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Division 6 - Lincoln Laboratory
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SUBJECT: TRIP TO BURROUGHS RESEARCH CENTER, Paoli, Pennsylvania, Tuesday, April 27, 1954

To: Group 63 Staff

From: D. R. Brown and D. A. Buck

Abstract: A trip was made to the Burroughs Research Center to discuss magnetic-core computer components and fabrication of metal cores. They are planning to make and improve metal cores and they have used magnetic cores in logical switching applications.

Core Fabrication and Study

Burroughs is assembling a metallurgical laboratory which will be able to compound, vacuum melt and cast, and roll ultra-thin metal tapes. Dr. John Cook is in charge of this laboratory. They point out that almost all of the thin molybdenum-Permalloy tapes used to date, regardless of supplier, have come from the same melt. They feel it worthwhile to compound other melts, varying the percentage of molybdenum. They plan to study the pulsed properties of many different cores and the extent of grain orientation in rolled tapes by using x-ray pole patterns. We were shown the x-ray equipment and a notebook of pole patterns already taken. They plan to study ferrite synthesis, but on a lesser scale.

They are at present making metal cores on a pilot-plant basis in the Philadelphia plant. They find high uniformity in a given batch, with excellent characteristics, and then poor uniformity and poor characteristics in the next batch. Switching coefficient, S_w, ranges from 0.25 to 0.35 oersted-microsecond. Switching time, however, is not measured between 10 percent points on the switching waveform as at M.I.T., rather from the start of the waveform to a point which is the intersection of the horizontal axis with a line tangent to the falling side of the second hump at its steepest point. Our S_w measurements may therefore differ from theirs. They are using cores from both Magnetics Inc. and Magnetic Metals, and do not expect their own production to supply their demand for some time.

Core Circuits

Burroughs favors the two-core-per-stage stepping register over the one-core-per-stage design. Their reasons are that the design of the two-core circuit is straightforward, the advance pulse amplitude and width are much less critical, and the voltage against which the advance current must be established is smaller, than in the one-core

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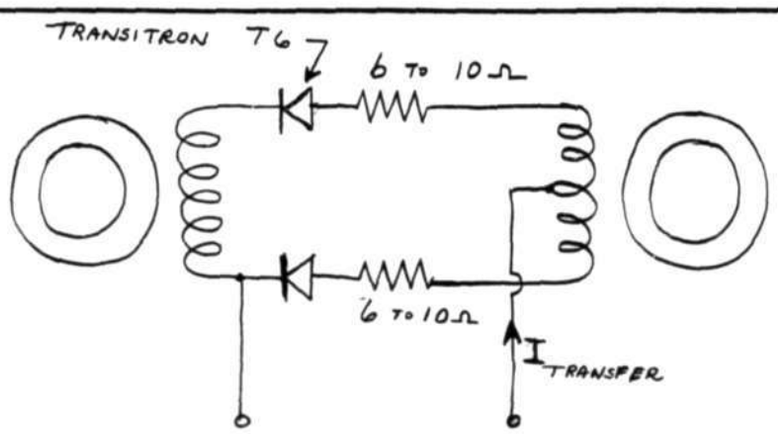
circuit. The latter consideration places the limit on the number of stages per driver tube, so that the one-core circuit, due to the higher back voltages involved, often require more driver tubes.

A very important point in their design philosophy is that cores are substituted for germanium diodes wherever possible. They feel cores to be much more reliable, and if their development hopes of a 25-cent metal core materialize, they say cores will be cheaper than diodes. This explains why some of their logical circuits use so many cores as compared to our own.

A split-winding gate circuit has been developed using only cores and diodes which facilitates transfer of information parallel-wise out of a stepping register. If anyone is interested in circuit details, he is referred to the MIT Milling Machine Project (Bldg. 32) where two stepping registers, coupled with split-winding gates, are in service. The gate circuit is as follows:



Burroughs magnetic core split-winding gate circuit. Turn on transfer current to turn gate on.

In their use of metal cores, they have found the number S_w/H_o a very useful figure of merit for different core materials.

Their stepping-register design has reached the point where they are now driving 40 stages from single hard-tube drivers at a bit-transfer rate of 200 kc. They package their core circuits in a 20-core plug-in package, 10 cores along each edge of a phenolic sheet, and diodes and resistors on the two sides.

Diodes

In their designs, they are using Transitron T6 diodes exclusively. They find National Union 1N107's fragile and higher priced (about $2.60 as compared to $1.25 for T6's). They are evaluating diodes from all sources for stepping register work. A peculiar behavior discovered in 1N91's

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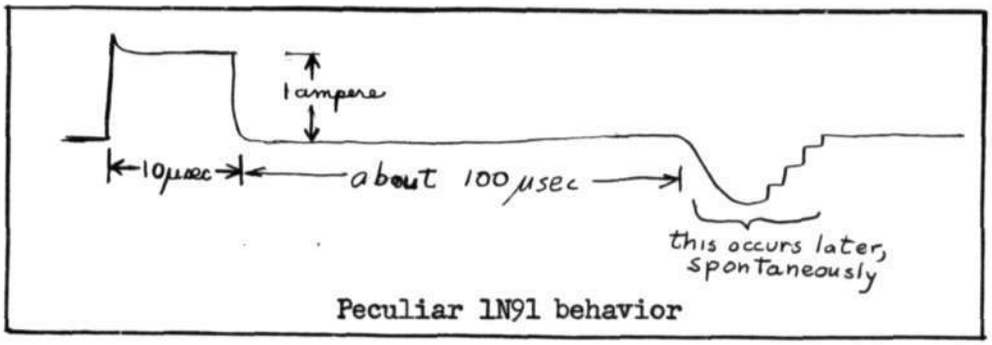
is a spontaneous backward flow of current some time after the forward passage of a 1 ampere pulse:



Peculiar 1N91 behavior

Beam-Switching Tube

We were also shown the new Burroughs beam-switching tube. Operating in a magnetic field, this tube utilizes magnetron-type paths to switch an electron beam to any one of 10 anodes, and will act as a ring counter up to several megacycles. It has no critical internal spacings, and it has a current-source-type output.

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