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A FAST ACTING VALVE WHICH OPERATES AT TEMPERATURES UP TO 400° C*

by

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Magnetically driven acoustic rods have been used to operate fast valves for some time in the field of plasma research.[1] These valves usually incorporate teflon seats and "0"-rings which are satisfactory up to a few hundred degrees Farenheit before permanent deformation occurs.

Recently it has become desireable to incorporate hot passive vacuum surfaces rather than cold active ones in plasma experiments. In order to remove impurities from surfaces down to a monolayer it is necessary to run these surfaces at temperatures around 600° to 700°F and consequently some new valve must be incorporated.

A major problem in operating such a valve is that the valve must be operated (cycled) while hot and the techniques used on most bakeable commercial valve seats, i. e., a cone and a sharp edge seat, will not work. Tests were conducted using this configuration and various materials but nothing very satisfactory resulted. The major difficulty was that with the high forces required to close these valves they had a tendency to cold weld and when opened while hot the interface was destroyed. Also, if the valve is to be opened while hot the relative coefficient of thermal expansion of the cone and seat materials becomes increasingly important. A valve of this configuration which would seat tight to a leak of less than 10^{-10} std. cc/sec. while hot or cold incorporated a Martinsetic stainless steel cone and a 304 stainless steel seat. These materials gave the greatest number of operating cycles but only a few tens of shots were possible before the leak became appreciable.

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A configuration which eliminated most of these problems and which had a life of several hundred cycles, before it was required to change the seat, is shown in Fig. 1. This valve incorporates a knife edge after Pattee[2] with a 65° included angle ground on the end of the actuating rod. The seat is OFHC copper in a soft condition. A Cu-Au "0"-ring makes up the other seal in the system and is held in compression by a threaded screw with internal hexagon drive. Again, because of the high tip speed, the rod is a hardened Martinsitic stainless, 420 stainless to Brinell 400, which is actuated magnetically.

Several versions of this system have been constructed and the copper seat life has been found to vary from a low of over 200 to over 500 operations with a leak of less than 10^{-10} std. cc/sec. before gradual leak degradation took place. The life depended somewhat on how many heat cool cycles the system went through. Each time on replacing the seat and "0"-ring the valve was again tight. Tests indicate that the life of the seat could be increased by increasing the closing force but no increase in force was required during the cycling mentioned. A 1/2-inch diameter seat like that in Fig. 1 required only 450 pounds of force to close, compared to about 750 pounds for a cone tipped valve of similar size. The valve has been operated up to temperatures of 400° C and no cold welding or interface effects have been observed.

Gas flow is from the region between the housing and the rod through the tight (0.002 inch clearance) guide to a virtual plenum whose gas content is varied by changing the pressure on the back side of the valve. Fast ion gauge studies indicate the gas is emitted quite rapidly and while the rod bounces when the acoustic energy is not removed after the first opening, Fig. 2 shows only one pulse of gas even though during the period of the picture the valve has opened several times.

For cold studies the Cu seat and Cu-Au "0"-ring can be replaced by a similar teflon piece with apparently unlimited life. The necessary closing force is thereby reduced to 75-100 pounds.

REFERENCES

1. J. Marshall, Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, 31, 341; 1958.

2. H. H. Pattee, Rev. Sci. Instr., 25, 1132 (1954).

FIGURE CAPTIONS

Fig. 1 Detail of the valve seat.

Fig. 2 Fast ion gauge measurement of the gas flux. 500 μsec/division.

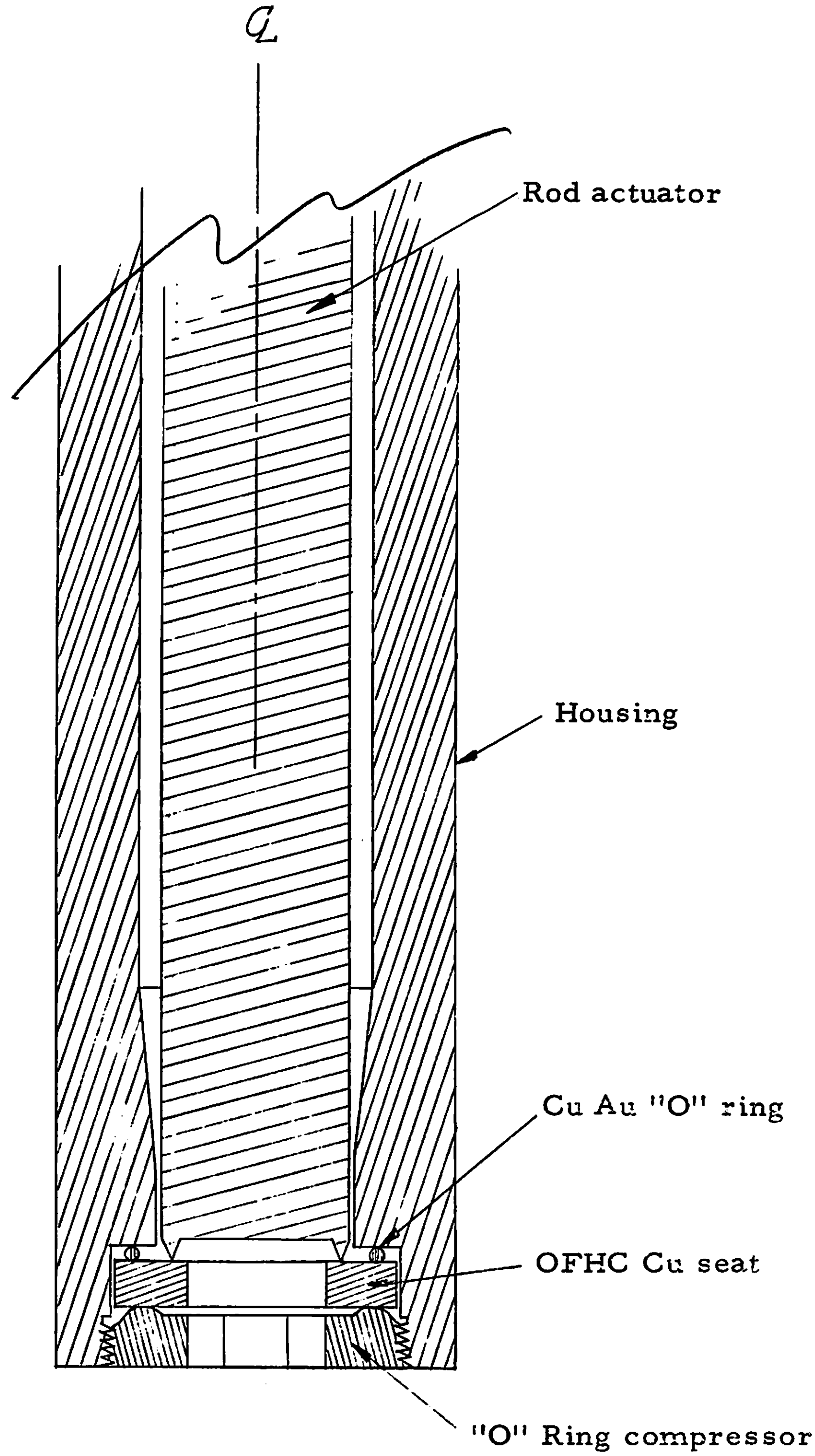

Fig. 1
Detail of the valve seat.

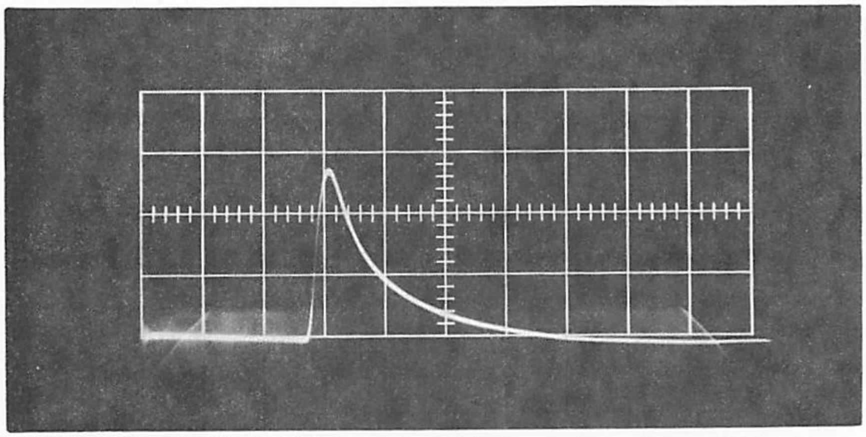

Fig. 2

Fast ion gauge measurement of the gas flux.
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