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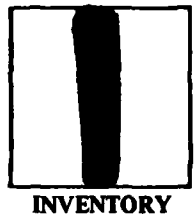

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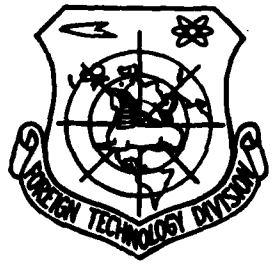
(SELECTED PORTIONS)

By

Y. A. Fedorov



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SEMICONDUCTOR PRODUCING INDUSTRY IN THE USSR
(SELECTED PORTIONS)

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SEMICONDUCTOR PRODUCING INDUSTRY IN THE USSR (SELECTED PORTIONS)

Y. A. Fedorov

However, besides the above mentioned achievements of the semiconductor producing industry, the most significant achievement is undoubtedly integrated systems.

The first integrated systems where germanium and silicon are applied, were brought into being in the USSR in the years of 1961-1962. Along with the monolithic systems, the hybrid systems have also been developed to serve computer and electronics industries.

The advantage of these hybrid systems lies not only in the equipment's dimension and its weight.

The electronic abilities of the integrated systems enable to increase significantly the equipment's reliability as well. They are also influenced by current and working voltage low levels as well as a detailed elaboration of the system and significant tolerance with regard to parameters' changes which take place at individual devices. This is very important for digital computers. The integrated systems also eliminate welded and soldered connections.

As a result of the above mentioned the integrated systems composed of many elements, are as reliable as separate elements, Significant increase of the reliability (at a rate of 1 or 2 orders) along with decrease in the dimensions, weight and usage of electricity enables to count on designing more complicated computing systems, better electronic memory with better capacity, etc.

On the other hand, pretty complicated systems can be transformed into very miniature devices. For instance, in the Soviet electronic crystal watches whose dimensions are 2 x 2 mm^2, there are from 700 to 1300 transistors.

The B3.04 calculator's processor with the 5 by 5 mm^2 crystal comprises 3,400 elements, whereas in the case of the EKWM B3.18 computer with the 5 by 5 mm^2 crystal (the computer is designed for technical calculations) comprises 16,000 transistors. Yet, this is not the final frontier. In the coming years they expect further diminishing of integrated systems' dimensions with a simultaneous increase of the crystal's dimensions.

The integration's present step forward, as it is exemplified above, is characterized by the amount of 500 to 700 transistors per 1 mm^2 of the crystal. However, this number will approach 1,000 to 1,500 transistors.

The increase of the integrated systems' complexity arises two problems which we are to face; the first problem is computers' application for designing these integrated systems; the second one is to design these systems from small elements and to locate them on the crystal having a big surface.

Computers, applied to design the integrated systems, become an indispensable part of the integrated system design due to these systems' present complexity. A human being is not simply able to mark and control the location of grids of thousands of coordinate references which represent the topology of the integrated systems based on a wide integration scale.

When the integrated systems are prepared, they are being on the semi-conducting crystal in the form of proper areas of the diffusing conducting paths, connecting terminals, etc.

For this particular purpose so called "photographic masks" are applied. These masks are glasses with transparent and non-transparent surfaces. They are used as the negatives in the photo-lithographic process of transferring the circuits, which are scaled down, on the semiconducting plate surface.

The USSR's design works in the field of photolithography were connected mostly with the planar technology and they were brought into being in the years of 1960-1961. However, it is worth drawing your attention to the fact that photolitography in the field of the mass production was used for the first time in order to obtain the structure of the germanium mesa transistors. We should also recall that the first production type of the planar transistor was also the germanium transistor.

The development of the technology of super high frequency semiconducting devices which took place after the cost increase of the planar technology as well as a fast increase of the integration scale in the mass production of integrated systems are accountable for a fast and continuous diminution of the dimensions of the picture-details (systems, transistors) along with a simultaneous increase of crystal dimensions. In the electronic industry it was connected first of all with the appearance of high frequency and super high frequency power transistors.

The semi-conductor industry required optical and mechanical equipment to fit specific requirements as to precision and the distributing ability. It has to be mentioned that this optics' distributing ability is 10-fold higher than this one which is applied in amateur and professional photography.

One of the most important achievements of the socialist system is socialist integration. The scientists from GDR and USSR maintaining close cooperation have developed a system of such an optico-mechanical equipment. This equipment includes:

the ANR-4 automatic 10 position repeater designed for making standard photographic masks on emulsion photographic plates by means of the multiplication method with a simultaneous diminution to desirable dimensions;

a "Kartimat III-E"automatic precise coordinatograph designed to draft photographic forms;

a device for references' locating and for exposing;

special microscopes which are used for control and testing.

This equipment is widely used for the production of semiconductors in the U.S.S.R. and other socialist countries. This equipment has been successfully demonstrated during different exhibitions.

Properties of these devices are described in details in "Photoligraphy and Optics", a book published by GDR and USSR scientists in 1974 . The book is published in both German and Russian by the "Technika"(Berlin) and "Sovietskoye Radio" (Moscow) publishing houses. However, one cann say that today's requirements of the quickly developing Semi-conductor Electronics are exceeding this equipment's upper limits.

An expected increase of the crystal's dimensions up to 8 to 10 and more millimetres and an decrease of the elements dimensions up to 1 micron and less rise new, very urgent requirements. In very many cases these requirements lie outside of these optical devices' possibility limits. Even the ultra-violet light's wave length becomes proportional to the dimensions of the negative's elements (the photographic mask). The mask begins behaving as the interference lattice. The solution for this problem lies in switching to the X-ray beams and narrow electronic beams.

As the semi-conductor producing industry undergoes development, new concepts keep arising. Not a long time ago the development of the computing technology was moving in the direction of big computers which collaborated with subscribers located hundreds

of kilometers. However, lots of hopes have been recently put into microprocessors.

The microprocessor came into being as a result of the development of semi-conductor producing industry. The microprocessor is very often made as a single crystal device. Switching from the logic to the memory, the usage of standard programs enable to significantly simplify the system, to create relatively simple and reliable equipment.

Microprocessors may be used in the measuring devices designed to process measurements' results; in cars to control sets of devices; for the information initial transformation for subscribers of big computers.

One of the most advantageous fields of microprocessors' application is processors which operate through the digital control.

At the 24th Congress of the CPSU I.I. Brezhnev said: "One modern processor with the digital control can substitute ten processors of the outdated structure'.

The design of the processors with digital control and appropriate microproprocessors to be used with them is one of the most important problems of the socialist integration. No doubt this is a very important problem, however it is not the only one. The specialization and cooperation in the field of semiconductors among the states-members of the Council for Mutual Economic Aid will be becomeing broader and broader.

Specialization and cooperation enable to use more efficiently industrial power, better satisfy the demands of the people's economy.

It is worth mentioning that a favorable specialization and

cooperation in any field, particularly in the field of electronics, can be materialized only under the condition of a wide scale international standartization. This problem becomes especially important since the semi-conductor producing industry's nomenclature includes thousands of items.

These problems are being successfully solved by the Council for Mutual Economic Aid's organization as well as by other international indtitutions.

The semi-conductor electronics can and has to be on one of the leaders in scientific and technological progress, to be one of the leaders in the construction of socialis and communism.

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