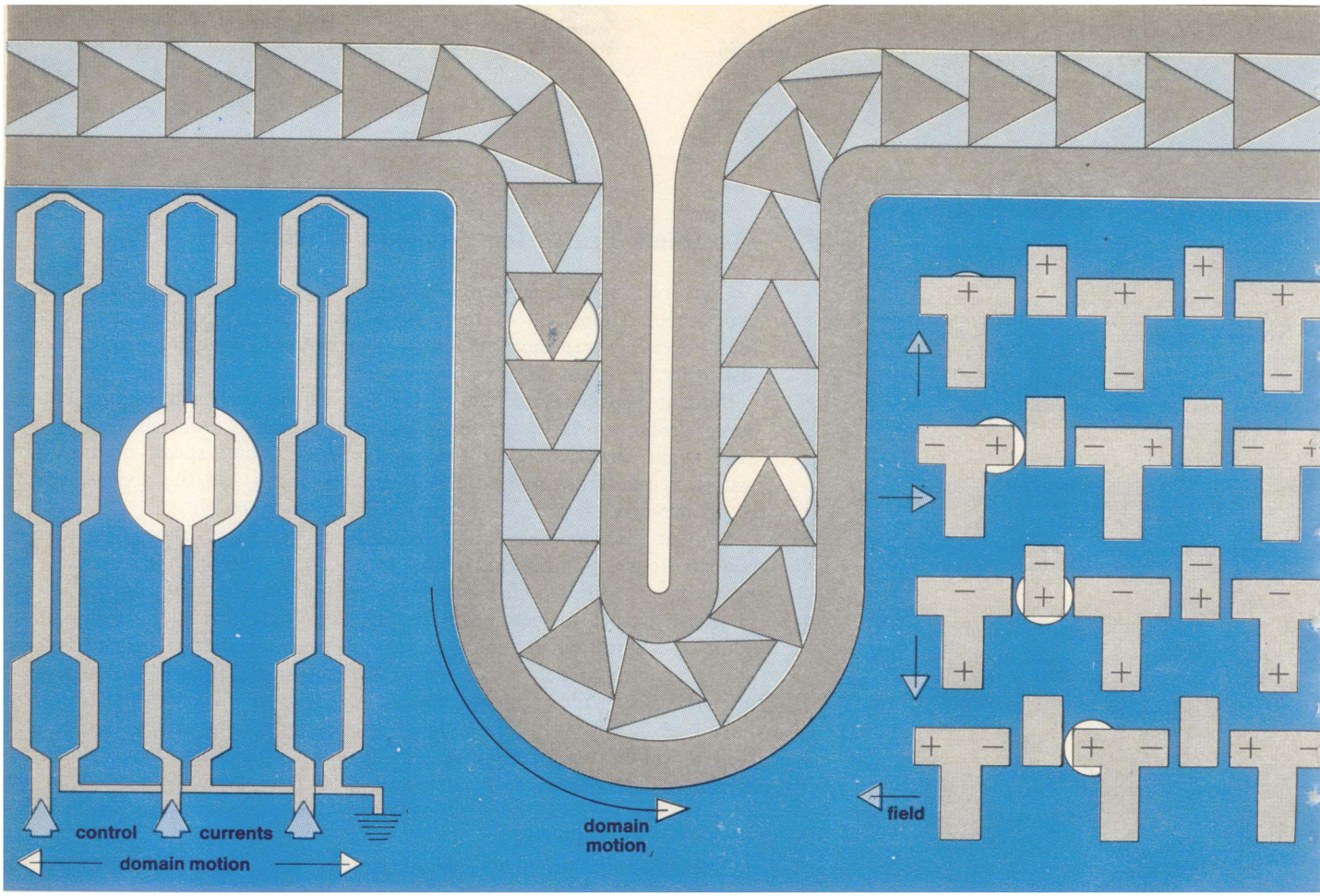

The magnetic abacus

Scientists at Bell Laboratories have invented ways to create, erase, and propel tiny cylindrical magnetic "bubbles" (domains) in sheets of orthoferrite—rare-earth iron oxide. Because the presence or absence of the bubbles at specific positions can represent binary numbers, they can perform many functions in digital data processing.

Bubbles are areas whose magnetic field is opposite to that in the rest of the material; their size and shape depend on the material and on an external magnetic "bias" field. In samarium terbium ferrite, for instance, 42 Oersteds maintains 0.0008-inch diameter bubbles. A bubble can be moved its own diameter in 0.01 microsecond, promising a data rate of over a million bits per second. We've invented three basic ways to move them:

In the first (above left), thin-film conductor loops are deposited onto the orthoferrite sheet. Currents through the loops move the bubbles from under one loop to an adjacent one. With a second pattern of loops at right angles to the first, the bubbles can move all over the sheet, like checkers.

In a second scheme (center), high permeability thin-film permalloy triangles are deposited on the sheet. A bubble "adheres" to any triangle it contacts. But, if the overall bias field is reduced, the bubble expands, and contacts the side of the next triangle. If the field is then strengthened, the bubble contracts, holding to the triangle it has contacted and sliding "downhill" off the original one. A bubble moves one step with each cycling (between 38 and 44 Oersteds) of the bias field; the permalloy "rails" confine the bubbles to the path.

A third scheme (right), a "T-and-bar" system, also uses a thin-film permalloy pattern on the sheet. Here, the bubbles are propelled by a field rotating in the plane of the sheet. The rotating field (arrows) causes changing polarities on the T's and bars; the bubbles shift in response. Rotation in the opposite direction reverses the movement.

In practical devices, we must be able to create and to detect the bubbles. We do the first by fission, from existing bubbles. We detect them by their external magnetic effects or optically.

A product of fundamental research in magnetism, the bubbles may provide compact and inexpensive data storage and processing for tomorrow's computers and telephone switching systems.

From the Research and Development Unit of the Bell System:

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