During the late 1960s the first reports appeared concerning a new generation of primary transducers for the measurement of mechanical quantities which utilized the strain sensitivity of semiconductors and were obtained by the technology of integrated microelectronics. This development has been called upon to play an important role in the evolution of measuring technology during the immediate future [1]. Currently some experience in the development of such transducers has been accumulated both here and abroad.

Analysis of the integrated mechanoelectric transducers described in the literature, primarily pressure transducers, permits the following classification criteria to be made for their structures: the material of the elastic element; the base material; the material of the strain-sensitive (transducer) element; the crystallographic orientation of the base for the elastic and sensing elements; the shape of the diaphragm; the type of strain-sensitive (transducer) element; the crystallographic orientation of the base for the elastic and sensing elements; the shape of the diaphragm; the type of strain-sensitive element; the topology of the strain-sensitive elements on the diaphragm.

Since a fairly large number of different topological variants of integrated pressure transducers are presently known, their classification in accord with the last criterion is a separate problem and is not discussed here.

In accord with the first two criteria one can classify the known integrated transducers as shown in Fig. 1 in which the various structures are designated by means of Roman numerals. The basic structures of the classification are shown in Fig. 2. We will discuss the features of these structures.

Structure I (see Fig. 1) looks like structure V but with the difference that the material of the elastic element used as the base of the strain-gauge resistor has a different type of conductivity compared with Fig. 2a. The starting material of the structure is cheap and simple. A drawback is the relative complexity of providing for the reproducibility and inspection of the elastic element's thickness. This is the structure of most of the transducers described in [2-7].

Structure II (and the similar structure VI) has more costly starting material which consists of a plate with a substrate of the n⁺-type and an n-epitaxial layer (Fig. 2b). It has good reproducibility and the thickness of the transducer's elastic element can be controlled simply by using special kinds of etching that are self-stopping at the n-n⁺ interface.
Fig. 2

The other properties are the same as for the structure in Fig. 2a. It is the structure of the transducers described in [8, 9].

Structure III (VII) (Fig. 2c) is similar to the foregoing with respect to reproducibility and thickness control of the transducer's elastic element. With a substrate (base) of opposite conductivity to the epitaxial layer (elastic element) it becomes possible to perform an insulating diffusion deep within the epitaxial layer and thereby to obtain electrical insulations for components including bipolar transistors. It is expedient to utilize this structure when it is necessary to integrate on the base electronic circuitry (amplifiers, analog-digital converters, etc.) such as, e.g., in the case of the integrated circuit of the pressure transducer described in [10]. Similar structures are also described in [11].

Structure IV (VIII) (Fig. 2d) is an alternative to the previous variant (Fig. 2c) with the advantages of oxide insulation for the components integrated on the base and with the drawbacks of the "Opik" process. Besides this, both sides of the elastic element can be coated with the same oxide, which is important not only for protecting the surface of the diaphragm from the environment but also for reducing the temperature errors of the transducers as well as extending the range of linear conversion by eliminating the initial flexure in the diaphragm that occurs in thin silicon diaphragm having the Si–SiO₂ structure due to the difference between the temperature coefficients of linear for silicon and silicon dioxide. One disadvantage is the relative complexity of reproducing and checking the shape of the elastic element as a result of the isotropic character of etching polycrystalline silicon [2].

Structure IX (Fig. 2e) is convenient for the creation of transducers that operate over a broad temperature range because of its oxide insulation of the strain-sensitive components from one another. It is notable that in this structure the elastic element can be separated from the base by a silicon dioxide layer which, as in the case of the preceding structure, makes for good reproducibility of the elastic element's thickness. A similar structure is typical for some high-temperature transducers of the Kulite company [13].

Structure X (Fig. 2f) combines the possibility of well-controlled shape and thickness of the transducer's elastic element [14].

Structure XI (Fig. 2g) is often called in the literature "silicon-on-sapphire" or an SOS-structure. Transducers having such a structure are described in [15, 16]. Their characteristics and a comparison with pure silicon structures merit special consideration.