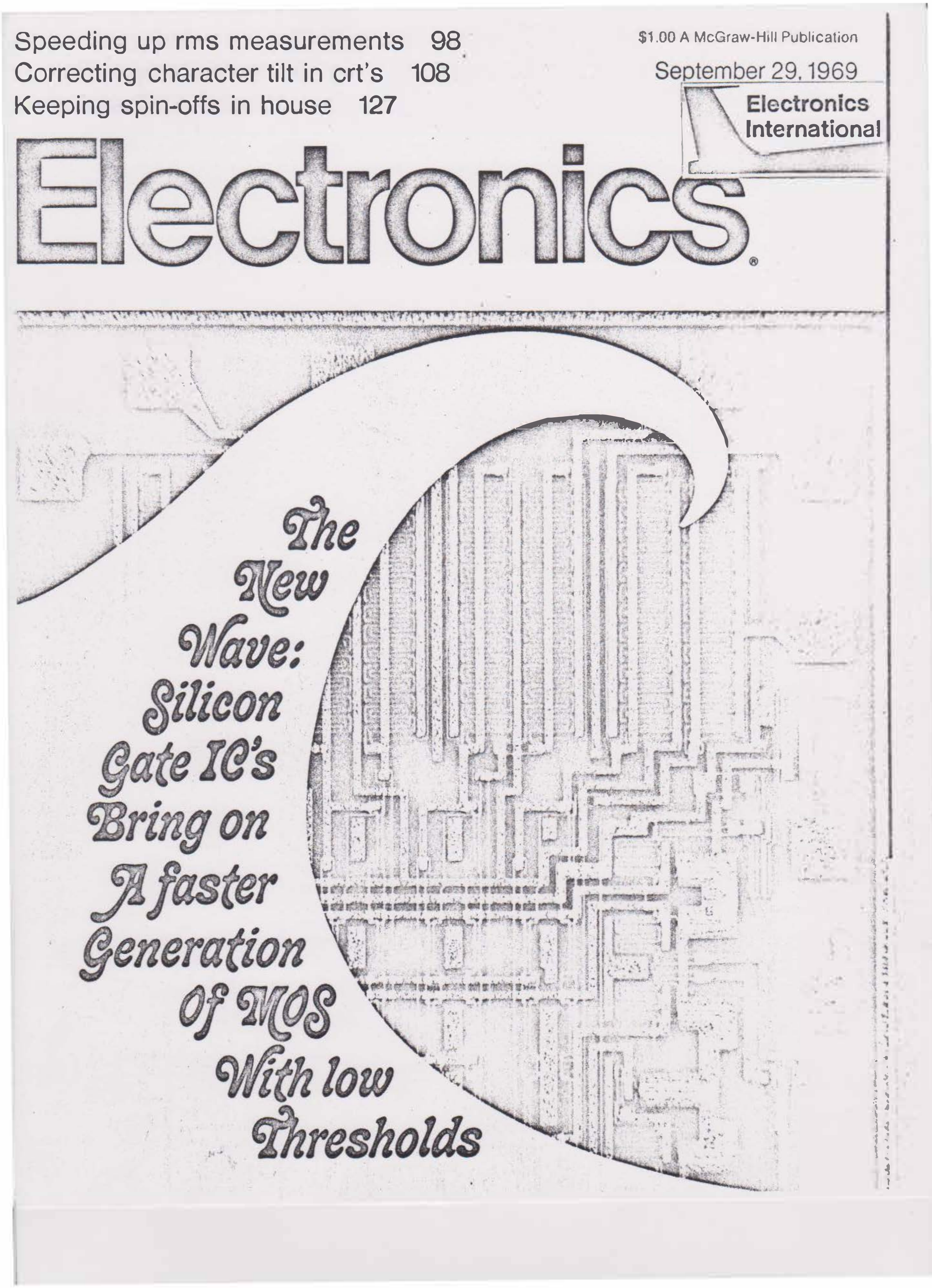
Electronics **article re: silicon-gate MOS technology, 29 September 1969**



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The New Wave: Silicon Gate IC's Bring on A faster Generation Of MOS With low Thresholds

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A faster generation of MOS devices with low thresholds is riding the crest of the new wave, silicon-gate IC's

In what may well be the technology's most startling change, highly doped silicon — not aluminum — is used as the gate electrode; the new technique lends itself to bipolar processing, say Federico Fagginand Thomas Klein, engineers at Fairchild Semiconductor

● Unquestionably, the silicon gate is the new wave in MOS technology. And it's no secret that silicon-gate integrated circuits have lived up to their promise of great speed and low threshold voltages, with the latter making them compatible with bipolar IC's. Just how well this promise has been fulfilled is evidenced by the committment both the Intel Corp. and Fairchild Semiconductor have made to the silicon-gate technique [*Electronics*, Sept. 15, p. 67]. In fact, Fairchild plans to use the technique in just about all of the company's new metal-oxide-semiconductor circuits.

Why is Fairchild so enamored with the silicon-gate technique? The answer, obviously, stems from several factors. But they all add up to this. The technique has already reduced threshold voltages to a mere 0.4 volt, it has tripled speed, and it has cut circuit area by as much as a half—thus more functions can be packed into a given chip area.

Aside from both present and future digital applications, the technique will be useful in making analog circuits for low-level input signals. But the most important application more than likely will be the marriage of MOS and bipolar transistors on the same chip. This marriage will come about because silicon-gate devices, with their protected gate oxide, can be exposed to high diffusion temperatures at almost any step in the process without risk of deterioration.

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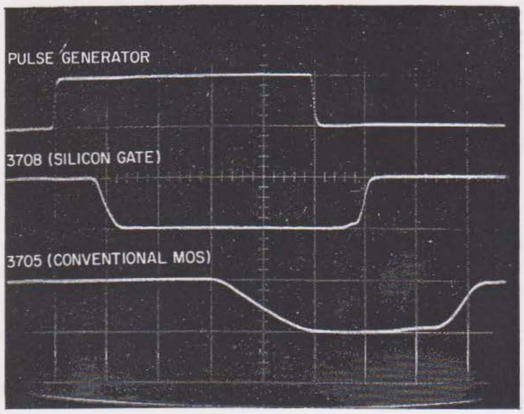
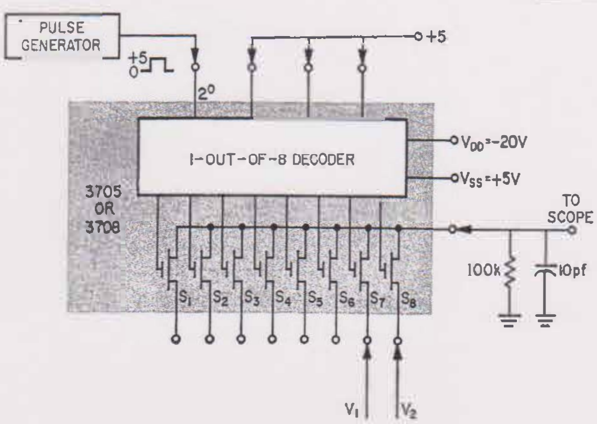


Waveforms: Control signal from the pulse generator causes the eight-channel multiplexer to switch channels. Switching occurs much more rapidly in the silicon-gate version of the multiplexer (3708) than in the conventional version (3705). Here, the IC's are switched from channel 7 to channel 8. Horizontal scale is 200 nsec per division; vertical scale is 5 volts per division. Test circuit is shown below.

In essence, the technique differs from the conventional approach in that the MOS IC is fabricated with polycrystalline silicon, rather than aluminum, as the gate electrode [*Electronics*, May 26, p. 49]. Both techniques are equal in terms of complexity—the number of masking steps are the same. Just why the silicon-gate technique hadn't been thought of earlier can be attributed largely to the fact that aluminum has always been the least troublesome part of MOS structures. Advances in the technology stemmed in large part from work on the dielectric and the semiconductor-dielectric interface, rather than on the aluminum. Moreover, poly silicon can't be wire bonded, and this probably contributed to the delay in considering the material. Researchers reasoned that an aluminum interconnection layer would still be needed.

Even when the first silicon-gate MOS devices were successfully fabricated, J. C. Sarace and his coworkers at Bell Telephone Laboratories who were doing the research apparently failed to recognize some of the most significant advantages of the structure. This was particularly true of the reduced threshold voltage and the higher component density. Fairchild entered the picture late in 1967, when it launched its silicon-gate research-and-development effort. And now, less than two years later, the company is going all out with the new technique.



A rose by any other name . . .

Metal oxide semiconductors they're called, but metal oxide semiconductors they're not—at least, the newer "MOS" devices are not.

When the term first was coined, no one foretold the proliferation of surface-controlled devices and IC's that were to depart from the traditional structure of a semiconductor in which a metallic oxide serves as an insulating layer. These changes have been so radical that MOS no longer is exactly accurate. First, silicon nitride entered the picture as an alternative to silicon dioxide. Now, highly doped silicon has come along as a replacement for the aluminum-gate electrode.

A far more descriptive term would be conductor-insulator-semiconductor, or CIS. Though such a term comes closer to the mark, its chances of being picked up and popularized are so slim as to be almost non-existent. So entrenched is the term MOS in engineering parlance that it would be virtually impossible for it to be dropped. And as if adding insult to injury, silicon-gate circuits can be described mathematically with the same physical and electrical models as MOS circuits. Little wonder the term MOS will be around for a while.