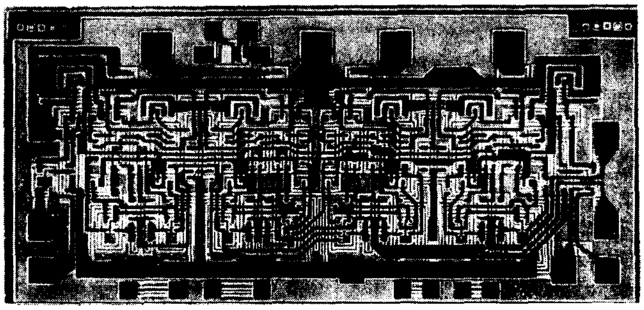

FIG. 3. Topology of a binary-decade counter.

crystal with 10 logic elements may be placed in the frame.

The maximum degrees of integration have been attained for integrated circuits based on MDS transistors, owing to the low dissipated power (for a low speed of response), the smallness of the area occupied by the MDS-integrated transistors on the crystals, and the relative simplicity of the technological process. The most complex MDS-integrated circuits perform the function of an entire calculator: for example, four arithmetic operations with eight-digit words. The most complex fast bipolar circuits contain 1000 and more electronic devices.

As an example, we present in Fig. 3 the topology (a photograph of the crystal) of a relatively simple integrated circuit—binary-decade counter. The crystal dimensions are 1.4×3.0 mm and it contains 130 components.

Subnanosecond logic circuits (switching time less than 10^{-9} sec) can be produced with ordinary bipolar transistors. The minimum transistor switching time is determined by the time of transit through the base of the carrier injected from the emitter: $\tau_{tr} = L/v_{max}$. The highest drift velocity v_{max} is equal to $\sim 10^6$ cm/sec. On the other hand, the minimum thickness of the base is determined by the voltage V applied to the base junction and by the field intensity at which an electrical breakdown begins: $V = L_b E_{br}$, where $E_{br} = 10^6$ V/cm. In consequence

$$\tau_{tr} = L_б/v_{max} = V/E_{tr} \quad v_{max} \approx 10^{-12} \text{ sec.}$$

To obtain such values of the switching time, however, we must work at submicron dimensions, for which we can hardly see any prospects.

The switching time of logic elements constructed on the basis of the Gunn effect is determined by the time of transit through a charge domain in the interelectrode space, since the RC-constant of the device turns out to be small ($\sim 10^{-11}$ sec), while the transit time is equal to $\sim 10^{-10}$ sec. The energy expenditures on one switching is then not less than 1 pJ. The dimensions of the device are assumed in these estimates to be higher than 10 μ, which is entirely attainable at the present level of semiconductor technology. Thus, the devices that operate on the basis of the Gunn effect turn out to be very promising for the construction of logic elements with a switching time of 0.1–1 nsec., guaranteeing a power consumption of the order of 1 pJ per switching.

The signal-transmission lines of computers based on logical elements with a switching time of less than 1 nsec should be of the waveguide type—microstrip or coaxial. The fastest circuits which can be connected up by conventional wiring lines can have signal-propagation delay times and switching fronts of the order of 2–3 nsec.

Future prospects of microelectronic devices for the computer industry are linked with the development of optoelectronic devices and techniques.

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S. V. Bogdanov and D. V. Sheloput. The Current State of Acoustooptics. The beginning of the report deals briefly with the history of the problem. It is noted that in spite of the fact that light diffraction by ultrasound was theoretically and experimentally studied as far back as in the thirties, only with the appearance of high-power coherent-light sources (lasers) did this phenomenon find practical application and be of interest again.

Further, the theory of this problem is considered and it is noted that two different situations usually obtain: Raman-Nath and Bragg diffractions[1]. Relations for the diffracted-light intensity are given for both types of diffraction. It is noted that in any of these cases: 1) a change in the sound frequency leads to a change in the direction of propagation of the diffracted light, 2) the frequency of the diffracted light differs from the frequency of the incident light by the sound frequency (or a multiple of it), 3) the diffracted-light intensity depends on the sound intensity, and 4) the diffraction efficiency depends on a certain combination of the parameters of the material $M_2 = n_0 p^2/\rho v^3$ (n_0 is the refractive index, p is the photoelastic constant, ρ is the density, and v is the sound velocity).

These distinctive features of light diffraction by ultrasound allows the construction of a number of acoustooptic devices for controlling laser radiation: 1) modulators, 2) deflectors, 3) devices for frequency shifting, 4) optical filters with tunable transparency, 5) optical shut-off devices, 6) scanners, and 7) phase modulators (the last two devices use light refraction). The performances of these devices are briefly described in the report. The present state of these performances is reflected in the report by a table in which the parameters of the modulators, deflectors, and scanners are given. It is noted that at present not only are the acoustooptical devices not inferior in all their principal parameters to the electrooptical devices, but in a number of their characteristics—the operating voltage, simplicity of construction, considerable freedom in the choice of material—they are superior.

It is noted in the report that considerable progress has been made in the choice of materials for the optical-band acoustooptical devices. Thus, for example, the authors have proposed glass[2] with a quality $M_2 = 1200$, which is a record value. The power of the electrical driving signal for the acoustooptical modulator constructed with this material is, for a 100% efficiency, only about 250 mW. At the same time, for the infrared band, the best material is still germanium, which was proposed by the authors for these purposes back in 1968[3]. A set of properties of a number of promising (in the acoustooptical sense) materials (including a number of liquids) is tabulated in the report.

It is pointed out in the report that light diffraction is observed not only on volume acoustic waves, but also on surface waves[4]. Of special interest is the so-called volume diffraction on surface waves, when the light propagates along the backing across the sound beam[5]. This diffraction has a number of distinctive features connected with the nature of surface waves.

In conclusion, the prospects of the development of acoustooptics are discussed.

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