The existing pneumatic systems which serve to measure distances and are designed on the nozzle-vane principle (Fig. 1a) have relatively small measurement ranges. Figure 2 shows such a system's characteristic \( h = f(S) \) (curve 1) for the measuring nozzle diameters \( d_1 = 1.6 \text{ mm} \) and \( d_2 = 2 \text{ mm} \) and a working pressure \( H = 1.5 \cdot 10^5 \text{ N/m}^2 \). It will be seen from this curve that its linear section amounts to 0.2 mm (for a linearity of 2-3%). It should also be noted that the working section of the characteristic is fairly close to the end of the measuring nozzle. The measuring gap within the linear section amounts to \( S = 0.15-0.35 \text{ mm} \). The small measurement limits and measuring gaps limit the possible applications of pneumatic instruments.

There exist several methods for increasing both the measurement range and the measuring gap \( S \) of pneumatic instruments. The most simple of them consists of increasing the parameters \( d_1, d_2, \) and \( H \). However, this raises the discharge of air and makes the instrument less economical. Moreover, with large air flows the measuring process is accompanied by a disagreeable noise. Therefore, at present we use the following pneumatic instrument's parameters: \( d_2 \leq 2 \text{ mm} \) and \( H \leq 2 \cdot 10^5 \text{ N/m}^2 \). The input nozzle diameter is set in the range of \( d_1 = 0.6-1.6 \text{ mm} \) according to the sensitivity requirements of the instrument.

Another method for extending the measurement range is applied in the so-called ejector system shown in Fig. 1b. In this case the input and measuring nozzles with diameters \( d_1 \) and \( d_2 \) respectively are placed at a small (0.3-0.5 mm) distance from each other, with the measuring nozzle length being 20-25 mm [1]. Such a construction provides a considerably larger measuring gap \( S \), with a slightly increased linear measurement section and sensitivity within its range.

Figure 2 shows the characteristic \( h = f(S) \) of the ejector system (curve 2) for the same parameters as in the above-mentioned ordinary system (\( d_1 = 1.6 \text{ mm}, d_2 = 2 \text{ mm}, H = 1.5 \cdot 10^5 \text{ N/m}^2 \) and \( l = 22 \text{ mm} \)). It will be seen that curve 2 crosses the axis of abscissas into the rarification range. The measuring gap then attains \( S = 0.5-0.9 \text{ mm} \). A higher working section of the characteristic is attained by a close location of the input and the measuring nozzles. Owing to this arrangement the losses of air at the input of the measuring nozzle are reduced and the rate of flow is increased in the clearance between the input and output nozzles. The latter produces an ejector effect, and the chamber between the nozzles, which is connected to the sensing element of the reading device, is provided with a rarification (see Fig. 2) whose value depends on the clearance under the measuring nozzle.

The most interesting feature for the practical application of ejector systems consists of their large measuring gap. This characteristic serves to extend the application range of contactless static instruments, in particular of the process-control instruments. The ejector systems are suitable for placing the measuring nozzle at a large distance from the tested component, and in the case of process control of machining with large tolerances (0.5-0.8 mm).

Difficulties may arise in placing the ejector systems in measuring devices (for instance, in pneumatic plug gauges) with relatively long measuring nozzles. In this case it is advisable to use systems with the so-called detached ejector which has been experimentally investigated by us.

Schematics of measuring systems with a detached ejector are shown in Fig. 3. The detached ejector, as a normal one, is 20-25 mm long and consists of the input and measuring nozzles of diameters \( d_1 \) and \( d'_2 \), respectively, with the latter connected either to a single (Fig. 3a) or a double (Fig. 3b) measuring nozzle which has a diameter \( d_2 \) and is located in the measuring attachment. The reading device is connected either between the ejector nozzles, or between the ejector and the measuring nozzles. In the first instance the instrument is more sensitive and attains the rarification range.

Figures 4, 5, and 6 show the characteristics \( h = f(S) \) and \( h' = f(S) \) of a detached ejector system with a single measuring nozzle of diameter \( d_{z} = 2.5 \) mm, and with two measuring nozzles of diameters \( d_{z} = 1.5 \) mm and \( d_{z} = 2 \) mm, respectively. The parameters of the detached ejector are: \( d_{1} = 1.6 \) mm, \( d'_{2} = 2.0 \) mm, \( l = 22 \) mm, and a working pressure \( H = 1.5 \cdot 10^{5} \text{ N/m}^{2} \). In order to obtain the required sensitivity and coverage of the working characteristic, the measuring nozzle diameter \( d_{z} \) should be larger than that of the ejector’s output nozzle. It will be seen from the