Stanley Oken

May 18, 1953

MASTER'S THESIS PROPOSAL

TITLE: Transistor Magnetic Core Drivers

BRIEF STATEMENT OF THE PROBLEM

An investigation of the problems involved in using transistors to drive magnetic cores.

HISTORY OF THE PROBLEM UP TO THE PRESENT TIME

With the advent of the use of magnetic cores for memory storage elements and possibly as logical elements, in digital computers[1] the problem of finding suitable drivers for the magnetic cores evolved.

The use of these cores has reduced the size of the computer memory to such an extent that the vacuum tube core drivers and the power supplies needed for them occupy a large part of the space allocated to the computer memory. Thus the next step in the miniaturization of components in the memory is that of reducing the size and power requirements of the core drivers. With the invention of the transistor, this problem has found a possible solution.

Transistors have many features which make them suitable for this operation. Some of these are;

1. They are small in size compared to vacuum tubes.

2. The power requirements of the transistor are in the milliwatt range. This means that small power supplies or batteries can be used to bias transistors.

3. With the cores now available the maximum operating speed appears to be limited by the switching time of the core rather than the response time of the transistor.

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[1] The computers at the Harvard Computational Laboratory and at the Digital Computer Laboratory at M.I.T.

Along with the favorable features which available transistors possess, they have the unfavorable aspect of only being able to safely supply relatively small currents. Thus for switching operations each winding on a core must have many turns. The building of large magnetic core memory arrays is therefore greatly complicated. This also leads to more mechanical failures. It is believed that when the experimental power transistors are commercially available this problem will be somewhat if not completely alleviated.

PROPOSED PROCEDURE

I. Determine the requirements on the current waveshape from the core driver. This will include such specifications as the amplitude, duration, rise time and fall time of the current pulse.

Two types of cores have sufficiently rectangular hysteresis loops to be usable in a coincident current memory system. They are the ferrite and metallic type cores. The ferrites switch in the relatively short time of about .5 μsec but require a large driving mmf of about 1 ampere turn, while the metallic cores switch in about 5 μsec and require .2 ampere turns. Both types of cores will be used in the experiments.

II. Determine the type of circuitry best suited to give the required driving pulse of current. The two types of circuitry to be evaluated are the regenerative type amplifier or the monostable multivibrator and the non-regenerative type of amplifier. Some of the more apparent advantages and disadvantages of the two circuits will be outlined below;

A. Regenerative Amplifier using point contact transistors.

1. Advantages

a) Since this is a monostable multivibrator, the input voltage need not be the same shape as the output required. The input voltage need only be of sufficient amplitude and width to trigger the circuit.

b) The core driver can be easily used as a gate for logical operations by varying the emitter bias voltage.

2. Disadvantages

a) The rise and fall times of the output current pulse are dependent upon the switching time of the transistor used. These times are somewhat faster than is desirable. Furthermore, since we must be operating close to the maximum allowable dissipation region in order to obtain the maximum current possible, any attempts to use capacitors to slow down the rise and fall times is apt to introduce power dissipation problems.

b) This circuit uses the "N" curve or negative resistance curve of a transistor. Thus the breakpoints of this curve must be well stabilized since they determine the output current pulse.

B. The non-regenerative type amplifier using junction transistors.

1. Advantages

a) The characteristics of the junction transistors are generally more stable than those of the point contact transistors which are the type used in the regenerative amplifier.

b) Connections such as the grounded emitter connection of the junction transistor can be made to have current gains of over 50, thus the input current pulse to the driver can be very small.

2. Disadvantages

a) The input voltage and thus also the current must be the same shape as the output current desired and not just a spike of voltage as was the case with the regenerative amplifier.

b) When the switching time of the cores is reduced, the maximum rise and fall time attainable from the junction transistor may limit the maximum operating speed of the system.

c) The maximum allowable power dissipation in the junction transistors which are available is about 30 milliwatts. Thus, only relatively small output currents are obtainable.

III. Determine the amount and type of stabilization that is required to give reliable operation of both types of core driver and core circuits. This may include stabilization of the breakpoints in the "N" curve of the regenerative amplifier, and a pulse standardizing circuit to stabilize the input pulses to the core driver.

IV. Determine the best operating conditions through use of life tests run by the Transistor Group at the Digital Computer Laboratory. These tests will be designed to help answer the following questions;

A. What is the maximum current obtainable under safe operating conditions?

B. Will the transistor fail if the operating path carries it into a region of excessive power dissipation, even for very short times, or does the average heating of the transistor cause the failure?

V. Build one plane of a coincident-current type of memory using only transistors, magnetic cores and crystal diodes. The proposed unit will consist of a 16 magnetic core array, two diode matrix switches, a sensing amplifier and circuitry which will display the array on an oscilloscope. Although the actual memory will not contain vacuum tubes, certain components in the system devised for testing the memory may consist of standard Whirlwind test equipment units. Once built the memory will be evaluated as to its stability, usefulness and limitations.

ESTIMATED DIVISION OF TIME

1.	Preparation of Proposal	75 hours
2.	Further study of literature	25 hours
3.	Experimental work and analysis	200 hours
4.	Correlation of results and formulation of deductions and conclusions	25 hours
5.	Preparation of thesis report	75 hours
6.	Total	400 hours

SIGNATURE AND DATE

Stanley Oken

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May 18, 1953

SUPERVISION AGREEMENT

I consider this material adequate for a Master's Thesis and agree to supervise and evaluate the thesis.

Approved: R. B. Adler

Asst. Prof. R. B. Adler

SO/cs

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