

THE FEATURES OF INTERVENTION IN THE CONSTRUCTION OF GAS METERS USING THE ACTION OF FOREIGN OBJECTS

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This article is devoted to the study of the construction features of gas meters of the membrane type and the principles of their operation. Traces of the mechanical action of foreign objects discovered and studied in the process of expert practice, which arise when interfering with the measuring and counting mechanisms of membrane-type gas meters, were analyzed. With the help of which changes could be made in the construction of parts and assemblies of measuring and counting mechanisms of membrane-type gas meters. According to the authors, the complex of studies carried out gives grounds to summarize that in the expert-trasological study of membrane-type gas meters, it is necessary to take into account their design features and principles of operation in order to identify possible interventions in the measuring and counting mechanisms of membrane-type gas meters during the examination.

Keywords: *gas meter, the casing, measuring mechanism, counting mechanism, connecting fittings, deflector, meter valve, measuring mechanism rollers.*

Introduction. Manufacturers of gas meters are constantly improving the construction features of these devices, but the increase in the cost of energy carriers led to the spread of cases of theft of natural gas by consumers, as a rule, by interfering with the operation of metering devices. The methods of unauthorized disclosure and interference in the operation of gas meters are not only being improved, but videos of the process of disclosure and interference are often posted on the Internet.

Despite the constant modernization of the construction features of gas meters, they increasingly become objects of expert traceological research. This article describes the most characteristic traces that appear when interfering with the construction of measuring and counting mechanisms of accounting devices.

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Aim. Therefore, the purpose of this study is to identify traces of mechanical and other influence of extraneous objects, which could be used to make changes in the construction of measuring and counting mechanisms of accounting devices.

Results. The expert (forensic) research of membrane-type gas meters is carried out in accordance with the following stages:

- 1) detailed research of objects:
 - a separate research;
 - a comparative research (if necessary, depending on the tasks assigned to the expert);
- 2) expert experiment (if necessary, depending on the tasks set before the expert); evaluation of the results of the conducted research and formulation of conclusions;
- 3) drawing up an expert's conclusion and drawing up an illustrative table.

The Dnipropetrovsk Scientific Research Institute of Forensic Expertise of the Ministry of Justice of Ukraine quite often receives membrane-type gas meters for expert examination. Their research requires knowledge about the construction of these metering devices, the principle of operation, possible options for interfering with the operation of membrane-type gas meters and changing their construction.

Let's first consider the construction features of gas meters of the membrane type. Counters consist of three main components: a metal case, a measuring mechanism and a counting mechanism.

The metal case consists of two parts: upper and lower, which are hermetically connected to each other. The measuring mechanism is placed in the middle of the case.

On the upper part of the case there are connecting pipes (input and output) for installation to the pipeline.

In order to protect against unauthorized interference with the operation of the gas meter by penetrating the inside of the meter through the inlet nozzle (gluing magnetic materials to the valves or other actions to change the construction of the gas meter) and to protect against contamination of the working surfaces on the inlet pipe, in the middle of the meter can be installed deflector (a device to protect against pollution and interference) [1].

The measuring mechanism of the counter consists of: 2 hermetic chambers; the internal volume of the chambers is divided into two parts by a gas-tight membrane. The middle of each membrane is connected to the valves of the distribution system and the shaft of the metering device through a system of levers. The valve seat of the distribution system (spool pair) is hermetically attached to the inlet/outlet openings of the chambers. The outlet of the meter and two valves (Fig. 1, mark 1) are installed on the valve seat, which are connected to the lever system (crank-lever mechanism) and can move on the seat along a given trajectory (Fig. 1, mark 2). When gas is supplied to the meter, gas is alternately displaced from one

working chamber to another. Their movement turns into a rotary one, which is then transmitted to the counting mechanism.

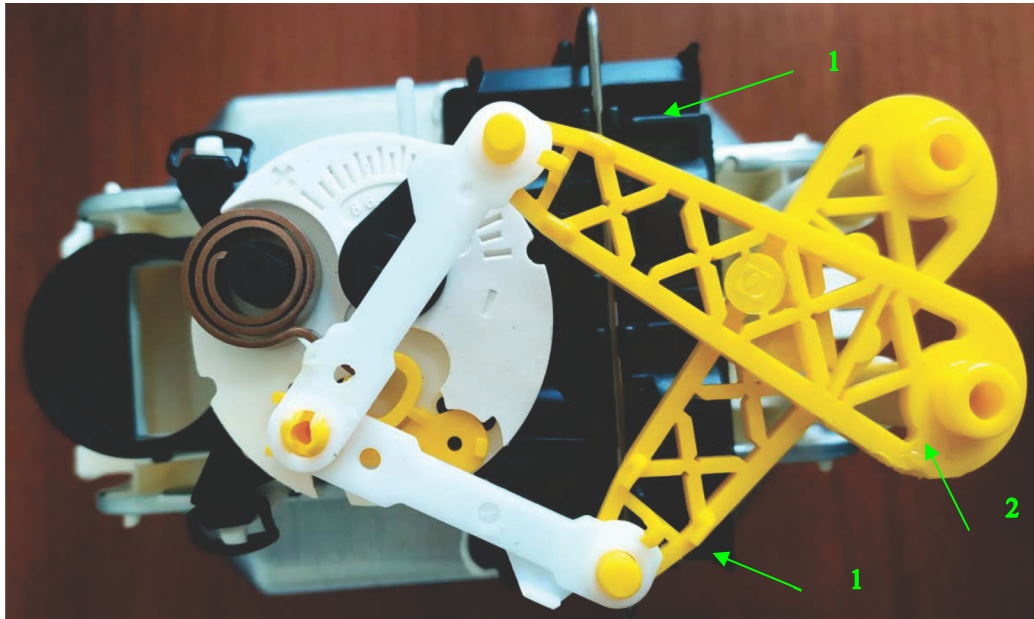


Figure 1 - Image of the measuring mechanism of a membrane-type gas meter (top view), where: 1 - valves, 2 - crank-lever mechanism

Parts and measuring mechanism nodes for membrane-type gas meters are usually made of plastics. Meter manufacturers note that the use of plastic measuring mechanisms significantly reduces the cost of production, increases resistance to the action of chemical gas components, significantly reduces the coefficient of friction in the moving parts of the mechanisms, and prevents interference with the operation of the meter by means of magnetic influence.

The counting mechanism of the gas meters is mechanical drum, is attached to the top of the counter housing, is usually placed in a plastic housing with a sight glass and is sealed with seals. The counting mechanism consists of a system of gears and rollers. The rotating movements of the gears, through the teeth, are transferred to the rollers of the eight roller unit of the counting mechanism. The eight roller unit consists of 5 black rollers and 3 red rollers and 7 transfer rollers between them. That is, the movements of the metering mechanism are turned into the rotating movements of the eight counting (counting) roller unit by means of the transfer gears.

The indicators are displayed in m^3 with 5 rolls before the goat and three rolls after the goat.

So the gas passing through the counter leads to a verbal movement of the measuring mechanism membrane. The lever system and the distribution system turns the verbal-progressive movement of the membranes into a rotating movement of the check mechanism.

That is, the counting mechanism is carried out in such a way that it can calculate the gas consumption for a specific period of time. These calculations are processed in digital equivalent. The digital reading is displayed on the counter mechanism housing panel.

Some models of gas meters provide for the use of a low frequency pulse generator mounted in a special socket on the metering mechanism housing.

In order to improve the protection of counters from unauthorized interference in their work, during the commissioning of the counter, it is necessary to break not only the counter mechanism, but also the gas pipeline to which the counter is mounted, the seal of the gas supply or operating organization.

Recently, during the investigation of gas meters, the expert is most often assigned to the task of detecting changes in the construction of the measuring mechanism by applying on the surface of the valve of the switchgear of the permanent magnet and making changes in the construction of the metering mechanism by removing the reference part of the metering disc.

Traces of mechanical influence of external objects, indicating possible changes in the construction of accounting devices are usually found already at investigation of external surfaces of gas meters. These are traces of different action in the form of damage to the paint coating, localized on the rear outer surface of the cover of the gas meter body (in some cases on the outer upper surface of the cover of the body) and closer to the right side surface (when using fabrics as lining for external magnesium, can be detected coating of colored matter) and on the mounting sections of the plastic housing of the counter mechanism with the sight glass to the top of the metal housing of the gas counter.

As the expert practice has shown, changes in the construction of the measuring mechanism of the accounting devices are introduced by damage or removal of seals stickers, seals of the factory-producer or the state-carrier, access through the inlet fitting of the upper part of the housing to the mechanisms of the measuring mechanism of the counter with the afterinstallation of additional equipment (magnet).

Changes in the construction of the checking mechanism are made by removing the seals of the manufacturer or the state check-box, damage to the integrity of the seal of the sticker (if available), removal of the plastic housing of the checking mechanism with inspection glass. After that, the roller wheel shaft is removed to remove the roller support, etc. Installation is carried out in reverse order with installation of additional spring.

After that, using external magnet, the measuring or counting mechanism of the counter [2] is stopped by simple manipulation. And, consequently, the possibility to calculate gas costs and to process costs in digital equivalent is stopped.

In this case, the investigation is subject to external and internal surfaces of the counter-gauge housing, internal surfaces of the inlet tube, the surfaces of the protective deflector (if

available), the surfaces of the measuring mechanism parts.

The research is also subject to:

- stickers-seals (in case of receipt for examination of meters, the inlet and outlet of which are closed with plugs sealed with stickers-seals or plastic and metal housings of the counting mechanism sealed with stickers-seals). Check their integrity, the presence of traces of mechanical and thermal impact on their surfaces and surfaces that were to be sealed in the border zone with stickers, discoloration, the presence (absence) of visually visible hidden inscriptions "OPENED OPENED", traces of adhesive layering, etc.;

- the seal of the gas supply or operating organization and the sealing material used to seal the gas pipeline to which the meter or the plastic and metal housings of the meter are mounted. Check their integrity, the presence of traces of mechanical and thermal impact on their surfaces and surfaces that were to be sealed.

Traces of the mechanical impact of foreign objects, which arise when changes are made to the construction of the measuring mechanism, by gluing to the surface of the valve of the distribution system of the magnet, can be located:

1) on the inner surfaces of the inlet nozzle in the form of scratches (Fig. 2, mark 1) and layering of the adhesive substance. In the absence of a protective deflector, in laboratory conditions, using magnified optical devices (microscopic examination), through the inlet pipe on the plastic parts of the crank-lever mechanism, it is possible to detect traces of the action of foreign objects (Fig. 3, mark 1) and layering of the adhesive substance;

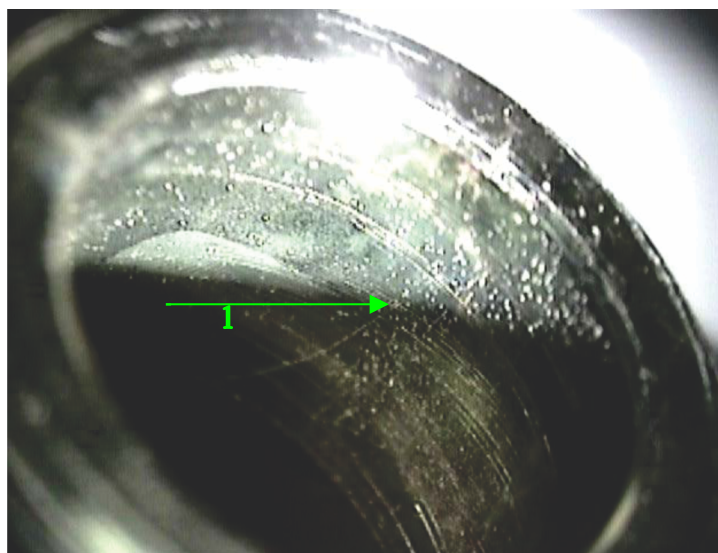


Figure 2 - Image of the internal surfaces of the inlet pipe of the membrane-type gas meter, where: 1 - traces in the form of scratches

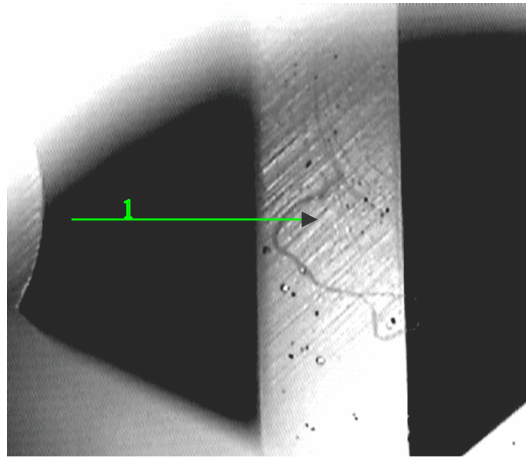


Figure 3 - Image of fragments of a plastic part of the crank-lever mechanism, made with the MBS-10 microscope at 8 times magnification, where: 1 - traces of the action of foreign objects

- 2) on the outer surfaces of the protective deflector (if it is present) in the form of residual deformation;
- 3) on the inner surfaces of the protective deflector (if it is present) in the form of scratches, dents, layers of adhesive;
- 4) on the inner surfaces of the upper part of the meter body in the form of scratches and adhesive layering;
- 5) on the plastic parts of the crank-lever mechanism in the form of scraping of the plastic, scratches and layering of the adhesive (Fig. 4, mark 1-2);
- 6) on the outer surfaces of the valve of the distribution system in the form of scratches, layering of an adhesive substance that can reflect (as a trace-absorbing substance) volumetric traces of foreign objects and existing foreign objects (Fig. 5, mark 1).

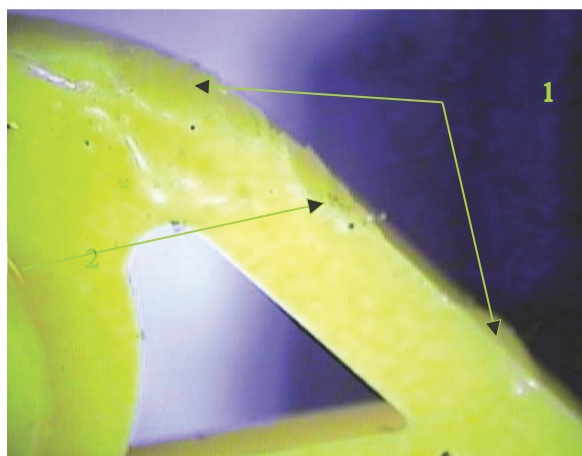


Figure 4 - Image of a fragment of a plastic part of a crank-lever mechanism made with the MBS-10 microscope at 8 times magnification, where: 1 - layering of the adhesive substance, 2 - traces in the form of plastic scrapings

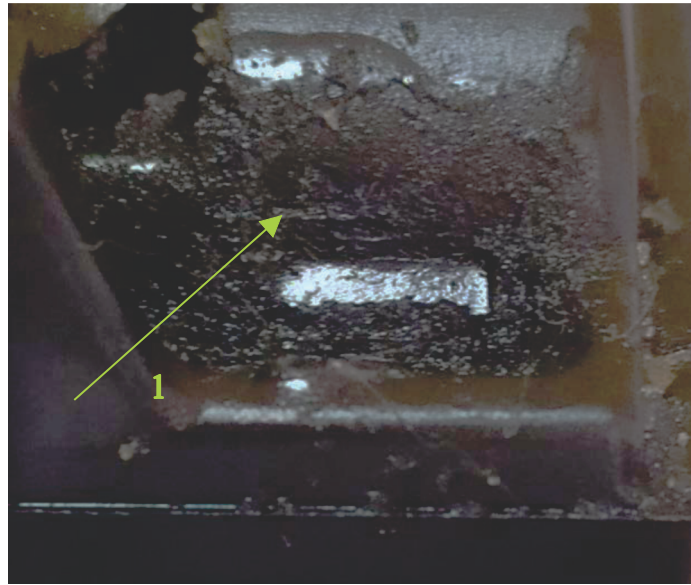


Figure 5 - Image of a fragment of a distribution system valve made with the MBS-10 microscope at 8x magnification, where: 1 - layering of an adhesive substance

Traces indicating interference in the construction of the measuring mechanism of the metering devices can be detected already when examining the internal surfaces of the inlet pipe using magnifying optical devices. But it is possible to make a categorical conclusion about making changes to the construction of the measuring mechanism by sticking a magnet on the valve surface of the distribution system only after examining the internal surfaces of the metering devices.

Traces of the mechanical impact of foreign objects, which occur when changes are made to the construction of the counting mechanism, are usually reflected on the internal surfaces, these are:

- 1) traces in the form of scratches and dents on the surfaces of the roller axis retainers of the counting mechanism, on the end surface of the axis itself or on the roller surfaces;
- 2) the available items are not provided by the construction of the manufacturing plant (wire, spring, etc.);
- 3) there are traces of foreign objects in the form of scratches, scrapes, dents, lack of supporting parts of roller protrusions, etc. on the surfaces of the counter roller (Fig. 6, mark 2, Fig. 7, mark 1).

It should also be noted that when the manufacturer changes the construction of gas meters or elements of accounting devices, new ways and methods of unauthorized interference in their work arise, which are constantly improved in order to hide offenses.

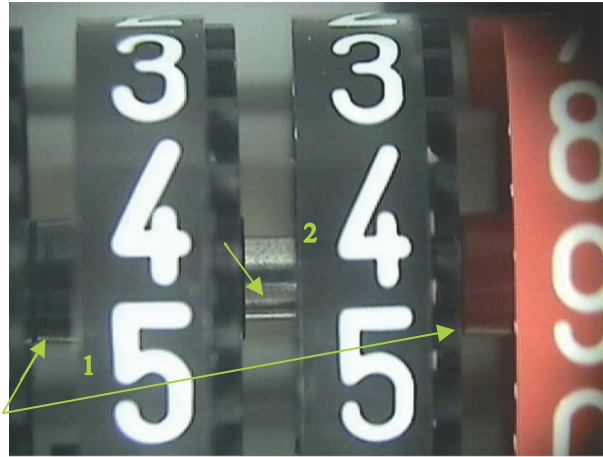


Figure 6 - Image of a fragment of the eight-roller block of the counting mechanism of the gas meter, made with the MBS-10 microscope at 8 magnification, where: 1 - the supporting part of the rollers, 2 - the missing supporting part of the rollers

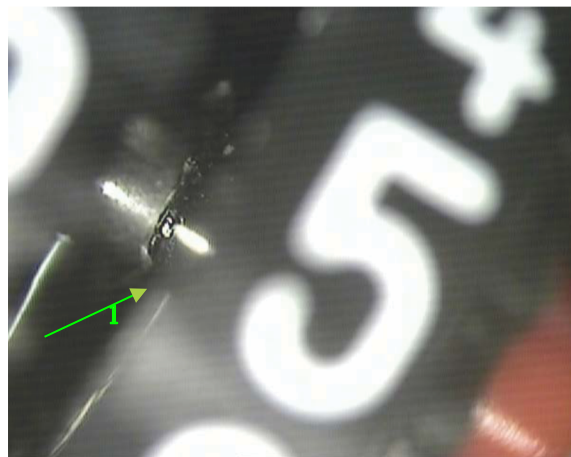


Figure 7- Image of a fragment of a roller with a missing supporting part, made with the MBS-10 microscope at 16 times magnification, where: 1- traces of object the action of a foreign

Expert practice provides an opportunity to analyze the signs researched during the examination of the external and internal surfaces of the metering devices and to determine the most characteristic locations of traces of extraneous action arising from unauthorized intervention in the measuring and counting mechanisms of membrane-type gas meters and to detect a change in their construction.

Conclusion. The set of conducted studies gives reason to draw conclusions that during the expert traceological study of membrane-type gas meters, it is necessary to take into account their construction features, as well as the study of metering devices requires knowledge of the principle of their operation, possible options for intervention in the

measuring and counting mechanisms of membrane-type gas meters and ways to change them structures.

Despite the improvement of methods of theft of energy carriers, traces of interference in their work are always displayed on the external and internal surfaces of metering devices. The full and scientifically substantiated evidence of interference in the operation of accounting devices is precisely the conclusion of the experts, which is based on the results of a traceological study conducted in expert institutions using modern forensic equipment.

References

1. Lichyl 'nyky hazu membranni RS. Nastanova shchodo ekspluatuvannya SMUK.407369 RE TOV «SAMHAZ» [Membrane gas meters RS. Instruction on the operation of SMUK.407369 RE SAMGAZ LLC]. Available at: https://www.samgas.com.ua/sites/default/files/_samgaz_re_red_0_6_3_10-12-2018_14.pdf (accessed 5 October 2022).
2. Hryzodub V.M., Datsenko S.A. (2019). *Trasolohichne doslidzhennya lichyl'nykiv hazu membrannoho typu* [Trasological study of membrane-type gas meters]. Visnyk ONDYSE [Bulletin of Odesa Research Institute of Forensic Expertise]. No. 5.
3. Levytskyi A.O., Kazavchinsky D.Yu. (2012). *Indykatorni plomby: ustriy, ekspluatatsiya ta trasolohichne doslidzhennya* [Indicator seals: device, operation and trasological research]. Odesa: Yzdatel' stvo tsentr. 280 p.
4. Shchukin O., Guzenko V., Moiseyev O. and others (2010) *Zapirno -plombuval'ni prystroyi yak ob' yekt kryminalistychnoho doslidzhennya* [Locking and sealing devices as an object of forensic research]. Lviv: LNISE (Lviv Research Institute of Forensic Expertise). 96 p.
5. Lichyl 'nyky hazu membranni SAMHAZ nastanova shchodo ekspluatuvannya SMUK.407369.014: RE [SAMGAZ membrane gas meters, instructions for operation A RE:] vailable at: http://samgas.com.ua/sites/default/files/lych_samgaz_re_zm4.pdf (accessed 5 October 2022).

ԳԱԶԻ ՀԱՇՎԻՉՆԵՐԻ ԿԱՌՈՒՑՎԱԾՈՒՄ ՕՏԱՐ ԱՌԱՐԿԱՆԵՐԻ ՕԳՏԱԳՈՐԾՄԱՄԲ ՄԻՋԱՄՏՈՒԹՅԱՆ ԱՌԱՆՁՆԱՀԱՏԿՈՒԹՅՈՒՆՆԵՐԸ

Ջակովիրկո Օ.Մ., Մայսարենկո Օ.Ի., Կովզել Մ.Ա., Բիլա Ա.Վ.

Սույն հոդվածը նվիրված է մենբրանային տիպի գազի հաշվիչների կառուցվածքային առանձնահատկությունների և դրանց աշխատանքի սկզբունքների ուսումնասիրությանը: Վերլուծվել և ընդհանրացվել է փորձագիտական գործունեության ընթացքում օտար առարկաների ազդեցությամբ գազի մենբրանային տիպի հաշվիչների հաշվարկաչափումային մեխանիզմների վրա մեխանիկական միջամտության հետքերի

հայտնաբերման գործնական փորձը: Հողվածում ներկայացված են այն բնորոշ հատկանիշները, որոնցով կարող են փոփոխություններ կատարվել մեմբրանային տիպի գազաչափերի հաշվարկաչափումային մեխանիզմների մասերի և հանգույցների կառուցվածքում:

Հեղինակների կարծիքով՝ կատարված հետազոտությունների համալիրը հիմք է տալիս ամփոփելու, որ մեմբրանային տիպի գազաչափերի փորձագիտա-հետաքրքրանական հետազոտության ժամանակ անհրաժեշտ է հաշվի առնել դրանց կառուցվածքային առանձնահատկությունները և շահագործման սկզբունքները՝ փորձաքննության ընթացքում մեմբրանային տիպի գազաչափերի հաշվարկաչափումային մեխանիզմներում միջամտությունների հնարավոր տարբերակները հայտնաբերելու համար:

Բանալի բառեր. գազային հաշվիչ, արկղ, չափման մեխանիզմ, հաշվարկային մեխանիզմ, միացնող կցամաս, դեֆլեկտոր, չափիչ փական, չափիչ մեխանիզմի հոլովակ:

ОСОБЕННОСТИ ВМЕШАТЕЛЬСТВА В КОНСТРУКЦИЮ СЧЕТЧИКОВ ГАЗА С ИСПОЛЬЗОВАНИЕМ ДЕЙСТВИЯ ПОСТОРОННИХ ПРЕДМЕТОВ

Заковырко О.М., Майстренко О.И., Ковзел М.А., Була А.В.

Данная статья посвящена изучению конструктивных особенностей счетчиков газа мембранного типа и принципов их работы. Проанализирован и обобщен практический опыт по обнаружению и изучению в процессе экспертной практики следов механического воздействия посторонних предметов, возникающие при воздействии на измерительно-счетные механизмы счетчиков газа мембранного типа. В статье исследуются характерные признаки, с помощью которых могли быть внесены изменения в конструкцию деталей и узлов измерительно-счетных механизмов счетчиков газа мембранного типа. По утверждению авторов, комплекс проведенных исследований дает основание резюмировать, что при экспертно-трасологическом исследовании счетчиков газа мембранного типа необходимо учитывать их конструктивные особенности и принципы действия с целью выявления в ходе экспертизы возможных вариантов вмешательств в измерительно-счетные механизмы счетчиков газа мембранного типа.

Ключевые слова: газовый счетчик, корпус, измерительный механизм, счетный механизм, соединительная арматура, дефлектор, измерительный вентиль, ролики измерительного механизма.

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