which leg *3* can accept. Therefore, when the setting pulse on leg *1* becomes larger than required to transfer flux to the first filled closer leg *3*, no further flux is available for transfer to leg *4*. In this 4-legged transfluxor, leg *2* is a dummy which remains always saturated in the same direction and provides the necessary return path for continuity of flux flow.

A transfluxor which can be set by either polarity of setting pulse can be obtained by using four apertures, as shown in Fig. 18. It is apparent that either a positive or a negative set pulse will cause leg *5* to reverse its flux. For a positive set pulse this will occur with corresponding reversals of legs *2* and *4*, and for a negative set pulse with reversals of legs *1* and *3*. The output flux path via legs *5* and *6* is unblocked by the setting of leg *5*. Blocking can also be of either polarity.

Conclusion

The transfluxor has the unique property of being able to control the transmission of electric power according to a stored level established by a setting pulse. In contrast to the magnetic amplifier in which the input command is not stored and must be present at all times, the transfluxor requires only a single setting. In contrast to the conventional memory core, the transfluxor is not only capable of storing a given amount of set-in flux, but also is capable of furnishing on demand, and for an indefinite length of time, an output according to the stored setting without affecting that setting in the least. In a sense, the transfluxor combines the functions of a magnetic amplifier and a memory core.

The multiaperture transfluxor core, made of square hysteresis-loop material, used at present for ring-shaped cores, is simple to manufacture. Like other magnetic elements it is a solid-state passive element which is rugged, stable in operation, and immune to permanent deterioration due to accidental overdriving of its associated circuits.

For these reasons it is believed that there is a great future for the transfluxors described in this paper, and similar ones that can be made with artifices based on manipulating the flux distribution in cores of square-loop-magnetic material having a number of apertures in various geometrical configurations.

References

1. The Transfluxor—A Magnetic Gate With Stored Variable Setting, **Jan A. Rajchman, Arthur W. Lo.** *RCA Review*, Radio Corporation of America, New York, N. Y., vol. XVI, no. 2, June 1955, pp. 303–11.

2. Magnistor Circuits, **R. L. Snyder.** *Electronic Design*, New York, N. Y., vol. 3, no. 8, August 1955.

3. A New Non-destructive Read for Magnetic Cores, **R. Thorensen, W. R. Arsenault.** *Proceedings of the Western Joint Computer Conference, March 1955*, Institute of Radio Engineers, New York, N. Y., 1955, pp. 111–16.

4. Static Magnetic Matrix Memory and Switching Circuits, **J. A. Rajchman.** *RCA Review*, Radio Corporation of America, New York, N. Y., vol. XIII, no. 2, June 1952, pp. 183–201.

Bilateral Magnetic Selection Systems for Large-Scale Computers

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SELECTIVE writing of information on a chosen channel of a large memory system (e.g., a magnetic drum memory) and selective reading of information from one out of many such memory channels can be accomplished by use of a single 2-way magnetic pyramid made solely of high quality magnetic saturable cores. A description is given of a working magnetic selection unit used in a large inventory control system with a few thousand magnetic drum channels.

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The Megacycle Ferractor

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THE ferractor is a magnetic amplifier designed to replace vacuum tubes in digital computer pulse circuits. Operation at information rates as high as $2^1/_2$ megacycles with moderate power gains and power levels has been achieved. This development represents an increase in the operating gain-bandwidth of magnetic amplifiers between one and two orders of magnitude over what has previously been reported.

This large step forward was due to a number of factors:

1. Improved circuits.
2. Improved methods of analysis of high-frequency magnetic amplifiers.
3. Improved magnetic materials and new developments in core construction.

Ferractors are readily adaptable to modular construction. In using them as building blocks the control and arithmetic sections of computers can be economically constructed with a minimum number of circuit types. All typical computer circuits: flip flops, binary counters, shift registers, etc., can be readily synthesized.

The construction of a special-purpose all-magnetic computer for military application, the Univac Magnetic Computer, is

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nearing completion. This machine uses approximately 1,500 ferractors, 9,000 germanium diodes, and several dozen transistors. Only a few vacuum tubes are used in the circuits which generate the carrier essential to the operation of the magnetic amplifier. The information rate of the machine is 660 kilocycles. This was chosen as a conservative figure for the first attempt at a large system.

The basic circuit is the series magnetic amplifier in which the output circuit is fed from a low impedance source. This type of amplifier has the following advantages:

1. Power is distributed from a constant-voltage low-impedance pulse power supply instead of a constant-current high-impedance power supply as heretofore used in magnetic circuits. It is much easier to generate and distribute high frequency pulse power at a low-impedance level than at a high-impedance level.
2. Each amplifier performs the functions of pulse shaping and timing, in addition to power amplification.
3. The zero output signal is easy to handle by straightforward amplitude clipping techniques.
4. The circuits are simple and require a minimum of components.

The analysis of the high frequency operation of magnetic amplifiers includes consideration of all core and circuit tolerances as well as the high frequency properties of magnetic materials and the associated diodes. In order that system reliability be realized a standard minimum output signal from an amplifier with maximum load is assumed. The design is such that the minimum output signal which is obtained under worst operating conditions is sufficiently large to operate the intended circuits in the computer. The zero signal is effectively suppressed by the amplitude clipper referred to in the foregoing. Furthermore, the magnetic cores have the property of integrating the effects of signals applied to them. Therefore, they are not as sensitive to high frequency noise as other types of circuits.

An exhaustive study of the characteristics of all commercial magnetic materials and some specially made in the laboratory showed the superiority of *4-79* molybdenum permalloy for magnetic amplifier applications. The analysis of the gain of magnetic amplifiers shows clearly the detrimental effect of space factor on magnetic amplifier gain. The gain goes down as the ratio of magnetic material cross section to air cross section in the amplifier output winding decreases. A realization of the importance of space factor led to the use of a stainless steel bobbin as a support for the magnetic material and wire. It is possible to fabricate stainless steel with much thinner walls than the ceramics which are customarily used as bobbins for magnetic amplifiers. Difficulty is experienced in machining ceramics to a thickness smaller than 0.015 inch. As this thickness is approached the ceramic loses strength and becomes as fragile as an egg shell. On the other hand, stainless steel can be fabricated into bobbins with walls of thicknesses as small as 0.003 inch. These bobbins have adequate strength if they are handled with care.

A typical design of a core for the computer referred to above has 13 wraps of 1/8-mil *4-79* molybdenum permalloy tape, 1/32 inch wide, wound on a stainless steel bobbin, 0.1 inch diameter. The cores are machine wound and potted in hermetic seal headers. The headers are then mounted on printed circuit boards which also contain associated diodes and resistors. These printed circuit boards are plugged into the computer frame work.

Laboratory experience with the computer has shown the magnetic circuits to be very reliable. In low frequency applications magnetic amplifiers have been unsurpassed in reliability when properly designed and packaged. Now that high speeds have been achieved with magnetic amplifiers, speeds that are comparable to those which can be obtained with any other available method of power amplification, the magnetic amplifier will find wide use in high-speed pulse handling systems.

Purpose and Application of the RCA BIZMAC System

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THIS presentation before the 1956 Western Joint Computer Conference is the first complete public presentation of the RCA (Radio Corporation of America) BIZMAC system. In November 1955, the system passed acceptance tests and was delivered in December to the Ordnance Tank-Automotive Command (OTAC) of the U. S. Army Ordnance Corps in Detroit, Mich.

This set of papers covers the system philosophy embodied in the equipment. It attempts to set forth the reasoning and planning behind the development of the data-handling equipment.

The RCA BIZMAC system is an accounting system in the broad sense that it aims to mechanize all the functions of record keeping, handling of data, calculation and decision, summarization, and prediction which are the basic functions of industrial paper work. It is a system developed to meet the requirements of such work, and not an attempt to apply an available component to the extent that it can be useful. The measure of its success is cost reduction to its user. By making a machine do routine "mental" work, it will help to free many people from tasks which are dull and repetitious, to be available for more creative and challenging work.

In the Ordnance application, the job to be performed is supply and stock control of tank and automotive parts. It is a task of some magnitude. The system must be able to keep inventory records on 250,000 items. Each item contains data of stock on hand at a number of depots, shipments made, goods received, back orders, stock-leveling action taken, various condition codes signifying such things as whether an item is new, or used, earmarked for overseas shipment, etc., as

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