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NASA TECH BRIEF

Veitch Diagram Plotter Simplifies Boolean Functions

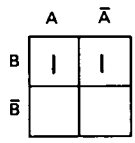

Figure 1.

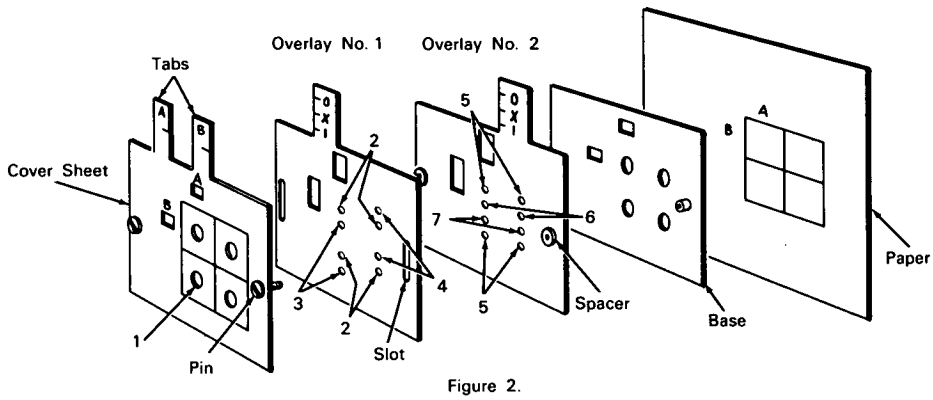

Figure 2.

The problem: Boolean functions that arise in computer design can be lengthy and complicated.

The solution: One way of simplifying them is by means of Veitch diagrams. A Veitch diagram is a group of squares representing all of the various combinations of inputs to a computer. If each of the various inputs to a computer, e. g., A, B, and C, can take either of two values, e. g., 0 or 1, then all eight combinations of A, B and C can be represented on a Veitch diagram having eight boxes. This innovation is a device for simplifying the plotting of a Veitch diagram and for assuring that such a plot is accurate. The device consists of several overlays which may easily be positioned to block all but the desired boxes.

How it's done: Figure 1 shows a Veitch diagram of two variables, A and B, in which the boxes AB and $\bar{A}B$ have 1's. To fill in the boxes with 1's, given the designations such as AB (which designates one box) or B (which designates two boxes), the designer must visually line up the designated columns and rows and write 1's in them. Although this can be done without trouble for only two variables, the difficulties increase rapidly as the number of variables increases, and a time-consuming and inaccurate plot often results.

Figure 2 shows an arrangement of the device for plotting two variables. A cover sheet of thin cardboard has a two-variable Veitch diagram printed on its surface. Each box of the Veitch diagram has a hole through it, and in the places where the names of the

(continued overleaf)

variables (e.g., A or B) are typically written, are openings A and B through which these names may be written. Below the cover sheet is a first variable overlay, No. 1, of thin cardboard having three sets of holes 2, 3, and 4. One set of four holes 2 may be aligned with all four holes 1 of the cover sheet when the first variable is redundant (i.e., if the first overlay is named A, and A is written in box A, then A and $\overline{A}$ both occur in the Boolean expression). A second set of holes 3 may be aligned with the holes under the variable in opening A when the overlay No. 1 is moved upward, to designate the first variable as 1 (e.g., A but not $\overline{A}$). A third set of two holes 4 may be aligned with the holes *not* in the column under opening A when the first variable is 0 (e.g., $\overline{A}$). Thus, if the first variable is A, the overlay No. 1 may be moved upward to block all but the "A" boxes and may be moved downward to block all but the "$\overline{A}$" boxes.

In a similar manner, a second variable overlay No. 2 contains three sets of holes, 5, 6, and 7. The first set 5 contains four holes which are aligned with the holes 1 of the cover sheet when the second variable is redundant. The second set of holes 6 may be aligned with the holes beside the row B when the variable overlay No. 2 is moved upward; the third set of holes 7 may be aligned with the holes *not* in the row beside opening B when overlay No. 2 is moved downward.

To properly position the two overlays, No. 1 and No. 2, two marked tabs are fixed to the cover sheet and two corresponding tabs are fixed to the two overlays No. 1 and No. 2. The movable overlays are confined to up and down motion by pins which are located in slots of the overlays. The pins are fixed to the cover sheet and to a base which is located below overlay No. 2. To prevent one overlay from dragging another along with it when the first is moved, spacers are located between the overlays; the spacers are pierced by the pins to prevent the spacers from moving up or down.

To plot a Boolean expression on the Veitch diagram plotter, e.g., $A\overline{B}$, a sheet of paper marked with the boxes of a Veitch diagram is placed underneath the base of the device. The names of the variables A and B are written on the paper through the openings A and B. The tab on overlay No. 1 is moved up to designate A. At this point, only the holes 3 in overlay No. 1 are open to the bottom paper, lining up with the left column of holes of the cover sheet and the base. The right column of holes in the cover sheet and the base are blocked out.

The tab on overlay No. 2 is now moved down to designate $\overline{B}$. Now the holes 7 in overlay No. 2 are lined up with the bottom row of holes in the cover sheet and the base. However, the right hole 7 was blocked when overlay No. 1 was raised to designate A, leaving only the left hole 7, designating $A\overline{B}$, open through the overlays to the paper.

Note:

The usefulness of the device is especially evident when many variables are involved and there is great difficulty in finding the boxes designated by a Boolean expression.

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

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