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# AN ELECTROMAGNETIC SEAL FOR THE IMPULSE FEEDING OF GASES INTO VACUUM APPARATUSES

(Elektromagnitnyi zatvor dlya impul'snogo napuska gaza v vakumnye vstroistva)

By

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# AN ELECTROMAGNETIC SEAL FOR THE IMPULSE FEEDING OF GASES INTO VACUUM APPARATUSES

SUMMARY

The construction of an electromagnetic seal for the impulse feeding of gases into vacuum apparatuses is described. The seal feeds small bursts of gas into an evacuated chamber at frequencies up to $10^3$ Hz. The long life time of the seal (more than $10^9$ cycles) results from the elimination of stressed metallic components and the use of "Viton" for the vacuum gasket under the valve.

The construction of electromagnetic seals for the impulse feeding of gases into evacuated chambers proposed in [1] ensures the operation of various types of apparatuses which use gas fed in short bursts at a frequency up to 10 Hz. At the same time there is a need for seals with long lifetimes which can function at high frequencies (hundreds of hours at frequencies of $10^2$-$10^3$ Hz). For this reason an improved version of the seal was developed with a longer lifetime and an increased gas flow burst frequency. The long lifetime results from the elimination of stressed metal components from the seal by the use of a gasket made of "Viton" (elastomer IRP 20-43) under the valve and by replacement of the mixed-composition armature with an all-metal one.

The construction of the seal and a diagram of its feeding apparatus are shown in Figure 1. The entire mechanism of the seal is contained in the metallic shell 2 which is filled with the gas being fed. Copper gasket 14, clamped between the base 16 and the body of screw 17, ensures that the seal will be vacuum-tight. The gas flows through measuring orifice 15. Armature 11, made of Armco steel, acts as the valve of the seal.

In the "closed" state the gas is kept from reaching the measuring orifice by the armature whose polished surface is pressed

against the "Viton" saddle 13 and held into the base with four elastic disks 10 (vacuum rubber 9024 "A"). The elastic disks are attached to a ring 9, which is fastened to the base with two screws 7.

The gas flows into the feeding unit when the armature is forced from the saddle by the pulsed magnetic field generated in the gap between the armature and magnetic conductor 5 by an impulse in the current flowing through coil 4. The magnetic conductor is made of an alloy of CrWPt steel (thickness 0.1-0.3 mm). The electromagnet is attached to the ring with two locking screws 3. The size of the working gap (about 0.2 mm) is adjusted with shims between the magnetic conductor and the ring. Support 12, made of viton, prevents contact between the armature and the magnetic conductor. Copper grid 6 and insert 8, decreasing current dispersion, help to concentrate the magnetic field in the working gap.

The activating current impulse, which flows to the coil through electrical contact 1, is discharged from capacitor $C_1$ into the induction coil of the seal's electromagnet. The capacitor is switched from charge to discharge by thyristor switches $T_1$ and $T_2$, respectively, and diode $D_1$. To decrease the amount of energy required and increase the frequency, resonance charge transfer and recharging of the capacitor through inductors (*) and (*) respectively is used. When the electromagnet is activated by a current impulse with a period of (*) 300 μs and an amplitude of (*) 400 ampere-turns, a gas burst is formed which has a duration of (*) 300 μs and a rise time of 100 μs. The amount of gas admitted per impulse depends on the diameter of the measuring orifice, the gas pressure on the valve, and the amplitude of the activating impulse.

The seal constructed in this way works at frequencies up to $10^3$ Hz. In tests the seal was operated at a frequency of (*) 700 Hz for a long time. After $10^9$ cycles (corresponding to (*) 3000 hours of continuous operation at a frequency of 100 Hz) its characteristics had not changed. The seal normally operates at

(*) TRANSLATOR'S NOTE: Original text had blank spaces at these spots.

temperatures under 150°C. If necessary, the temperature may be increased. In this case the rubber disks must be replaced with steel or tungsten springs and the "Viton" saddle must be replaced with a metal one (in this case the base itself acts as the saddle). The opposing surfaces of the armature and saddle are grounded. Under these conditions however, the lifetime of the seal decreases. Tests have shown that valves with saddles made of various materials (copper, aluminum, Cul6Ti alloy, carbon steel, Armco steel, stainless steel, tantalum) permit feeding (*) $10^8$ bursts of gas at a frequency of $10^3$ Hz. These seals stop working because of wear in the armature and the saddle (the measuring orifice becomes clogged by particles resulting from this wear, the seal under the armature is broken).

The authors thank G. I. Dimov for his assistance and fruitful discussion.

## References

[1] G. I. Dimov, PTE, No. 5, 168 (1968).

(*) TRANSLATOR'S NOTE: Original text had blank space at this spot.

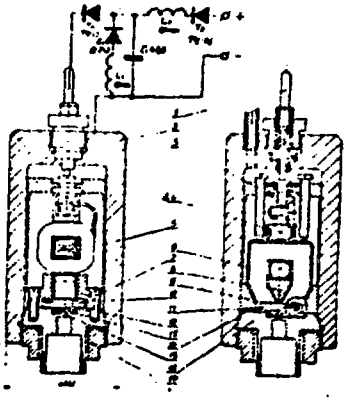

Figure 1. Construction of the seal
1 - inlet, 2 - shell, 3 - lock screw, 4 - coil, 5 - magnetic conductor, 6 - grid, 7 - screws, 8 - insert, 9 - ring, 10 - elastic disk, 11 - armature, 12 - support, 13 - saddle, 14 - gasket, 15 - measuring orifice, 16 - base, 17 - screw.