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THREADED VACUUM CONNECTION

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In vacuum systems that are using pumps to create high vacuum, in emergencies, such as power outages, there is a possibility that cold oil from the rough-vacuum pumps can get into the hot oil of the steam-oil pumps. To prevent such emergency situations, automatic electric vacuum valves are usually used to close the series connection between the rough-vacuum and steam-oil pumps. The article proposes, manufactures and tests a new connection model of the device, consisting of an automatic valve and a rough vacuum tank in a vacuum system.

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INTRODUCTION

Vacuum connections in accelerator systems constitute the main part of the vacuum device. It`s main purpose is ensuring a tight connection of all elements of the vacuum system, both extended accelerators and “tabletop”. The mane problem of all vacuum connections is possible incompatibility with other elements of vacuum systems because of nonstandard connecting parts design. In particular [1], connecting elements lack of structural parts necessary for providing sealing reliable for vacuum systems. The article is considering creation of new vacuum connection that can be used with the mentioned type of connecting parts. The vacuum connection is used in modification of vacuum system of experimental installation [2] to add automatic electric vacuum valve [1]. This modification is necessary to prevent possibility that cold oil from the rough-vacuum pumps can get into the hot oil of the steam-oil pumps in case of emergencies, such as power outages.

1. VACUUM CONNECTION

According to the technology, vacuum connections must ensure quick and repeated disassembly and assembly of each connecting node, ensuring minimal leakage, while having a simple manufacturing technology.

Typically, the connecting nodes have clamping sealing mechanism, and the sealing element is metal [3] (soft aluminum, copper) or dielectric [4] (vacuum rubber, Teflon). Several examples of connecting nodes are given in ref. [1]. In the vacuum flange connection in Fig. 1 [1], a copper gasket 1 is used as a sealing element.

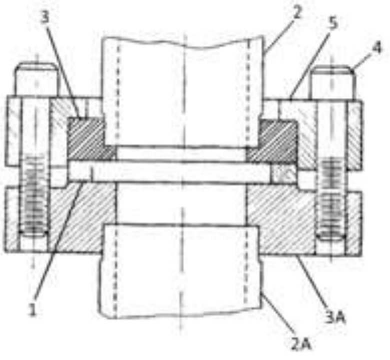


Fig. 1. Flange connection with copper gasket: 1 – copper gasket; 2 and 2A – pipes; 3 and 3A – sealing flanges; 4 – clamping bolts; 5 – socket flange

Sealing flanges 3 and 3A are soldered to pipes 2 and 2A. Vacuum sealing is achieved by pressing the gasket 1 with six bolts 4, which tighten the cap flange 5 to the flange 3A. Fig. 2 [3] shows a vacuum connection of pipes 1 and 1A, which have conical ends and annular slots for inserting half rings 2. The connection provides a seal using a thin copper gasket 3. Initially, the gasket is completely flat, but during translational movement, carried out by rotation along the threads of the two flanges 4 and 4A, it is deformed by the pressure of the half-rings 2 and takes on a conical shape at the ends of the pipes 1 and 1A, providing a vacuum sealing.

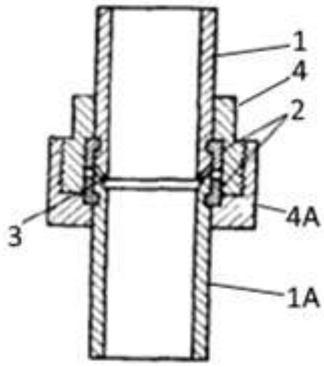


Fig. 2. Vacuum pipe connection: 1 and 1A – pipes; 2 – half rings (4 pcs.); 3 – copper gasket; 4 and 4A – flanges

Figs. 3 and 4 in ref. [2] show two vacuum connections on a rubber seal. On the inner part of part 1 (see Fig. 3), a profile is milled according to the author's figure. Nut 2, pressure ring 3 and rubber seal 4 are sequentially put on the vacuum pipeline. When nut 2 rotates from the thread of part 1, it transmits mechanical force to rubber seal 4 through pressure ring 3. Thus, a vacuum seal is created. Fig. 4 shows a telescopic seal [2]. A ring 6 with an outer diameter larger than the diameter of the pipe 3 and an inner diameter equal to the inner diameter of the pipe 3 is soldered (welded) to the end of the pipe 3. A coupling 5 with an internal thread is first put on this pipe 3 with a sliding fit according to the drawing. A nut 2 with an external thread according to the thread on the coupling 5 and a rubber seal 1 are put on the second pipe 4, with a sliding fit, smaller in outer diameter than the inner diameter of the pipe 3. This assembly is inserted inside the pipe 3. The translational movement of the nut 2 transmits a pressing action to the seal 1.

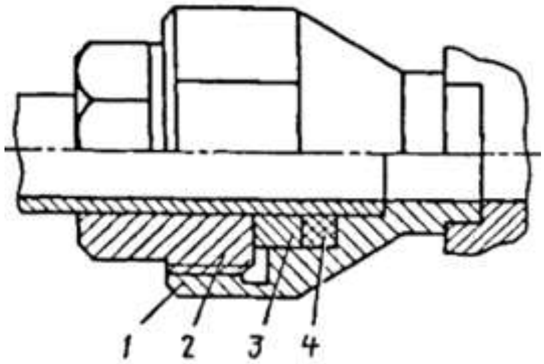


Fig. 3. Nipple connection with rubber seal:
1 – part; 2 – nut; 3 – clamping ring; 4 – rubber seal

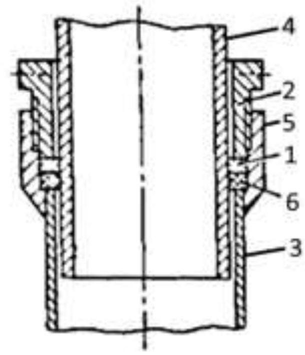


Fig. 4. Telescopic seal: 1 – rubber seal;
2 – coupling with external thread; 3 and 4 – pipes;
5 – nut with internal thread; 6 – ring

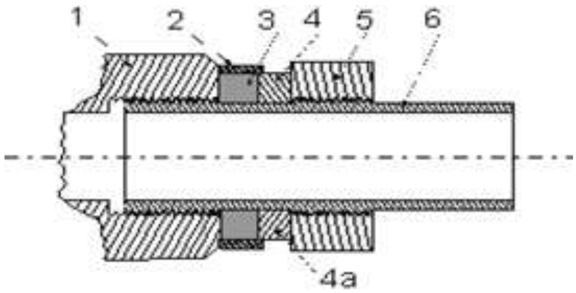


Fig. 5. Diagram of the created vacuum connection:
1 – standard valve body; 2 – restrictive ring;
3 – vacuum rubber; 4 and 4a – half rings;
5 – clamp nut; 6 – threaded pipe

Fig. 6. Emergency valve with 2 copies of created vacuum connection: 1 – standard valve body;
2 – restrictive ring; 3 – half rings; 5 – clamp nut;
6 – threaded pipe; 7 – intermediate washer;
8 – electromagnetic valve control

Since the connection models discussed above are not suitable for usage with the automatic wale, used in experimental system, described in ref. [3], conditions, a connection that meets the task is reliable, and easy to manufacture, was developed (Fig. 5). On pipe 6, which serves as an extension of the vacuum line, a thread was made with a size of 1/2" of the thread of the valve body. At some distance from the edge of the pipe 6, a recess is made, equal in diameter to a diameter slightly smaller than the diameter of the thread on the valve, and equal in width to the sum of the thickness of the rubber seal 3 and the thickness of the half-rings 4, 4a. The diameter is equal to the inner diameter of the ring 2. It should be noted that when the clamping nut 5 is rotated, due to poor sliding between the half-rings 4 and 4a and the clamping nut 5 (this can occur as a result of poor surface treatment of parts 4 and 5), the half-rings may rotate and the vacuum rubber may be rubbed (crushed), which can lead to a violation of the vacuum seal. To avoid such cases, the rubbing surfaces are lubricated with diffusion oil or an intermediate washer is installed. The vacuum seal between the half rings 4 (4a) and the rubber ring 3 is achieved as a result of the translational movement of the nut 5. This design was manufactured, tested and showed reliable sealing (Fig. 6).

2. VACUUM SYSTEM MODIFICATION

Created vacuum connection is used to implement automatic valve in the experimental installation "Volna" [2]. The rough-vacuum system (Fig. 7) includes: rough-vacuum pumps 6 and 8 for pumping out chamber 1; three diffusion pumps 2, 3 and 4 perform pumping to high vacuum in chamber 1; rough-vacuum pump 6 maintains rough-vacuum in the diffusion pumps when clamps 5 are open. In an emergency situation (unforeseen power outage in the network 9), valve 7 [1] closes the rough-vacuum path, avoiding suction of rough-vacuum oil into the diffusion pumps. The vacuum volume of the rough-vacuum tank 10 maintains the rough-vacuum in the diffusion pumps until the oil cools down.

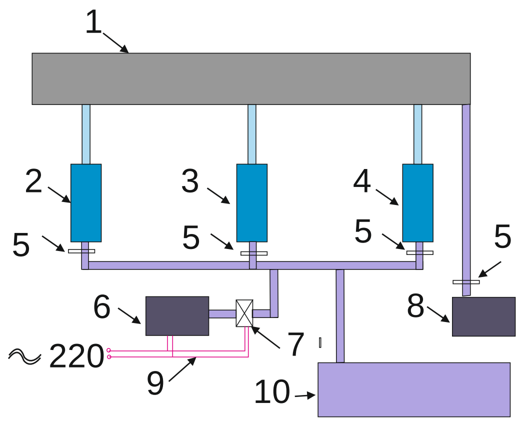
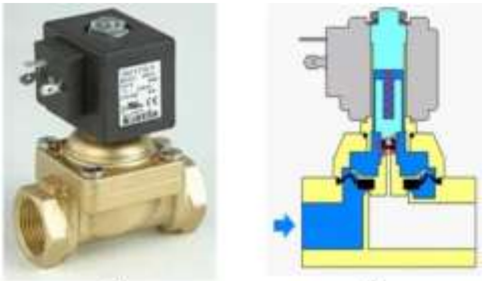


Fig. 7. Scheme of the modified vacuum system
(description of elements is given in the text)

Fig. 8 [4] shows a vacuum valve that meets the technical requirements of the system for automatic (in the event of an emergency power outage) closing of the vacuum path. It is installed (see Fig. 7, item 7) in the rough-vacuum system of the experimental installation.



A B

Fig. 8. Automatic valve used in system (A). Section of the automatic valve (B)

Using the created vacuum connection, the rough-vacuum tank and automatic vacuum valve [1] were successfully installed in the system [2] matching of the rough-vacuum pump with the rough-vacuum line of the installation. This way, the system was protected from emergency situations, namely, a power outage, which could lead to cold rough-vacuum oil from the rough-vacuum pump getting into the hot oil of the switched-on steam-oil pump.

CONCLUSIONS

Known vacuum connections used in technology were studied and analyzed. Based on the data obtained, a new, non-standard vacuum connection that met the technical requirements for modifying the vacuum system was developed. Using this vacuum connection automatic electrical rough-vacuum valve and rough-vacuum was successfully installed in the vacuum system of experimental installation “Volna” [2]. After the modification, vacuum system was successfully tested for 2 months, with periodic artificial power outages, and showed a high level of a reliability, confirming the effectiveness of the created vacuum connection.

ACKNOWLEDGEMENTS

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РІЗЬБОВЕ ВАКУУМНЕ З’ЄДНАННЯ

Р.А. Мельничук, Г.О. Кривоносов, Г.В. Сотніков

У вакуумних системах, що використовують насоси для створення високого вакууму, в аварійних ситуаціях, таких як відключення електроенергії, існує ймовірність потрапляння холодного масла з форвакуумних насосів у гаряче масло паромасляних насосів. Для запобігання таким аварійним ситуаціям зазвичай використовуються автоматичні електричні вакуумні клапани для замикання послідовного з'єднання між форвакуумними та паромасляними насосами. Запропоновано, виготовлено та випробувано нову модель з'єднання пристрою, що складається з автоматичного клапана та форвакуумного резервуара у вакуумній системі.