a) = y(b) = 0$, by computing approximate solutions to the minimization problem

$$(2)\,\delta\int_a^b (py'^2 - qy^2 - \lambda ry^2)\ dx = 0$$

in the calculus of variations will be discussed. Here p, q, and $r > 0$ are given functions of x. Using a mesh of $N + 1$ intervals of equal length, the solution $y(x)$ is approximated in the i^{th} interval by a Lagrange interpolation polynomial of fixed degree m through $m + 1$ nearby ordinates y_i. Requiring that this approximating function minimize the integral in (2) leads to an N^{th} order matrix equation

(3) $Ay = \lambda By$,

in which A and B are symmetric and B is positive definite, for λ and the y_i

Some numerical results for the case $p \equiv 1, q \equiv 0$, and $r \equiv 1$ will be presented.

26. PROGRAMMING A COMPUTER TO PLAY GAMES

A. L. SAMUEL

As Von Neumann and Morgenstern have demonstrated*, games and economic behvior have many elements in common. A study of possible methods of programming computers to play games can, therefore, be expected to lead to a better understanding of the ways in which computers may be applied toward the solution of hitherto unsolved problems of real economic significance. Game-playing programs will be discussed and illustrated by a program which causes the IBM 704 to play an acceptable game of checkers against the average player.

* "The Theory of Games and Economic Behavior."

The program, as written, contains provisions for the subsequent addition of an elementary learning procedure which should enable the computer to profit from its experience during actual play.

27. MUSICAL COMPOSITION WITH A DIGITAL COMPUTER

L. A. Hiller, Jr. and L. M. Isaacson

If random numbers generated by a digital computer are used to designate notes of the musical scale, rhythmic patterns and other factors which make up a musical texture, then these numbers may be subjected to machine computations which express the rules of musical composition. Consequently, it becomes possible for a computer to simulate in many ways the processes of musical composition. Codes have been written which permit the ILLIAC at the University of Illinois to write four-part counterpoint and the musical structures suitable for transcription for performance by a string quartet. A tape recording of a string quartet made up of computer composed music will be used to illustrate progress to date on this problem.

28. THE POTENTIALITIES OF A HIGH-CAPACITY STORE FOR MACHINE TRANSLATION

Irving Wieselman

This paper will describe (1) the characterstics of an ideal machine translator, (2) give an historical summary of the results achieved by the machine translation to date (actual and simulated).

Previous systems of translations were limited principally by the characteristics of machines available and by the lack of adequate analyses of syntactical structures. A rapid-access high-capacity store is able to eliminate many of the problems of the automatic dictionary and aid in providing information for the syntactical problem. Finally, there will be a discussion of methods which have been proposed to obtain proper syntax mechanically and of the research problems remaining in the solution of the translation problem.

30. SIMULATION TECHNIQUES FOR THE TEST AND EVALUATION OF REAL-TIME COMPUTER PROGRAMS

D. R. Israel

Simulation techniques are suggested as "test equipment" for evaluation of large real-time control systems in which the factors of time, safety, environment, and cost preclude live testing. Examples of three categories of real-time input non-controllable, controllable, and manual intervention, are given and means of simulating each type are described. It is shown that simulation facilities, especially when incorporated into system design, can be an economical and effective test and training medium for real-time control systems.

31. DATA RECORDING IN REAL-TIME CONTROL SYSTEMS

H. E. Frachtman

An important facility in a real-time control system is the ability to collect and record data while the system is in operation. This data can later be processed and reduced to yield summaries and other specific information pertinent to system operation. These facilities, recording and reduction, can be used to give summary information on system performance, to analyze system operation, to communicate with another control system, or to permit the system to re-enact its operation at some later time.

32. A SYSTEM FOR GENERAL-PURPOSE ANALOG-DIGITAL COMPUTATION

Walter F. Bauer and George P. West

A large high speed, high accuracy, analog-to-digital converter was ordered with specific applications to missile simulation in mind. In this paper the converter is described particularly from the programmer's point of view. In a combined analog-digital simulation, problem considerations indicate the digital computer might be hard put to keep up with the computation. A general control is described which allows data to be transferred quickly between the converter and the digital computer, at the same time requiring a minimum of programming effort. An example is given which illustrates the flexibility and convenience of the converter control.

33. SAMPLING FREQUENCY OF DIGITAL SERVOMECHANISMS

Julius Tou

A digital servomechanism is essentially a sampled-data feedback control system utilizing a digital computer to perform sampling, error-detection and digital compensation for the system. Through appropriate programming or data-processing in the digital computer, the system error can be reduced. The system error between sampling instants depends upon the sampling rate of the error signal. Accurate systems may require a higher sampling rate. In this paper a derivation of the system-error equation is outlined and a method of determining the sampling frequency to meet system-error specification is described.

34. PROGRESS IN SIMULATION OF VALVE TRAIN DYNAMICS

W. C. Franke

A simple, linear, mass-spring equivalent system was found not to suffice when simulating the overhead valve train of an internal combustion engine. Accurate prediction of valve motion with the intention of evaluating a particular cam and train design was desired. This paper describes the development of a simulation circuit that takes into account some valve train non-linearities that affect valve motion. Comparison of engine results with computer runs using both the linear simulation and the one recently developed indicates that a closer approach to predicting valve motion has been made. Areas for further correlation studies are pointed out.

35. SERVOMULTIPLIER ERROR STUDY

Robert A. Bruns

The servomultiplier has been used in preference to other analog-computer multiplier types at low problem speed because of its high accuracy and the ease of producing several product pairs simultaneously. However, in order to evaluate servomultiplier performance, it has been necessary to make an error study. This study has led to experimental methods involving two types of plots: (1) direct-error, and (2) integral-error-squared. With the results obtained from these data, it has been possible to select and maintain precision potentiometers which have been used in the servomultipliers, and to improve servoamplifier design.

36. THE REFUGE RELAY FUNCTION GENERATOR

K. B. Tuttle

This paper describes a device f or approximating arbitrary functions of one variable by straight lines whose slopes may be varied between ± 89°30′. By properly combining five constant input voltages, all integral voltages between ± 121 volts may be obtained. Pulses from an external source drive a rotary selector switch which connects manually-preset, three-position switches to apply the desired combination of input voltages to an integrator whose output is the desired slope. The switching arrangements used minimize the amount of apparatus required. Advantages of the device in simplicity and reliability, and further extensions of the principles employed, are discussed.

37. A TRANSISTOR OPERATIONAL D.C. AMPLIFIER

W. Hochwald and F. H. Gerhard

A chopper stabilized operational d.c. amplifier meeting military requirements for airborne computer applications is described. With the exception of two cathode follower stages provided by a ruggedized, subminiature dual triode tube and a mechanical modulator, transistor circuitry is employed throughout. With suitable external feedback networks, the amplifier is capable of performing the operations of addition and integration with errors of 0.01% or less under severe airborne environmental conditions. Circuit details and analyses are presented with typical performance figures.

38. MATHEMATICAL TECHNIQUES IN DATA PROCESSING PROBLEMS

F. L. Alt and M. Zelen

Problems in the so-called data processing field are noteworthy for complicated logical structures and relationships. The task of formulating and analyzing such problems requires ability and experience in dealing in an abstract way with such logical entities, and is therefore properly considered as a mathematical field of endeavor, just as all of modern logic is practically a branch of mathematics. Several examples are given in which the successful solution of data processing problems depends critically on the use of advanced mathematical methods.

39. THE COMPUTING PROBLEM IN THE ANALYSIS OF NON-STOCHASTIC TIME SERIES USING AN AUTOREGRESSION MODEL

Z. Szatrowski

An autoregression model of type x_{ij}

$$= \sum_{q=1}^{p} \left(b_{jq} + 1/p \sum_{r=1}^{p} b_{rq}\right) x_{i,\,j-q} + l_{ij}$$

can be used to represent a non-stochastic time series (economics, meteorology, biology, etc.). The series is assumed to have a cyclical and trend component measured by $\sum_{q=1}^{p} \bar{b}_{.q}\, x_{i,\,j-q}$, a "changing" periodic component measured by $\sum_{q=1}^{p} b_{jq}\, x_{i,\,j-q}$ and a "random" component, l_{ij}. The computing required in getting least squares estimates of the b_{jq}'s is of the same order as a multiple regression analysis with p^2 variables. For example, the analysis of an economic time series for changing seasonal, cyclicals, etc. and some measures of statistical significance would require the solution of 36 equations in 36 unknowns.

40. DISCRETE VARIABLE PROBLEMS ON THE SWAC COMPUTER

C. Tompkins

This paper will concern the application of the SWAC computer to problems whose variables are discrete. It reports a continuing experience with this computer on problems of this type by many workers.

Genesis of some problems and the difficulties of applying a general purpose computer to their solution will be outlined.

Introduction of commands not normally available in present day computers will be appraised.

The algebraic problem of rejecting situations isomorphic with one already considered in problems of exhaustive search will be considered.

Approximate solutions of some maximizing problems will be mentioned.

41. NUMERICAL EXPERIMENTS WITH METHODS FOR SOLVING PARTIAL DIFFERENTIAL EQUATIONS

David Young

During the past four years the author has performed a number of numerical experiments on high speed computers in order to test and to supplement theoretical studies on the effectiveness of certain finite difference procedures for solving elliptic and parabolic partial differential equations. The accuracy of the solution of the difference equation as a solution of the original differential equation is studied as well as the effectiveness of various numerical procedures for solving the difference equation. For elliptic equations the primary concern is with rates of convergence of iterative methods, whereas stability is usually of considerable importance for parabolic equations.

42. SORTING ON A MULTIPLE TAPE UNIT

Wallace Klammer

A magnetic tape storage unit is described which simplifies the problem of sorting. Using 50 tapes with one moving head assembly rather than one continuous tape, the unit enables a computer to distribute a large file into segments for rapid sorting in the computer's internal storage. The distribution can be done quickly since access time to one of the 50 tapes is less than one second and internal computation continues during this time. The computer program for the entire operation is described. An appended table gives running times for sorting operations of various magnitudes.

43. AUTOMATIC DIGITAL ENCODING SYSTEM II

E. K. Blum

Automatic Digital Encoding System II (ADES II) is designed to mechanize the translation of mathematical formulas into programs of coded instructions for a digital computer. The system consists of a formulation language, an Encoder, and a digital computer.

The formulation language closely resembles ordinary mathematical notation. The syntax is based on the theory of recursive functions, and is general enough to describe most problems submitted to a digital computer. In ADES II, the language of ADES I is extended to include double and triple recursion.

The Encoder consists of a computer loaded with routines for translating from ADES language into the program language of the computer. The ADES language and the logical design of the Encoder are applicable to most computers.

44. A MATHEMATICAL LANGUAGE COMPILER

J. Chipps, M. Koschmann, A. Perlis, S. Orgel and J. Smith

A mathematical language compiler is defined and its structure is outlined. The compiler creates a machine program directly from a flow chart. Of prime importance is the symbol scanner structure. The symbol scanner examines pairs of symbols, determines their admissability from an entry in a matrix, which is easily augmented or changed, and triggers a unique generator which compiles the symbol's meaning. This allows for simple scanner structure regardless of the complication of the string of symbols being scanned. The compiler was originally written for the Datatron.

45. PSYCHOLOGICAL TESTS AND SELECTION OF COMPUTER PROGRAMMERS

T. C. Rowan

A personnel selection system based on a psychological test can be of real value if it is properly developed, administered and maintained.

The development of a programmer selection system is discussed with emphasis on special problems which may arise in selecting such personnel. A description is given of the selection program evolving at the RAND Corporation and an attempt is made to draw from this experience some suggestions for others facing similar problems. The test materials which have been experimented with at RAND are presented, together with evidence as to their efficacy.

Concluding remarks emphasize that a psychological test should be only a part of the selection program and that such a program, tests included, should reflect the particular characteristics of the individual firm.

46. COMPUTER PROGRAMMING AND CODING AT THE HIGH SCHOOL LEVEL

Aaron L. Buchman

This paper concerns a course in computer programming and coding being offered at the Hutchinson Central Technical High School, Buffalo, New York. The paper begins with a description of the automatic digital computer built by the pupils in the mathematics classes of the author. There follows the course of study used in the computer classes at the high school. A tape containing the orders of a typical program, as set up by the pupils of the class, is described. The author invites other high schools to offer a similar course to seniors studying their fourth year of mathematics.

47. A PROPOSAL FOR TRAINING YOUNGSTERS IN DIGITAL COMPUTING TECHNIQUES

Rollin P. Mayer

The current and predicted shortage of people familiar with and trained in computer techniques may be alleviated by beginning training at the elementary school level. It is demonstrated that the average 12-year old youngster can learn the basic concepts of digital computers if inexpensive models, properly prepared instruction manuals, and technical magazines designed for his age level, are made available.

The basic philosophy of inexpensive construction of computer components is outlined and demonstrated with working models made of cardboard and common pins.

48. SOME ENGINEERING ASPECTS OF THE NERVOUS SYSTEM

Harold Schapiro

A comparison between the human nervous system and a large computer-controlled electro-mechanical system will be made. The mechanics of the central nervous system will be discussed first, as this topic should be of great interest to computer engineers. A short anatomical description of the brain will be given in order to acquaint the audience with the areas of particular interest and the problems involved in a study of the brain. A discussion of the workings of individual neurons will follow. Comparisons between these building blocks of the nervous system and building blocks (flip-flop gates, etc.) used in computing machinery will be made.

Two theories concerning the operation of neural nets will be given. These are the McCulloch, Pitts deterministic approach (that closely parallels the Boolean algebra approach to the logical design of computer diode nets) and the von Neumann statistical approach. Some uses of information theory in the study of the nervous system will also be given.

Analogies between feedback mechanisms and the nervous system's input-output devices will be made.

Some experimental techniques including electroencephalography and neuron probes will be described. It is hoped that movies of some experimental animals will be available.

49. ON THE RECOGNITION OF INFORMATION WITH A DIGITAL COMPUTER

Herbert T. Glantz

The use of digital computers for table lookup operations has become a standard procedure. If the input data is subject to errors, however, table lookup will fail. Since the information content of the data is not necessarily destroyed by the presence of certain faults, it should be feasible to design a recognition technique which will anticipate and correct a variety of probable errors. This paper proposes a mathematical model for the generalized recognition problem and details the operation of this model both in direct table lookup recognition and in a special type of threshold or error analysis recognition.

50. A LEARNING PROCESS SUITABLE FOR MECHANIZATION

JOSEPH M. WIER

An elementary learning process which is easily mechanized is described. This process may be used to extract functional relationships which exist among the variables present in a completely or partially predictable digital environment. The results achieved by using the process take the form of a function_table arranged in such a way as to be conveniently employed in predicting the future behavior of the variables in the environment. A criterion for eliminating those variables which are of little or no consequence to the functional relations is described, and a few possible fields of application are pointed out.

51. CIRCUIT REALIZATION OF BINARY FUNCTIONS USING THRESHOLD DEVICES

EDWARD P. STABLER

A theoretical model of a threshold device is used as a fundamental building block for digital machine synthesis. It is shown that the model can be made to behave as a gating element of the types commonly used in digital circuitry, but also that the model can exhibit a wide variety of functional behavior. This flexibility may be used to reduce the amount of equipment necessary for a specified machine. Some of the limitations and capabilities of these techniques are discussed.

52. DESIGNING COMPUTER CIRCUITS WITH A COMPUTER

GENE H. LEICHNER

Digital computer circuits require that a number of tolerance conditions be met at one time. The number of these tolerance conditions which must be simultaneously satisfied in some circuits, such as a flipflop using transistor switching elements, is very large. The design of these circuits can be materially aided by using a digital computing machine to solve the resulting simultaneous equations. This paper discusses the derivation and solution of the five simultaneous non-linear algebraic equations resulting from an analysis of a flipflop circuit using transistors. The method has been carried out using the Illiac at the University of Illinois.

53. THE DESIGN OF SYNCHRONIZING BUFFERS FOR COLLECTING AND DISTRIBUTING DIGITAL DATA

HENRY C. KREIDE

A synchronizing buffer is a device which collects digital data from m input channels and distributes it to n output channels. The rate of collection at the input must be equal to the rate of distribution at the output. Properties of the collection-distribution process are used to determine such results as the minimum possible transfer time and the smallest possible storage capacity. Using these results as the criteria for optimum design, the synchronizing buffer is synthesized in terms of logical elements. This buffer is similar to but more complex than a shift register, a special case of the collection-distribution problem.

54. LATIN SQUARES AND MAGNETIC-CORE MATRIX STORAGE

NELSON M. BLACHMAN

By associating a magnetic core with each of the n^2 positions in a set (complete or incomplete) of orthogonal Latin squares and associating an interrogating wire with each of the n symbols appearing in each Latin square, it is possible to construct Minnick and Ashenhurst's multiple-coincidence matrix store. Each core is threaded by a multiplicity of interrogating wires in such a way that the disturbance caused in uninterrogated cores during interrogation is smaller than with the usual arrangement in which only two wires thread each core. When a complete set of orthogonal Latin squares is used, the array of cores and wires can be extended slightly to yield a configuration closely related to a finite projective geometry. Here each pair of wires threads in common one and only one core, and each pair of cores is threaded by one and only one wire. Although the multiple-coincidence system is not efficient when a large multiplicity of interrogating wires is used, a low multiplicity may be found advantageous if a sufficiently simple method can be found for selecting interrogating wires.

55. CHARACTERISTIC VALUES OF ARBITRARY MATRICES

MARK LOTKIN

Many problems arising in the applied scientific fields require the determination of the characteristic values of arbitrary matrices. A number of techniques are presently being used for the solution of this problem, and some of them seem to be satisfactory.

What is proposed here is a new method; it has been found to work quite well. It is based on the well known theorem that any matrix can be reduced to triangular form by a sequence of unitary transformations, and that in this triangular form the diagonal elements represent the characteristic values.

The principal triangle of the matrix initially possessing the lower norm is chosen for annihilation. Then a pivotal off-diagonal element in that triangle is selected, and a unitary transform is determined in such a manner as to reduce the total norm of the triangle. This process is repeated until the norm has been decreased to the desired tolerance. The convergence of this procedure has been established.

56. AN EFFICIENT FORM OF INVERSE FOR SPARSE MATRICES

WM. ORCHARD-HAYS

The inverse of a matrix need not be specified in matrix form. Whenever it is necessary to apply the inverse of a sparse matrix, i.e., one with few non-zero elements, the form of the inverse can be very important with regard to the time required to generate and apply it. A modification of the product form of the inverse — based on the elementary technique of elimination and resubstitution— has proved very effective on the JOHNNIAC computer at RAND. It is used in conjunction with a code for the simplex method. An illustrative example of this form of inverse is presented.

57. THE METHOD OF REDUCED MATRICES FOR A GENERAL TRANSPORTATION PROBLEM

PAUL S. DWYER AND BERNARD A. GALLER

A new method based on reduced matrices for finding the exact solution to the k-dimensional problem is described. Also, methods are described for finding easily good approximate solutions for the k-dimensional transportation problem. Such a solution can then be used in lieu of the exact solution or as a first feasible solution in some other method, such as the simplex method. Results from some of the runs already made on computers are included. The same program will handle either the minimization or maximization forms of the problem.

58. THE TARSKI DECISION PROCEDURE

GEORGE E. COLLINS

The Tarski decision procedure is an algorithm for deciding on the validity of any elementary statement about polynomials over the field of real numbers. Examples of such statements are given and a generalization of the procedure is described. Applications are cited, including linear and non-linear programming and approximation of analytic functions. None of the possible applications has yet been realized because of the amount of calculation required. However, computers may soon make such applications realizable. A thorough study of the procedure is being conducted using the IBM 704. Some of the methods and results of this study are described.

59. LEAKAGE ERROR IN A SEMI-DISCRETE ANALOG OF THE HEAT EQUATION

NORMAN E. FRIEDMANN

Leakage error bounds are determined for a stable semi-discrete analog replacing the linear heat equation. The results are expressed in terms of Fourier number and the number of spatial lattice subdivisions.
Methods used are applicable to the first, second and third boundary value problems, linear as well as quasi-linear. The latter case is briefly considered.

60. ON PARTIAL DIFFERENTIAL EQUATIONS WITH IRREGULAR BOUNDARIES

H. REICHENBACH

A code is being developed to handle partial differential equations which can be solved by applying the Gauss-Seidel iteration technique. It is aimed at problems where irregular boundaries or discontinuities make it difficult to use a rectangular point grid. In the present code grid points to be relaxed may be spaced in a random fashion throughout the range of an arbitrarily shaped surface or solid.

61. OPTIMUM RECURRENCE FORMULAS FOR A FOURTH ORDER PARABOLIC PARTIAL DIFFERENTIAL EQUATION

STEPHEN H. CRANDALL

The equation for the transient transverse motion of a uniform elastic beam is approximated by a family of finite difference approximations. This family contains recurrence formulas which without using more points than formulas previously used have higher-order truncation errors. The stability limits of these formulas are obtained and the discretization errors of their solutions are examined.

-END-

AUTOMATIC PROGRAMMING
(cont'd from page 11)

would be composed of instructions made up of micro-commands. A number of programmers would program instructions from microinstructions. At each level, the programmers would prescribe the routines or instructions necessary; it would be the responsibility of the next "lower" level group to fashion these tools so that they are in some sense optimum. Most likely programmers at the production level would know nothing of the activity at the microprogramming level, and vice-versa. This is nearly the case at the present time between production programmers and those programmers preparing compiling routines and the computation system. Future computation system design will largely integrate the activities of the three levels.

There seems little doubt that the degree of success of microprogramming will be primarily a function of the speed with which synthesized instructions can be executed. Five years ago, most computer people were satisfied that floating point could be performed interpretively and that the slow speeds were acceptable. As computer usage increased, it became evident that floating point operation in this fashion was much too slow, that floating point as built-in hardware was necessary. This may prove to be the experience again with microprogramming. As soon as an instruction is synthesized, used, and appreciated, users will want it included as hardware so that it will operate faster. Microprogrammed instructions must operate at speeds competitive with their permanent, wired-in counterparts or the whole technique will fall into disfavor and die of atrophy.

APPENDIX

The following is a list of desirable compiler features which the Univac Scientific Exchange (USE) organization recently adopted.

1. Compile subroutines from pseudo-instructions. A pseudo instruction requiring the use of some library subroutine would appear in the main program. The subroutine necessary to carry out the desired function would then be automatically compiled into a so-called compiled region. The line of coding which originally contained the pseudo-instruction would be replaced by the appropriate calling sequence of one or more instructions.

2. Assign cell numbers to otherwise undefined symbolic addresses. Ordinarily these cell numbers will be assigned addresses in a complied region. This feature allows easy assignment of working storage locations.

3. Use numerical constants as addresses. The compiler should be able to detect that an address section of an instruction is actually a numerical constant. The value of this number would then be stored in an otherwise unused cell in the compiled region — the address of that cell would be filled in as the appropriate address section of the instruction.

4. Symbolic addresses. The compiler should be able to accept symbolic addresses similar to those now accepted as standard for subroutines by the USE Organization. Implicit in the phrase symbolic addresses is the concept of free addressing.

5. Easy method of writing numbers. In this sense a number is a numerical constant which occupies one or more full registers and is ordinarily thought of as a number — this is in contrast to the writing of numerical addresses. It is expected that both stated point and floating point single and double precision decimal numbers will be acceptable to the compiler as well as octal numbers.

6. Ability to generate in-out routines. The thought here is that the programmer could make relatively simple specifications of the form of the numerical output which he desires and that the compiler would generate and assemble automatically the routine necessary to do the particular job specified.

7. Ability to make any type of change easily with both card and tape input. This is obviously a worthwhile and noncontroversial objective. However, the discussion showed that there may be considerable compromise necessary to work out the details of just how such generalized changes would be made.

8. Generate calling sequences. This ability of the compiler was alluded to in point number 1 above. A calling sequence may very well require more than just an RJ — the common compiler should be able to generate automatically these calling sequences in a predictable fashion.

9. Provide binary tape output. In some in-

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stallations a binary tape output may be the most common form of output, in others, it may be provided as an option. In any case the compiler should have this ability.

10. Provide symbolic side-by-side listing. Some installations have found this type of listing a most useful form of output, particularly during trouble-shooting periods. The symbolic side-by-side listing is to be contrasted with the present method at some installations where the original keypunched cards are listed on one piece of paper; subsequently a related listing showing the translated code (usually in octal) is produced on another piece of paper.

11. Detect errors during input conversion. Clearly typing or syntactical errors may be made in preparing the code and the input cards or tape. A good compiler should be able to detect such errors, make a list of them for use by the programmer, and still continue the conversion if at all possible. This then allows the programmer to study the list of errors and correct as many as possible before returning to the machine.

12. The compiler must be able to handle symbolic programs which are input on either cards or tape — in other words both forms of input must be possible and convenient.

13. Compatibility with mistake diagnostic routines. The form of the input and the provisions made for the programmers use of mistake diagnostic routines must be completely compatible. That is, information which the programmer must specify in order to diagnose coding errors, must be in a form which can be handled by the compiler and is compatible with the ordinary form of input.

14. Can incorporate USE subroutines. The compiler should be able to handle a USE subroutine unchanged from its original symbolic form and incorporate such a subroutine into the main body of a program when that symbolic subroutine is included as part of the original manuscript.

15. Identification of Output. Any material which the compiler produces as output should be completely identified as a matter of routine. For example, the symbolic side-by-side listing should be identified — this would include the programmer's name, the date if possible, program number, etc.

16. Direct input. After the compiler has completed the read-in and compiling of a program, along with any changes which might have been incorporated, the translated program will finally be stored in its operating position so that the program may be executed immediately after compilation has been completed without any intermediate steps being necessary.

17. Compatibility with operational procedures. There should be built into the compiler some provision for handling simple operational instructions having to do with the sequencing and button pushing which are necessary to complete a run on the machine. It is not intended that the inclusion of this point requires that the common compiler shall have built into it automatic operational features — rather the compiler should be planned so that when a particular installation decides that they want to incorporate automatic operational procedures, the compiler will be able to accept these changes without any major modifications.

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BOOKS AND OTHER PUBLICATIONS

(List 21; "Computers and Automation", Vol. 5, No. 11, Nov., 1956)

This is a list of books, articles, periodicals, papers, 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 of this type 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".

Holzbock, Werner G. / Instruments for Measurement and Control / Reinhold Publishing Co., 430 Park Ave., New York, N.Y. / 1955, printed, 371 pp., cost ?

This book describes and illustrates recent devices for measuring and controlling temperature, moisture, pressure, flow, uniformity, etc. In non-mathematical language, the book discusses the design, construction and operation of instruments, shows how various instruments compare with each other, and points out the factors to consider in choosing the proper instrument for a particular job. Fully covered are various process variables and the commercially available instruments for their measurement; analytical process instrumentation; devices used in controller actions; and such final control elements as valves, pumps, transformers and motors. A last chapter entitled "Trends" discusses the development of centralized systems, miniaturization, and digital computers. There is a glossary, pp. 359-362.

Leidesdorf, Samuel D. / "Electronics in the Small Office" in the "Journal of Machine Accounting Systems and Management" / National Machine Accountants Association, 6109 N. Karlov, Chicago 30, Ill. / June 1956, vol. 7 no. 6, printed, pp. 39-40, $2.50 per year.

(Review by Ned Chapin)

This general article has nothing new to say but it covers familiar ground rather well. The author addresses himself to four problem areas as follows: 1. "Is our business large enough to justify the use of electronic equipment?" (The author sidesteps a direct answer by pointing to the development of small-size computers); 2. "If we decide to install such equipment, how will the saving compare with the cost?" (The author says one should look not only at costs but also at benefits); 3. "What are the advantages (and disadvantages) of having electronic equipment?" (The author points to better and more timely information as a possible advantage, and to the large financial outlay necessary to acquire and install a computer as a possible disadvantage); 4. "If we decide to investigate the use of electronic equipment, how do we go about this?" (The author suggests a sound procedure and does not overlook the place of consultants; he heads his own consulting firm). This article originally appeared in the January 1956 issue of Credit and Financial Management.

Haskins and Sells / Data Processing by Electronics / Haskins and Sells, New York, N.Y. (with offices in other cities) / 1955, printed, 113 pp., free on request

(Review by Ned Chapin)

This book, published by a public accounting firm for the benefit of its clients and prospective clients, presents an overview of some aspects of the use of computers in business. The general tone of the book reminds one of some large manufacturers' programming courses for business people. The first 20 pages of the book are entitled "A General Description of Electronic Data-Processing Systems and the Factors Involved in Considering Their Use". Four pages are devoted to a rather general comparison of manual, punched card, and computer methods of data processing in business. Then three pages are devoted to defining and introducing computer terms. This is followed by three pages devoted to introducing programming, summarized with the not very enlightening statement ".... programming is planning..." Ten pages are then devoted to "Preparing for the Electronic System". This part covers briefly such topics as organization planning, integrated data processing, inflexibilities, costs, etc.

The second part of the book covering 32 pages is entitled "Basic Theory, Systems Components, and Techniques in Application". The first nine pages introduce binary notation and the necessity for programming a computer. The treatment here is reminiscent of that in a widely seen film put out by another accounting management firm. The next fourteen pages introduce computer units, devices, and components, such as arithmetic unit, magnetic cores, buffers, flip-flops, etc. The subsequent six pages are devoted to an example of program-

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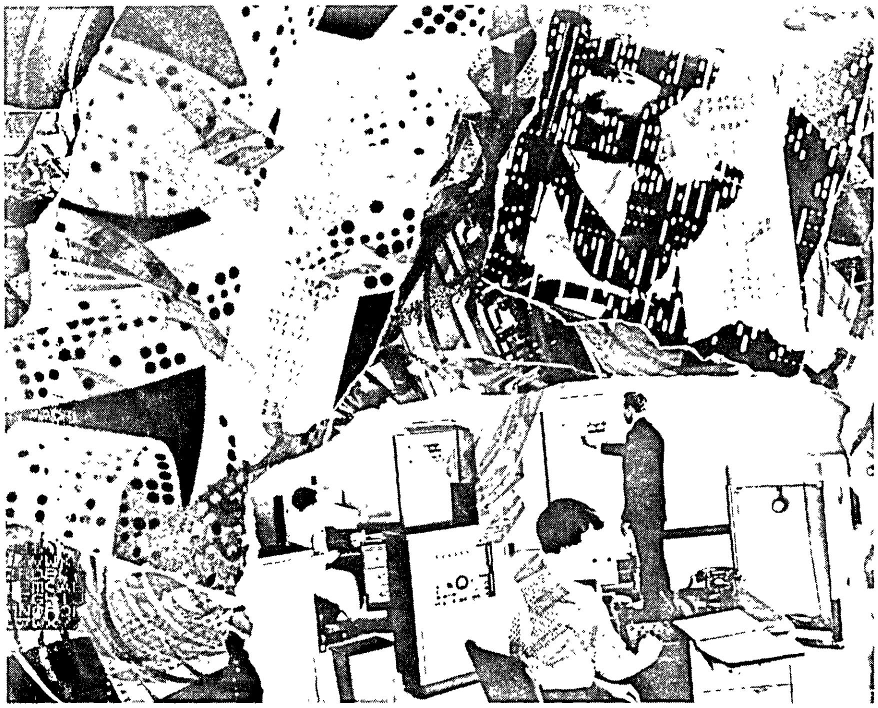

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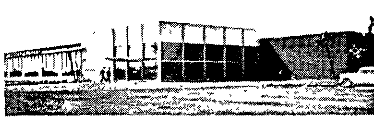

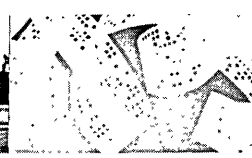

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NEW PATENTS

RAYMOND R. SKOLNICK, Reg. Patent Agent
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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.

June 12, 1956 (cont'd): 2,750,114 / Loring P. Crosman, Darien, Conn. / Sperry Rand Corp., Dél. / A reversible accumulator for accumulating digit values by addition or subtraction.

2,750,457 / Edward D. Padgett, Haddonfield, N.J. / U.S.A. / An amplifier for a pulse wave having a very low repetition rate.

2,750,500 / William Ross Aiken, Berkeley, Calif., / U.S.A. / A linear pulse integrator.

2,750,584 / Lester I. Goldfischer, Queens Village, N.Y. / General Precision Lab., Inc., N.Y. / An analog to digital converter.

June 19, 1956: 2,751,149 / Earle A. Young and Harold F. Bennett, Rochester, N.Y. / Eastman Kodak Co., Rochester, N.Y. / A digital computer for computing square roots by subtracting successive odd numbers.

2,751,448 / Harold Andrew Timken Jr., and Frederick Clark Lancor, Silver Spring, Md./ Vitro Corp. of America, Verona, N.J. / A programming device.

2,751,536 / Lester E. Lundquist, Jr., Dayton, Ohio / U.S.A. / A servo system adapted for weak signal recording.

June 26, 1956: 2,752,093 / George L. Bush, Flushing, and John W. Cornwell, Syosset, N.Y. / The Teleregister Corp., New York, N.Y. / An indicator device and analog computer circuit.

2,752,507 / Gabriel Henry Leon Dureau, Le Perreux, Fr. / Societe Alsacienne de Constructions Mecaniques, Paris, Fr. / A device for decoding of coded electric pulses.

2,752,569 / Cyril Gordon Treadwell, London, Eng. / International Standard Electric Corp., New York, N.Y. / An electric pulse code modulation system.

July 3, 1956: 2,753,498 / John W. Gray, Chappaqua, N.Y. / General Precision Laboratory, Inc., N.Y. / A cyclic function modifying circuit.

2,753,500 / Carlo L. Calosi, Rome, Italy / Raytheon Manufacturing Co., Waltham, Mass. / An electronic position and motion control system.

2,753,505 / John J. Larew, Scotia, and Kenneth N. Burnett, Schenectady, N.Y. / General Electric Co., N.Y. / A servomechanism.

2,753,527 / Robert Adler, Northfield, Ill./Zenith Radio Corp., Ill. / An electromechanical pulse storage line.

2,753,545 / George E. Lund, Havertown, Pa. / Burroughs Corp., Detroit, Mich. / A two-element per bit shift register requiring a single advance pulse.

2,753,547 / Erwin Donath and William S. Knowles, Princeton, N.J. / Applied Science Corp. of Princeton, N.J. / An apparatus for transferring data from a first to a second position wherein the transfer path includes a component having a variable linear transfer characteristic.

July 10, 1956: 2,754,053 / Wilfred H. Howe, Sharon, and William E. Vannak, Foxboro, Mass. / Foxboro Co., Foxboro, Mass. / A pneumatic computing system.

2,754,054 / William H.T. Helmig, Leiden, and Theodorus Reumerman, Zandvoort, Netherlands / - / A device for determining a check symbol for a symbol group.

2,754,055 / Arthur F. Naylor, Haddonfield, N.J. / U.S.A. / A navigation computer.

2,754,056 / Herbert Friedman, Arlington, Va. / - / A pulse rate counter.

2,754,057 / William H. Stahl, Middlebury, Conn. / The Bristol Co., Waterbury, Conn. / A reverse-flow integrating apparatus.

2,754,058 / George A. Crowther, Manhasset, N.Y. / Sperry Rand Corp., Del. / A mechanism for controlling the aiming of ordnance.

2,754,059 / Dwight D. Wilcox, Jr., Rochester, N.Y. / U.S.A. / An electronic differential digital computer.

2,754,418 / Alfred Bennett, New York, N.Y. and John C. Owen, Palisades Park, N.J. / Bendix Aviation Corp., Teterboro, N.J. / A control circuit for a servo system.

2,754,420 / Stanley Ratcliffe, Great Malvern, Eng. / National Research Development Corp., London, Eng. / An automatic frequency control system.

2,754,421 / Harris A. Robinson, Philadelphia, Pa. / U.S.A. / A frequency control system.

2,754,502 / Arthur H. Dickinson, Greenwich, Conn. / International Business Machines Corp., New York, N.Y. / A data processing machine.

2,754,503 / G. Donald Forbes, Sudbury, Mass. / Arthur D. Little, Inc., Cambridge, Mass. / A digital reading apparatus

July 17, 1956: 2,755,021 / Ernest W. Silvertooth, La Crescenta, Calif. / Librascope, Inc., Glendale, Calif. / An analog computer for

(cont'd on page 42)

BACK COPIES

REFERENCE INFORMATION: (with notes regarding latest issues containing same)

Organizations:
Roster of Organizations in the Computer Field (June, 1956)
Roster of Computing Services (June 1956)
Roster of Consulting Services (June 1956)
Computing Machinery and Automation:
Types of Automatic Computing Machinery (Dec. 1955)
Roster of Automatic Computers (June, 1956)
Outstanding Examples of Automation (July 1954)
Commercial Automatic Computers (Dec. 1954)
Types of Components of Automatic Computing Machinery (March 1955)
Products and Services in the Computer Field:
Products and Services for Sale or Rent (June 1956)
Classes of Products and Services (June 1956)
Words and Terms:
Glossary of Terms and Expressions in the Computer Field (Oct. 1956)
Information and Publications:
Books and Other Publications (many issues)
New Patents (nearly every issue)
Roster of Magazines (Dec. 1955)
Titles and Abstracts of Papers Given at Meetings (many issues)
People:
Who's Who in the Computer Field (June, 1955, and later issues)

BACK COPY PRICES: If available, $1.25 each, except June 1955, $4.00, and June 1956 $6.00 (the June issue is the Computer Directory issue).

----------Mail this Request----------
or a copy of It

To: Berkeley Enterprises
815 Washington St., R182
Newtonville 60, Mass.

Please send me the following back copies ____________________

____

I enclose $ ______ in full payment.
My name: ____________________
My address: ____________________

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NEW PATENTS

(cont'd from page 42)

simultaneous equations.

2,755,023 / Benjamin Cooper, New York, N.Y., and Albert F. Hohmann, Teaneck, N.J. / Benjamin Cooper, New York, N.Y. / A sensing device.

2,755,381 / Eugene L. Woodcock, Levittown, N.Y. / Sperry Rand Corp., Del. / A delay line trigger circuit.

July 24, 1956: 2,755,994 / Frederic C. Williams, Timperley, and Tom Kilburn, Manchester, Eng. / National Research Development Corp., London, Eng. / An electronic digital computing device.

2,755,996 / Frederic C. Williams, Timperley, Tom Kilburn, Manchester, and Eric Roberts Laithwaite, Kirkham, Eng. / National Research Development Corp., London, Eng. / A digital data storage system.

July 31, 1956: 2,756,934 / Garrett F. Ziffer, Cambridge, Mass. / Tracerlab, Inc., Boston, Mass. / An electronic counter.

August 7, 1956: 2,757,604 / William F. W. Von Glahn, Valley Stream, N.Y. / Burroughs Corp., Detroit, Mich. / A decoding and character forming means for high speed recorder.

2,757,863 / John Stewart, Hollinwood, Eng. / Ferrante Limited, Hollinwood, Eng. / A navigational computer.

2,757,864 / Brian Watson Pollard and Raymond Stuart-Williams, Hollinwood, Lancashire, Eng. / National Research Development Corp., London, Eng. / An information translating apparatus.

August 14, 1956: 2,758,786 / Raymond H. Lazinski, New York, N.Y. / - / A departmental program analyzer machine.

2,758,787 / Jean H. Felker, Livingston, N.J. / Bell Telephone Lab., Inc., New York, N.Y. / A serial binary digital multiplier.

2,758,788 / Robert E. Yaeger, Califon, N.J. / Bell Telephone Lab., Inc., New York, N.Y. / A binary code translator, adder and register.

2,759,135 / Harold D. Albrecht, Collingswood, Robert W. Harralson, Burlington, and Rodger H. Fricke, Haddonfield, N.J. / Radio Corp. of America, Del. / A servo system with feedback control.

2,759,157 / Thomas H. Wiancko, Altadena, Calif. / - / An angular accelerometer.

August 21, 1956: 2,759,784 / Harry E. Burke, Pasadena, Calif. / Consolidated Electrodynamics Corp., Pasadena, Calif. / A decimal-digital recording system.

2,760,006 / Leonard Lieberman, New York, N.Y. / - / Modulation of intelligence signals.

2,760,063 / Dallas R. Andrews, Collingswood, N.J. / Radio Corp. of America, Del. / A magnetic pulse recorder.

2,760,064 / Persa R. Bell, Oak Ridge, Tenn. / U.S.A. / A pulse analyzer for determining pulse-height distribution

2,760,085 / Robert I. Van Nice, Glenshaw, Pa. / Westinghouse Electric Corp., E. Pittsburgh, Pa. / A flip-flop circuit element for a control system.

2,760,087 / Jean H. Felker, Livingston, N.J. / Bell Telephone Lab., Inc., New York, N.Y. / A transistor memory circuit.

2,760,130 / Duane A. Carney, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Iowa / A differential servo control.

-END-

Page 1
Form 3526
Rev. 8-60

Read the instructions on page 2 of this form.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

Computers and Automation (Insert exact title of publication) published monthly (State exact frequency of issue)
at New York, N.Y. (Name of post office and State where publication has second-class entry) for ...., 19.....

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

	Name	Address
Publisher	Berkeley Enterprises, Inc., 815 Washington St., Newtonville 60, Mass.	
Editor	Edmund C. Berkeley, 34 Otis St., Newtonville 60, Mass.	
Managing editor	same	
Business manager	same	

2. The owner is (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

Name / Address

Berkeley Enterprises, Inc., 815 Washington St., Newtonville 60, Mass.
Edmund C. Berkeley, 34 Otis St., Newtonville 60, Mass.
W.L. Mandel, P.O. Box 29, New York 10, N.Y.
M.S. Weinstein, 83 Melrose Ave., Albany 3, N.Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state)

Name / Address

none

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.) xxx

Edmund C. Berkeley
(Signature of editor, publisher, business manager, or owner)

Sworn to and subscribed before me this 5th day of October, 1956

[SEAL]

George W. [illegible]

(My commission expires Mar 17, 19[illegible])

16—18730-6

MANUSCRIPTS

We are interested in articles, papers, reference information, science fiction, and discussion relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the fifth 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 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. 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.

Reference Information. We desire to print or reprint reference information: lists, rosters, abstracts, bibliographies, etc., of use to computer people. We are interested in making arrangements for systematic publication from time to time of such information, with other people besides our own staff. Anyone who would like to take the responsibility for a type of reference information should write us.

Fiction. We desire to print or reprint fiction which explores scientific ideas and possibilities about computing machinery, robots, cybernetics, automation, etc., and their implications, and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words.

Discussion. We desire to print in "Forum" brief discussions, arguments, announcements, news, letters, descriptions of remarkable new developments, etc., anything likely to be of substantial interest to computer people.

(cont'd on page 46)

BOOKS
(cont'd from page 38)

ming of part of a payroll application. The last five pages of the section are devoted to explaining a diagram of a more complete payroll application.

The book has a good Appendix describing computers, which was reprinted in the Controllers Foundation Electronics in Business. This Appendix covers 46 pages and includes information on the following computers: Datamatic 1000, Datatron 204, IBM-650, IBM-702, IBM-705, Miniac, Monrobot-MU, CRC-102D, NCR-303, Bizmac, UNIVAC I, UNIVAC II, Univac File, and Elecom 125. These computer descriptions, though perhaps not the best that have been published, are good. In fact, this Appendix appears to be the main strength and worth of the book. The first sections of the book are not very well organized and rather superficial, even for someone just entering the field.

The Principles of Computer Simulation (outside title); Principles of Computer Simulators: Theory, Maintenance (inside title) / Dept. of the Navy, Office of Naval Research, Special Devices Center, distributed by the U. S. Dept. of Commerce, Office of Technical Services, Washington, D. C. / 1955, photo offset, 150 pp., $3.00

An important and valuable reference book, written simply, covering analog computers for modern simulators such as aircraft and submarine trainers. The book covers rudiments common to all analog-computer simulators. Because of the prevalence of Operational Flight Trainers in the field of trainers, most examples treated refer to this type of simulator. General principles as well as specific components of computers are discussed. An excellent chapter is included on mathematical methods used for solving equations. The book is amply illustrated. The titles of the seven chapters are: The Analog Computer Simulator; Mathematics and Motion; Computer Servomechanisms; Vacuum Tube Circuits in Analog Computers; Mathematical Operations with Computers; Components; Maintenance.

Pieper, A. G., and R. Q. Tillman / Sonar Digital Recorder: Digiter / Naval Research Lab., distributed by the U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. / 1956, printed, 8 pp., $0.50

A report on the final development of a logarithmic voltmeter and printer which has been designed to print automatically the acoustic level of a sonar signal in decibels, accurate to ±0.2 db and having a dynamic range of 50 db. The system is expected to be found useful in other applications as well as sonar.

Beggs, Joseph Stiles / Mechanism / McGraw Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1955, printed, 418 pp., $6.50

An interesting advanced text on mechanism, including gears, cams, linkages, links, computing mechanisms, the control of mechanisms, etc. It is devoted especially to kinematics, rather than to specific design of mechanisms. The text makes every effort to give the student a thorough background in the kinematics of gears, cams, rotary drives, linkages, etc. An excellent mechanism bibliography is included, also an excellent "Repertory of Mechanisms", alphabetically arranged illustrations of mechanical movements by the type of motion they produce. Both the practising design engineer and the student will find this a reference book for the analysis of mechanism and a source of mechanical movements.

Richtmyer, F. K., E. H. Kennard and T. Lauritsen / Introduction to Modern Physics, New Fifth Edition / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1955, printed, 666 pp., $8.50

A fascinating report and an excellent textbook (assuming calculus) on 20th century physics, brought up-to-date. Titles of Chapters: Historical Sketch; The Theory of Relativity; Electrons and the Photoelectric Effect; The Origin of the Quantum Theory; The Nuclear Atom and the Origin of the Spectral Lines; Wave Mechanics; Atomic Structure and Optical Spectra; X-Rays; Wave Mechanics of Matter in Bulk; The Nucleus; Cosmic Rays and Fundamental Particles.

Management Methods, Editors / Workshop for Management, 1956 Edition, Proceedings of the Eighth Annual Systems Meeting / Management Publishing Corp., 23 West Putnam Ave., Greenwich, Conn. / 1956, printed, 499 pp, $19.00, may be ordered on approval.

(Review by Ned Chapin)

Part of this edited and handsomely presented transcript is of significant interest to readers of Computers and Automation. Pages 23 to 258 are devoted to general business systems topics, such as work measurement, procedure writing, etc. Pages 259 to 395 are devoted to the use of computers in business, and pages 396 to 482 are devoted to an introduction to operations research (management science). A complete listing of the articles of interest follows:

James W. Smith, Peter Laubach, E. P. Little, F. P. Di Blasi, Norman J. Ream / Organizing for an electronics survey / pp. 259-291. —An excellent general summary of the investigation stage of the application of the computer in business.

Saul Rosen, Gerald Licht / A survey of general purpose electronic computers for data processing / pp. 292-299. —A non-technical and very general summary of some of the more popular,

(cont'd on page 46)

BOOKS
(cont'd from page 44)

available computers.

Arvid Jacobson / Training personnel for electronic applications to business problems / pp. 300-303. —A plea for the universities to take a more active role in meeting businesses' needs for computer personnel.

R. M. Gilmore Jr / Experience in installing a large-scale electronic computer / pp. 304-314. —A review of Chrysler's experience with the IBM 702.

John J. Finelli / A magnetic tape electronic data processing system / pp. 315-323. —Some comments on the UNIVAC I installation at Metropolitan Life Insurance Co.

V. C. Wilson, F. Walton Wanner / Application of EDP to production planning, and material control / pp. 324-353. —A discussion of what International Harvester hopes to do with their IBM 702 in Chicago.

Rolla R. Ross / Application of electronic data processing to billing and accounting / pp. 354-360. —A more integrated approach is necessary when a computer is to be used.

Ralph C. McCollum / Application of electronic data processing to billing and accounting in a public utility / pp. 361-373. —An example of an elaborate approach to using computers in business.

D. L. Barlow, Frank A. Gring, Herbert A. Grigg, Mr. Peterson, Mr. Reynolds, J. Henry McCall, Thomas G. Rizzo / Integrated data processing / pp. 374-395. —Brief summaries of the experience of Alcoa, Port of New York Authority, and American Smelting and Refining Co.

Paynter, Henry M., editor / A Palimpsest on the Electronic Analog Art / George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass./ 1955, printed, 270 pp., $1.00

(Review by Edith Taunton)

A very useful collection of 35 papers by many authors, most reprinted, and commentaries, giving introductory and fundamental information concerning electronic analog computers. Includes commentaries, methodology, and descriptions of analog computers and their applications.

Ferranti, Ltd., hosts / Conference on Linear Programming, May, 1954 / Ferranti, Ltd., 21 Portland Place, London, W 1, England / 1954, mimeographed, 92 pp., free on request

Includes six papers on linear programming theory, methodology and application, by G. P. M. Heselden, A. Land, G. Morton, J. A. C. Brown, E. M. L. Beale, D. G. Prinz, and others given at a conference organized by Ferranti, and held in London on May 4, 1954.

National Simulation Conference / Proceedings, National Simulation Conference, Jan. 19, 20, 21, 1956, Dallas, Texas / Department of Electrical Engineering, Southern Methodist University, Dallas, Tex. /1956, photo offset, app. 212 pp., $5.00

Contains 35 papers presented at the National Simulation Conference, January, 1956, Dallas, Texas. Titles of papers include: "Simulation of Military Vehicle Suspension Systems"; "Application of GEDA Analog Computers to Study Temperature Transients in a Plastic Windshield"; "The Simulation of a Proposed Airborne Digital Computer on the IBM 701". Contains illustrative diagrams, tables, and photographs.

Institution of Production Engineers / The Automatic Factory — What Does It Mean? Report of the Conference, Margate, June, 1955 / Institution of Production Engineers, 10 Chesterfield St., London, W1, England / June, 1955, printed, 228 pp, cost?

(Review by Edith Taunton)

A report of a conference held at Margate, June 16 to 19, 1955, to discuss automation. Contains 21 interesting and informative reports and discussions on the automatic factory, the automatic office, computer-controlled machine tools, etc.; also a description of the automation exhibits displayed at the conference.

-END-

MANUSCRIPTS
(cont'd from page 43)

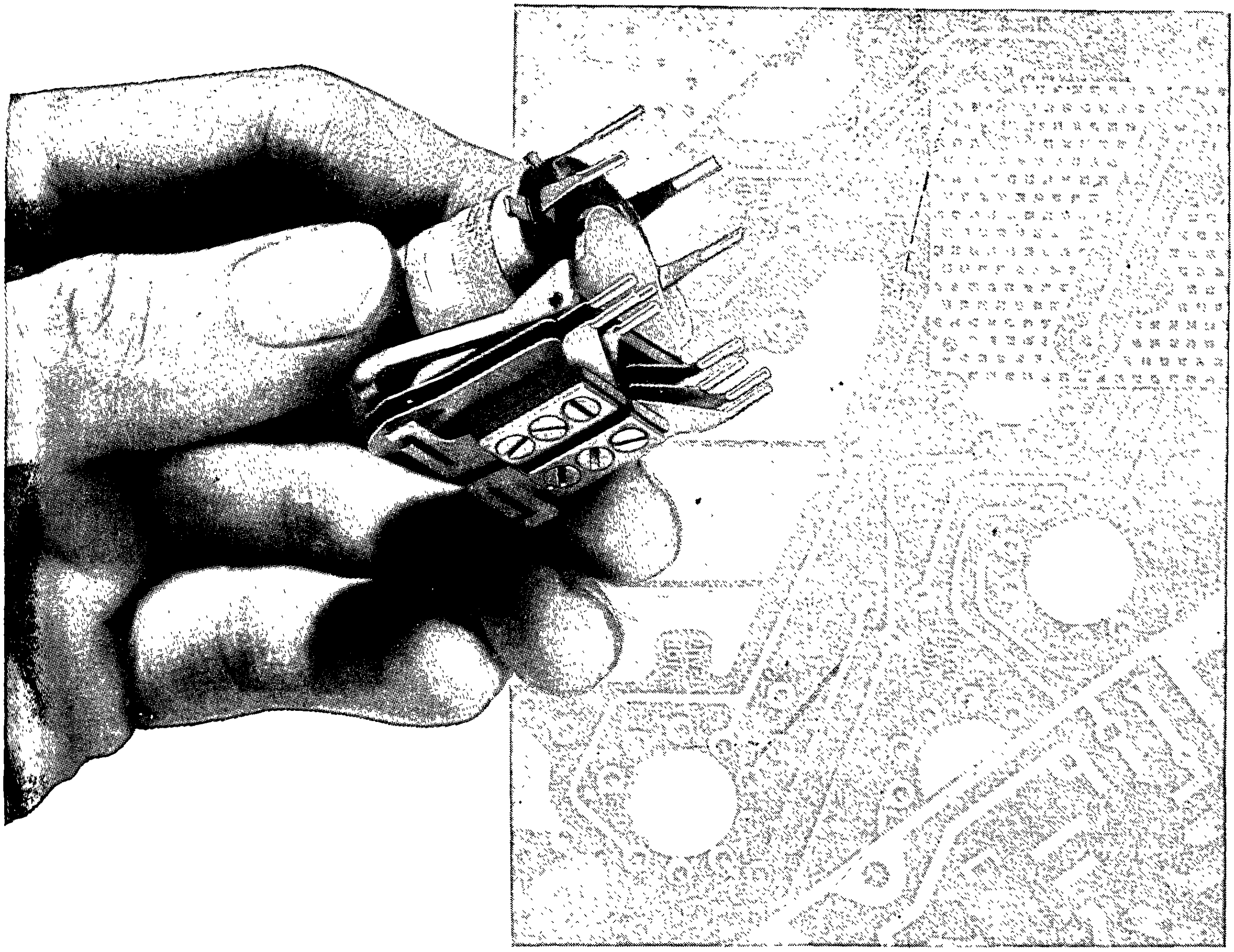
<u>Payments.</u> In many cases, we make small token payments for articles, papers, and fiction, if the author wishes to be paid. The rate is ordinarily ½¢ a word, the maximum is $20, and both depend on length in words, whether printed before, whether article or paper, etc.

- END -

SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The June issue of "Computers and Automation" in each year commencing with 1955 is a special issue of "The Computer Directory" containing a cumulative "Roster of Organizations", and a cumulative "Roster of Products and Services in the Computer Field", and other reference information.

In the autumn of 1956 we shall publish Edition No. 2 of a cumulative "Who's Who in the Computer Field", as an extra number of "Computers and Automation".



NOW!

dependable relays for printed circuits

Maybe you, too, have been awaiting availability of a *good* relay for direct insertion into printed circuits. Now Automatic Electric can solve your problem with a miniature relay that is just right.

120 million operations, without a single readjustment or relubrication! That's what you get from this rugged, improved Series SQPC Relay, because it features a special *heavy-duty* bearing and bearing pin. Also a recess in the bearing plate retains an adequate supply of lubricant for long-term lubrication of the bearing pin.

Consider these additional advantages:

1. The sections of the terminals that insert into the printed circuit board are NOT brazed or welded into place, but are integral parts of the coil terminals and contact springs—thus preventing internal loss in conductivity or continuity.
2. Terminal design permits direct plug-in of the relay into a printed circuit board, ready to be secured in place with any acceptable soldering technique.

Usually the desired contact spring combination, or pile-up, is sufficiently large so that additional mounting (support) of the relay is not necessary.

SQPC Miniature Printed Circuit Relays are available with many different contact spring arrangements, and for a multitude of applications. Springs can be made of phosphor-bronze, "Bronco" metal, or other special-purpose materials, as required.

Of course the long life, heavy-duty features of the improved SQPC Relay can be had in the conventional type of plug-in relay, if regular sockets are preferred for use, whether in printed circuitry or other applications.

To get complete details, write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Illinois. *In Canada:* Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC

Originators of the dial telephone • Pioneers in automatic control

GENERAL SYSTEM

POWER OF COMPUTER
(cont'd from page 17)

got tired of the business. Even the authors of serious textbooks on cybernetics have begun to draw startling parallels between the functioning of their new toys and the behavior of the human brain.

Of course the parallel is there, but why should it occasion surprise? If a man designs a machine to take over some of his functions is it surprising that its characteristics should be anthropomorphic? For years we have used the contour map of a soap bubble to tell us the torsional stress distribution in irregular shafts; and the same equations turn up in the most unexpected places in every field of physical science. Surely it should be obvious that all knowledge is one, and that there is a guiding principle which makes it so.

LIFE MORE PLEASANT

The future of our civilization stretches invitingly before us, and there is room to spare for computers of ever increasing scope and power to help us in our search for knowledge and progress. But there is surely no need for concern that our machines will be capable of many things which man's unaided efforts could not accomplish. The same thing may be said of a hammer or a scissors, or any of the million devices which man's ingenuity has created to make his task less heavy and his life more pleasant.

We have created in the new computers impressive and sometimes awe-inspring tools; but no automatic device can evaluate, electronically or otherwise, the nuances which the human brain juggles and sorts continuously during its life span. We are completely ignorant of the input signals which man's brain automatically uses; and until we can specify them precisely we cannot introduce them to our tools.

There is a sobering bit of advice in one of Kipling's works which summarizes better than I can what this short talk has been trying to say. It is the conclusion of his poem, "The Secret of the Machines":

"But remember, please, the law by which
we live;
We are not built to comprehend a lie;
We can neither love, nor pity, nor forgive;
If you make a slip in handling us, you die!
We are greater than the peoples or the
kings;
Be humble, as you crawl beneath our rods;
Our touch can alter all created things;
We are everything on earth — except the
gods.

Though our smoke may hide the heavens
from your eyes
It will vanish, and the stars will shine again;
Because for all our power and weight and
size
We are nothing but the children of your brain."

-END-

WHO'S WHO ENTRY FORM

"Computers and Automation" publishes from time to time a Who's Who or roster of individuals interested in the computer field. Edition No. 1 of a cumulative Who's Who appeared in the June 1955 issue of "Computers and Automation". During the autumn of 1956 we plan to publish an extra number (not included in the subscription) of "Computers and Automation", which will be over 100 pages long, and will consist of Edition No. 2 of a cumulative "Who's Who in the Computer Field".

If you are interested in computers and desire to have your entry appear (at no cost to you), following is the form of entry. To avoid tearing the magazine, the form may be copied on any piece of paper:

1. Name (please print)____________________

2. Your Address?____________________

3. Your Organization?____________________

4. Its Address?____________________

5. Your Title?____________________

6. YOUR MAIN COMPUTER INTERESTS?

( ) Applications ( ) Mathematics
( ) Business ( ) Programming
( ) Construction ( ) Sales
( ) Design ( ) Other (specify)
( ) Electronics
( ) Logic ____________________

____

7. Year of Birth?____________________

8. College or last school?____________________

9. Year entered the computer field?________

10. Occupation?____________________

11. Anything else? (publications, distinctions, etc.____________________

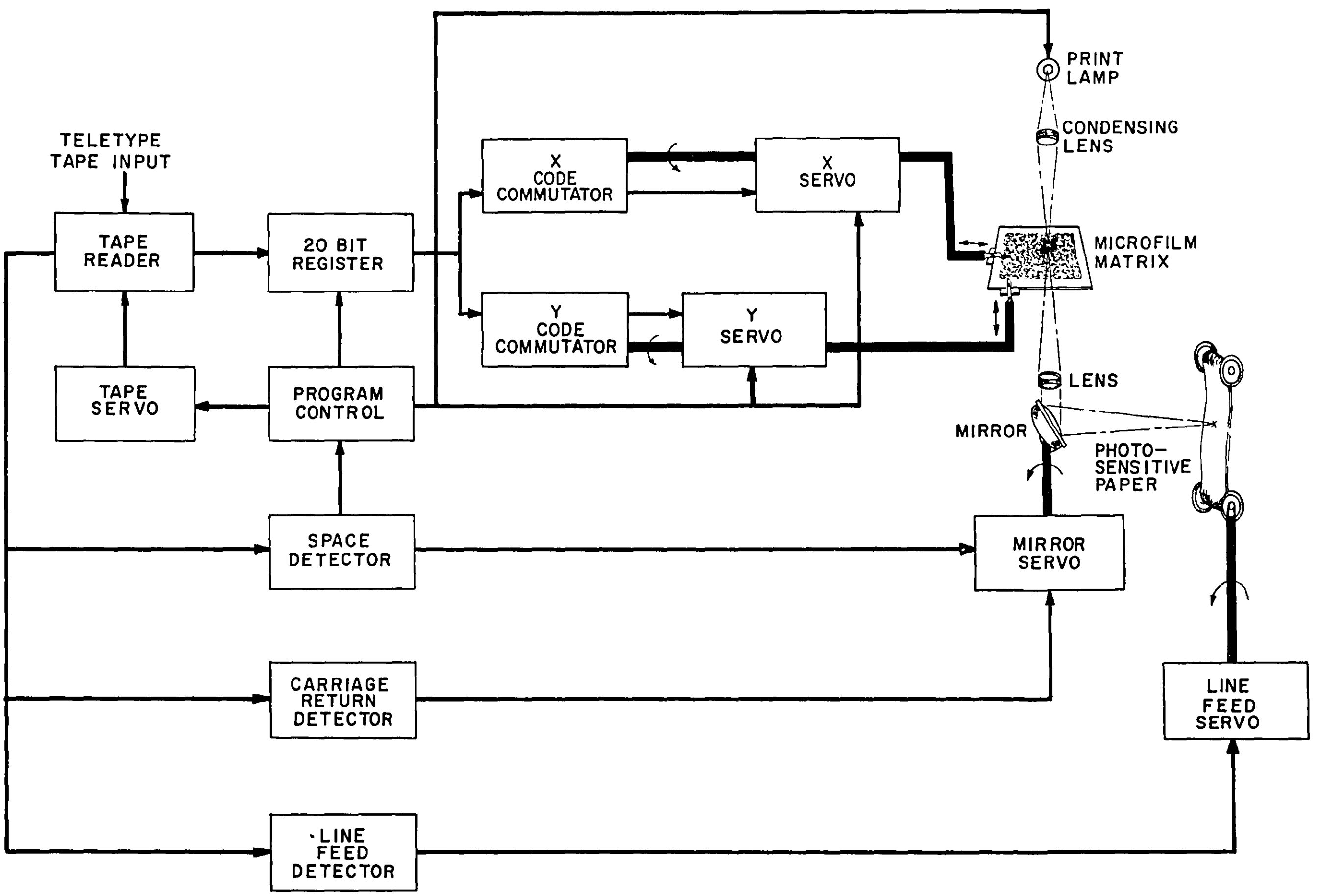
____

MICRO-IMAGE FILE
(cont'd from page 27)

performs a function similar to the character spacing on a typewriter: it automatically advances the image one space on the photographic paper for each printout. Upon completion of a line, a line-feed servo advances the paper a fixed amount.

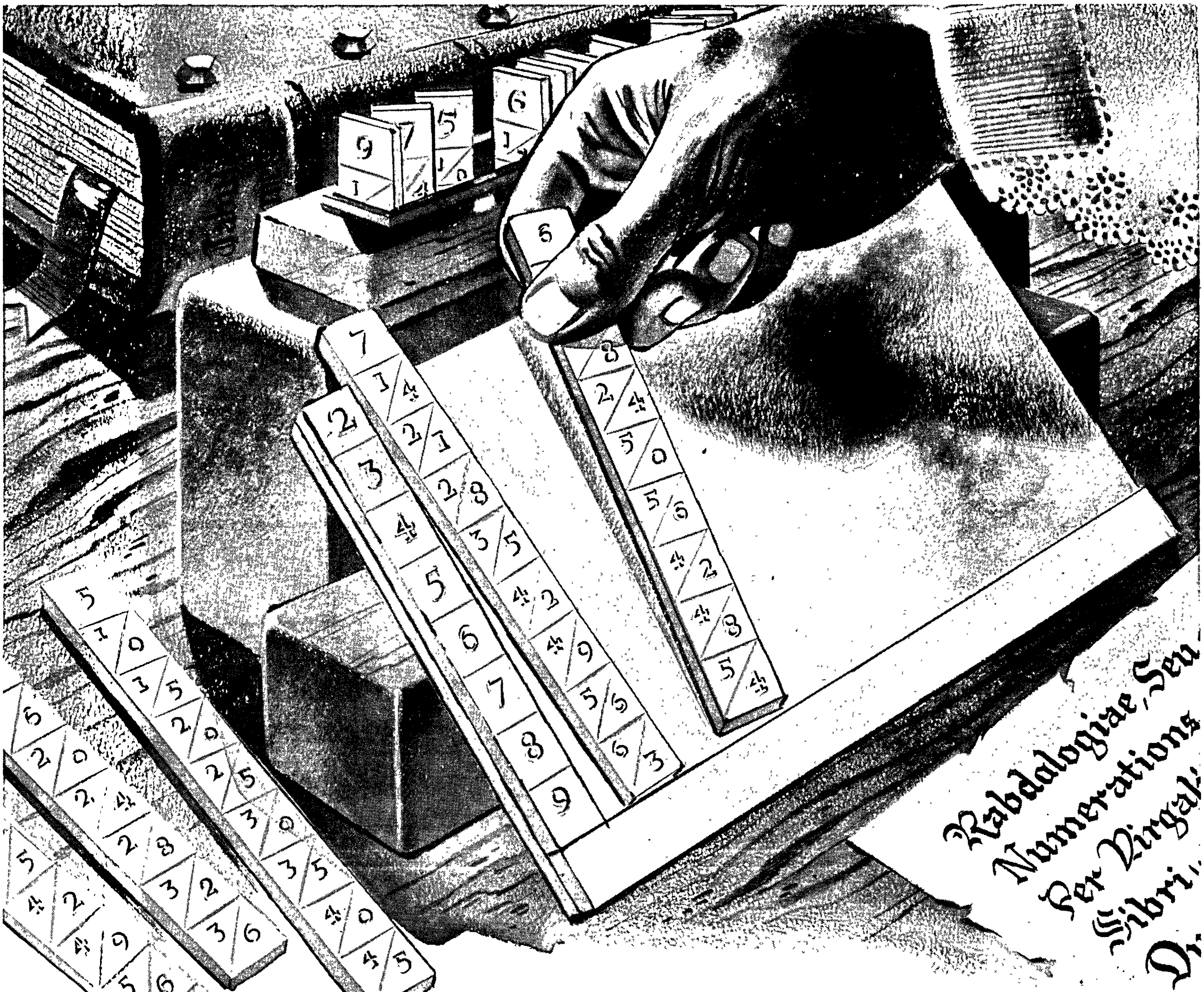
The instrument recognizes two other symbols, the "carriage return" and the "line feed." These symbols instruct the machine to return the step positioning mirror to its zero position, and to advance the paper one line. Whenever these functions are desired, they can be inserted into the teletype tape.

Although the machine was primarily designed as an outscriber for obtaining programmed printing from a large file of negatives, it can temporarily be set up as an inscriber to prepare its own matrices of 10,000 frames each. Using the same machine to prepare a matrix insures that each frame will be accurately located whenever it is subsequently used.



DIGITAL AUTOMATIC MICROFILM SELECTOR AND PRINTER

-END-



ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
815 Washington St., Newtonville 60, Mass.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles, papers, and reference information related to computing machinery, robots, automatic control, 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 $5.50 a year in the United States. Single copies are $1.25, except the June issue, "The Computer Directory", (1956, $6.00; 1955, $4.00). For the titles of articles and papers in recent issues of the magazine, see the "Back Copies" page in this issue.

2. What is the circulation? The circulation includes 2400 subscribers, (as of August 10); over 300 purchasers of individual back copies; and an estimated 3000 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are 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 August issue was 2800 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.

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. We reserve the right not to accept advertising that does not meet our standards.

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8 1/2" x 11" (ad size, 7" x 10") 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.

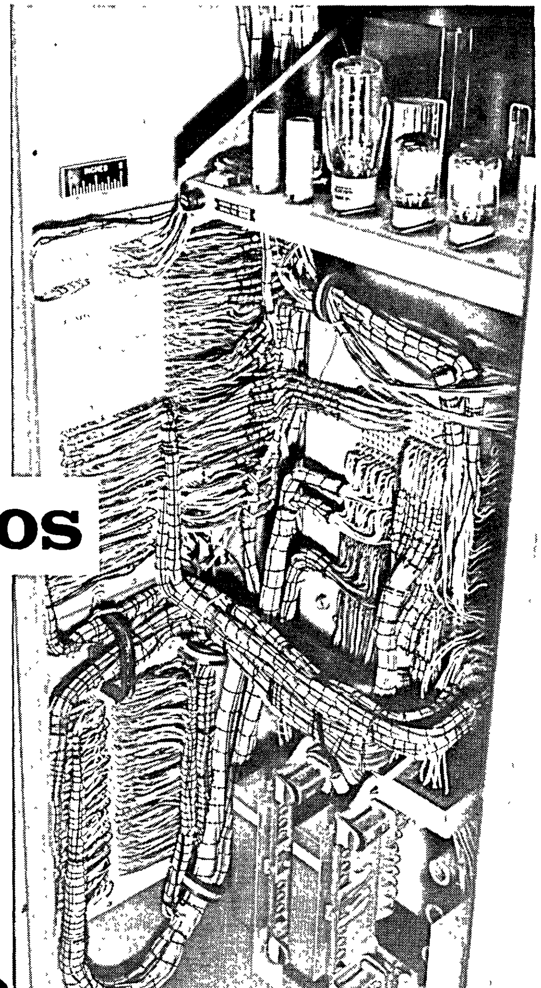
Display advertising is sold in units of a full page (ad size 7" x 10", basic rate, $190) two-thirds page (basic rate, $145), half page (basic rate, $97), and quarter page (basic rate, $55); back cover, $370; inside front or back cover, $230. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $320; four-page printed insert (two sheets), $590. Classified advertising is sold by the word (60 cents a word) with a minimum of 20 words.

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

Aircraft-Marine Products, Inc.
American Bosch Corp.
Ampex Corp.
Armour Research Found.
Arnold Engineering Co.
Automatic Electric Co.
Bendix Aviation Corp.
Bryant Chucking Grinder Co.
Cambridge Thermionic
Epsco, Inc.
Ferranti Electric Co.
Ferroxcube Corp.
General Electric Co.
Hughes Research and Development Lab.
International Business Machines Corp.
Lockheed Aircraft Corp.
Lockheed Missile Systems
The Glenn L. Martin Co.
Monrobot Corp.
Norden-Ketay Corp.
Northrop Aircraft Inc.
George A. Philbrick Researches, Inc.
Potter Instrument Co.
Ramo-Wooldridge Corp.
R. C. A. Service Co.
Reeves Instrument Co.
Remington Rand, Inc.
Republic Aviation Corp.
Sprague Electric Co.
Sylvania Electric Products, Inc.

Amp's Creative Approach
TO BETTER WIRING

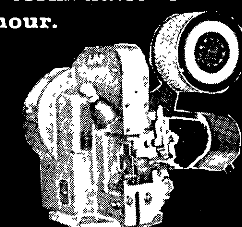
Order out of Chaos



For today's intricate circuitry, A-MP's "Taper Technique"—with or without programming boards—makes possible the greatest number of orderly connections in the smallest space.

See your nearest A-MP representative or write the General Office.

A-MP's Automatic Crimping Machine produces up to 4,000 finished Taper terminations per hour.



Aircraft-Marine Products, Inc.
GENERAL OFFICE: HARRISBURG, PA.

A-MP

A-MP of Canada, Ltd., Toronto, Canada
A-MP-Holland N.V., 's-Hertogenbosch, Holland
Aircraft-Marine Products (G.B.) Ltd., London, England
Societe A-MP de France, Courbevoie, Seine, France

Photo courtesy of National Advisory Committee for Aeronautics

ADVERTISING INDEX

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?

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).

READER'S INQUIRY

If you wish more information about any products or services mentioned in one or more of these advertisements, you may circle the appropriate CA Nos. 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.

READER'S INQUIRY FORM

Paste label on envelope: ↓

Enclose form in envelope: ↓

BUSINESS REPLY LABEL

NO POSTAGE STAMP NECESSARY IF MAILED IN U.S.A.

4¢ Postage Will Be Paid By --

BERKELEY ENTERPRISES, INC.
38 East 1st Street
New York 3, N.Y.

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

READER'S INQUIRY FORM

Name (please print)

Your Address?

Your Organization?

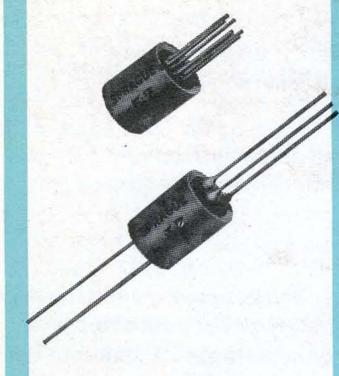
Its Address?

Your Title?

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

REMARKS:



ACTUAL SIZE

a new complete line of

subminiature pulse transformers

Take maximum advantage of available space on crowded wiring boards and in crammed chassis with Sprague's truly miniaturized line of reliable pulse transformers.

Designed to meet the environmental requirements of specification MIL-T-27A, these new Sprague designs offer dependability without sacrifice in electrical performance of their larger counterparts. The hermetically-sealed tubular metal cases are available with pin terminals on one end for mounting on printed wiring boards or with the conventional wire leads on opposite ends. The complete set of standard ratings shown below will take care of most circuit requirements.

• • •

Complete data on Sprague's new type 5Z pulse transformers are shown in Engineering Bulletin 503, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 377 Marshall Street, North Adams, Mass.

TYPICAL SPECIFICATIONS

Cat. No.*	Turns Ratio	Lp (mH)	LL (μH)	Cd (μμF)	Source Impedance 100 Ω: Load (Ohms)	Pulse Width** (μsec)	Rise Time (μsec)	Source Impedance 500 Ω: Load (Ohms)	Pulse Width** (μsec)	Rise Time (μsec)	Source Impedance 1000 Ω: Load (Ohms)	Pulse Width** (μsec)	Rise Time (μsec)
5Z1 and 5Z2	1:1	0.5	1.0	6.0	50 100 200	1.8 1.2 0.8	0.01 0.01 0.01	250 500 1000	0.40 0.28 0.22	0.01 0.01 0.01	500 1000 2000	0.24 0.20 0.15	0.01 0.01 0.01
5Z3 and 5Z4	3:1	0.5	2.0	6.0	5 11 22	1.8 1.2 0.8	0.02 0.02 0.02	27 55 110	0.40 0.28 0.22	0.02 0.02 0.02	55 110 220	0.24 0.20 0.15	0.02 0.02 0.02
5Z5 and 5Z6	5:1	0.5	2.5	6.0	4 8	1.2 0.8	0.02 0.02	10 20 40	0.40 0.28 0.22	0.02 0.02 0.02	20 40 80	0.24 0.20 0.15	0.02 0.02 0.02
5Z7 and 5Z8	1:1:1	0.5	2.0	12.0	50 100 200	1.8 1.2 0.8	0.025 0.025 0.025	250 500 1000	0.40 0.28 0.22	0.02 0.02 0.02	500 1000 2000	0.24 0.20 0.15	0.02 0.02 0.02
5Z9 and 5Z10	1:1	1.0	1.5	6.0	50 100 200	3.4 2.2 1.6	0.015 0.015 0.015	250 500 1000	0.70 0.54 0.40	0.015 0.015 0.015	500 1000 2000	0.38 0.28 0.25	0.015 0.015 0.015
5Z11 and 5Z12	3:1	1.0	2.5	6.0	5 11 22	3.4 2.2 1.6	0.02 0.02 0.02	27 55 110	0.70 0.54 0.40	0.02 0.02 0.02	55 110 220	0.38 0.28 0.25	0.02 0.02 0.02
5Z13 and 5Z14	5:1	1.0	4.0	6.0	4 8	2.2 1.6	0.02 0.02	10 20 40	0.70 0.54 0.40	0.02 0.02 0.02	20 40 80	0.38 0.28 0.25	0.02 0.02 0.02
5Z15 and 5Z16	1:1:1	1.0	2.5	12.0	50 100 200	3.4 2.2 1.6	0.025 0.025 0.025	250 500 1000	0.70 0.54 0.40	0.025 0.025 0.025	500 1000 2000	0.38 0.28 0.25	0.025 0.025 0.025
5Z17 and 5Z18	1:1	2.5	3.0	6.0	50 100 200	8.7 5.4 3.6	0.02 0.02 0.02	250 500 1000	1.9 1.2 0.8	0.02 0.02 0.02	500 1000 2000	0.94 0.66 0.45	0.02 0.02 0.02
5Z19 and 5Z20	3:1	2.5	3.5	6.0	5 11 22	8.7 5.4 3.6	0.025 0.025 0.025	27 55 110	1.9 1.2 0.8	0.025 0.025 0.025	55 110 220	0.94 0.66 0.45	0.025 0.025 0.025
5Z21 and 5Z22	5:1	2.5	5.0	6.0	4 8	5.4 3.6	0.025 0.025	10 20 40	1.9 1.2 0.8	0.025 0.025 0.025	20 40 80	0.94 0.66 0.45	0.025 0.025 0.025
5Z23 and 5Z24	1:1:1	2.5	6.5	12.0	50 100 200	8.7 5.4 3.6	0.04 0.04 0.04	250 500 1000	1.9 1.2 0.8	0.04 0.04 0.04	500 1000 2000	0.94 0.66 0.45	0.04 0.04 0.04
5Z25 and 5Z26	1:1	6.0	6.0	6.0	50 100 200	21.0 13.0 8.4	0.03 0.03 0.03	250 500 1000	4.0 2.6 1.8	0.03 0.03 0.03	500 1000 2000	1.8 1.4 1.0	0.03 0.03 0.03
5Z27 and 5Z28	3:1	6.0	11.0	6.0	5 11 22	21.0 13.0 8.4	0.04 0.04 0.04	27 55 110	4.0 2.6 1.8	0.04 0.04 0.04	55 110 220	1.8 1.4 1.0	0.04 0.04 0.04
5Z29 and 5Z30	5:1	6.0	14.0	6.0	4 8	13.0 8.4	0.04 0.04	10 20 40	4.0 2.6 1.8	0.04 0.04 0.04	20 40 80	1.8 1.4 1.0	0.04 0.04 0.04
5Z31 and 5Z32	1:1:1	6.0	17.0	12.0	50 100 200	21.0 13.0 8.4	0.07 0.07 0.07	250 500 1000	4.0 2.6 1.8	0.07 0.07 0.07	500 1000 2000	1.8 1.4 1.0	0.07 0.07 0.07

*First cat. no. is for 2-ended style, second is for single-ended plug-in style.
NOTE: Two winding transformers can be furnished with tapped windings to customer specifications.

**For 10% Droop.

the mark of reliability

SPRAGUE®

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT