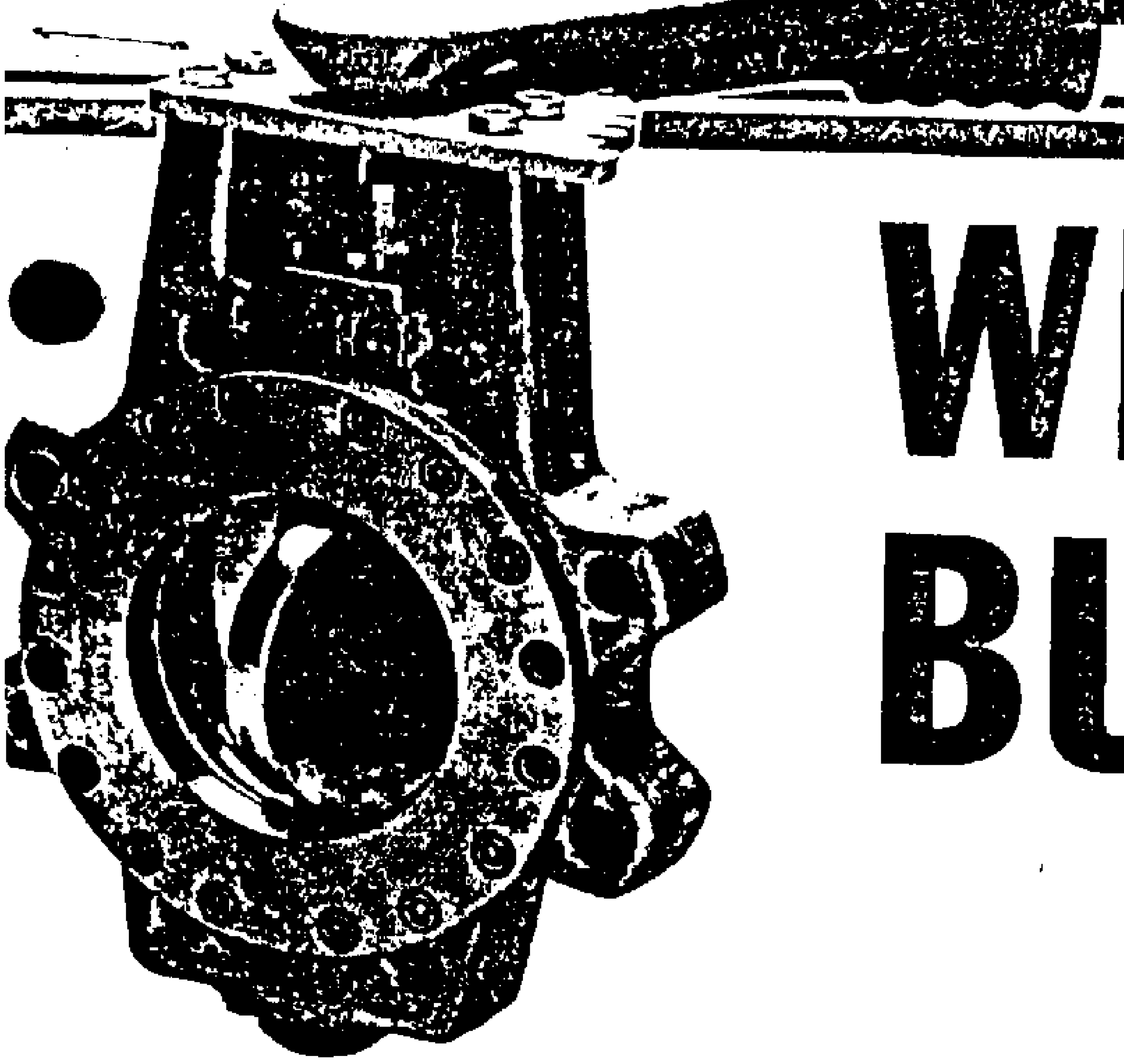

WHY A BUTTERFLY

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e basic concept of the butterfly ve can perhaps be best illustrated comparison with a damper in a e pipe: a round disc, of essential- the same diameter as the pipe, ating on an axis at a right angle the pipe centerline.

Vhen closed, the disc is posi- ned at a right angle to the fluid v; when open, the disc is parallel the fluid flow. The butterfly e is thus a rotary, quarter-turn e.

he name "butterfly" derives om the appearance of the disc assembly, which bears e resemblance to the body and stretched wings of a butterfly.

elopment History

utterfly valves, in the form of pers, have been used as flow trol devices for centuries. In e early devices, the disc had no ing surface as such. The edge he disc merely swept the inner neter of the pipe to alter flow out ever achieving tight shut- The devices were very inexpen- to manufacture since the only s needed were a stem and disc, g the pipe itself as the valve y.

ith the advent of rubber liners, h closed the gap between the edge and the pipe or valve , the damper became a tight- ng valve. While natural rubber s were not successful in this ication, the develoment of syn- c rubbers in the 1950's offered non-sticking, non-swelling char- istics required for acceptable -term sealing.

ft rubber liners seal by allow- e edge of the disc to compress ubber, producing a local con- pressure higher than the line ure. Typically, tight shut-off soft rubber liners is limited to ure differentials on the order 50 psi.

against higher pressures, dge of the disc would have to ely compress the rubber liner, ting in high operating torque destructive wear on the liner. Left in the closed position for an extended period of time under high- er pressures, the rubber tends to deform permanently, bulging out on both sides of the disc edge and making it difficult or impossible to open the valve.

The rubber liner is also limited to temperatures below about 300°F and to fluids that will not have an adverse chemical reaction on the rubber.

The development of tetrafluor- oethylene (TFE) offered a material that has many desirable properties for valve seals and seats. Since TFE is not nearly as resilient as rubber, it could not be directly substituted for rubber in order to upgrade the performance of rubber-lined valves. In fact, much development work had to occur before seats were designed that could exploit the capabilities of TFE and similar plastics in the areas of pressure, temperature, chemical inertness and low operational torque.

The result of these developments transformed the butterfly valve into today's high-performance butterfly valves for pressures up to 1480 psi and beyond.

Economic Factors

The single most important reason for selecting a butterfly valve is its low cost compared to other types of valves on the market today. A related advantage is the compact size and light weight of a butterfly valve, which results from its smaller end-to-end dimensions.

Installation costs, like initial costs, are equally attractive. A small maintenance crew, for exam- ple, can easily install or replace a 16-inch butterfly valve without using mechanical lifting equipment. Economies are also possible with pipe hanger supports and other in- stallation and prepration expenses.

Seat replacement, particularly in high-performance butterfly valves, is relatively simple. Stem packing can be replaced without disassem- bling stem and disc and, in many installations, without even remov- ing the valve actuator.

Butterfly valves are often speci- fied for throttling and flow regu- lating service because of their inher- ent approximately "equal percen- tage" flow characteristics, as dif- ferentiated from the linear or quick-opening flow characteristics of some other valve type.

Types and Codes

While there is a great diversity of butterfly valves on the market today, there are three primary groups, each of which is defined by applicable industry codes and standards.

Industrial Rubber-Lined Butterfly Valves

Applicable Standards:
MSS-SP67, API 609
(October, 1983 Edition)

This type makes up the largest segment of the total butterfly valve market and is generally offered at the lowest price. While limited in its applications, as noted below, current models of this type of but- terfly valve are much improved over earlier models. In those models, the stem on which the disc was mounted passed through the centerline of the valve body—and through the top and bottom of the rubber liner. The two points where the stem passed through the liner were difficult to seal and through leakage at these points was a com- mon problem.

In the early 1960's, the problem was corrected by off-setting the stem from the valve centerline so that it did not pass through the seal- ing area of the rubber liner. The liner thus provided a continuous, uninterrupted seal area through a full 360°.

Despite improved sealing, how- ever, the use of a rubber liner gen- erally limits maximum differential pressure to around 285 psi, the maximum rating of ANSI 150. Re- sistance of the rubber liner to various fluid media and higher tem- peratures imposes further limits on applications.

Water Works (AWWA) Butterfly Valves

Applicable Standards:
Rubber lined —
ANSI/AWWA C504
Metal seated —
AWWA C505

Though usually limited to water and sewage, these valves are occa- sionally specified for other services. They are supplied in smaller sizes as rubber-lined valves with extra- heavy stems and in larger sizes— up to 72 inches—with adjustable seats. The rubber-seated valves are generally limited to 150 psi dif- ferential pressure. So-called metal- seated valves of this type (which have no seat except for the close proximity of the disc to the wall of the flow passage) are generally limited to 200 psi pressure differential.

The American Waterworks As- sociation (AWWA) specifies end- to-end dimensions, body materials, minimum shaft diameters and stem materials as well as several other design parameters.

High-Performance Butterfly Valves

Applicable Standards:
API 609 (October, 1983 Edition)
and MSS-SPXX (in develop- ment - number not yet assigned)

As mentioned earlier, this is the latest type of butterfly valve on the market today. It was not until Oc- tober of 1983, in fact, that an in- dustry standard was produced in- dicating its acceptance in the valve market. Other industry standards are expected to follow shortly.

High-performance butterfly valves (HPBV's) are rather sophis- ticated valves designed for tight shut-off at relatively high temper- atures and pressures (as compared to other types of butterfly valves). They have dynamic (pressure as- sisted) TFE sealing and have full ANSI pressure ratings in classes 150, 300 and 600 (1480 psi) or higher at ambient temperatures.

Temperature capability ranges up to 450° - 500°F, although pressure ratings are significantly reduced at the higher temperatures.

The inherent cost advantages of a flangeless or wafer-type butterfly valve (designed to be bolted between pipe flanges), when combined with higher pressure/temperature capability, has created an enormous market for HPBV's where gate and glove valves were previously used. Further developments with the HPBV have resulted in versions which are fire-tested for flammable liquid service, versions for cryogenic services at −320°F and, most recently, versions with metal seats which push the capability of the valves into applications which had been exclusively held by gate, globe and plug valves.

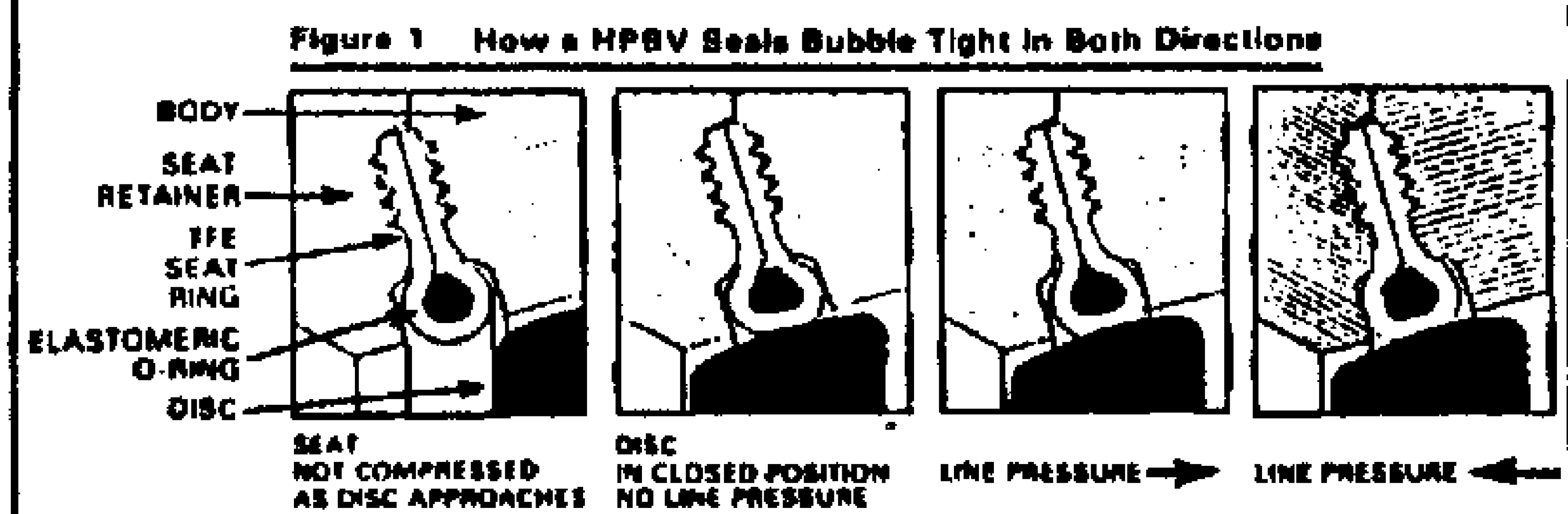
HPBV Design

The performance of a HPBV is dependent on the seat design, along with several other design considerations. All HPBV's presently on the market are designed with an offset seat; the seat is set off to one side of the stem to provide an uninterrupted circular seal ring against which the disc seats when closed. The TFE seats can be designed so that fluid line pressure acts upon the seat to *increase* the contact pressure between seat and disc very similar to an O-ring sealing concept. This results in a leak-tight valve at all rated pressures.

A properly designed seat should provide bi-directional, tight shut-of, sealing drop-tight at high as well as low pressure differentials. It should also produce a low operating torque, should be self-cleaning (not become packed with suspended solids in the fluid media), and should perform all of its required functions within the normal pressure/temperature ratings of the valve.

All these requirements for good seat design can be achieved only with an extremely flexible and resilient seat. An HPBV seat which meets these design requirements is illustrated below (Figure 1).

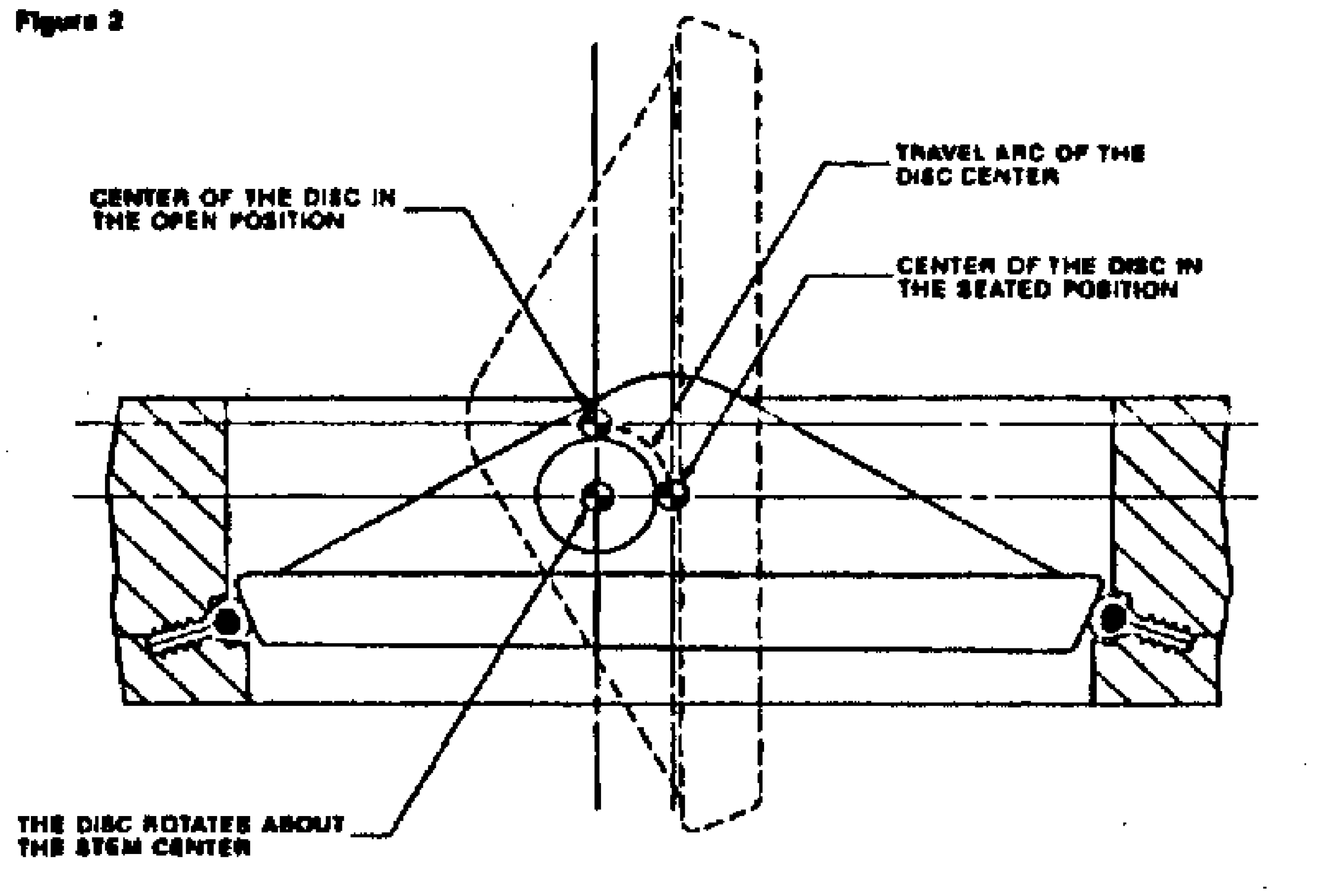
Figure 1 How a HPBV Seals Bubble Tight In Both Directions



Most high-performance butterfly valves on the market today employ a *second*, almost imperceptible offset of the disc. These valves are sometimes referred to as "double offset" high-performance butterfly valves.

When the stem of such a valve is rotated (see Figure 2), the second offset provides a camming action which, in the fully open position, completely removes the disc from any contact with the seat. Without this offset, the disc would stay in constant compressive contact with the seat in the two areas where the plane of the disc intersects the plane of the seat. In this situation, after the valve has remained open for a long time—and especially after a few temperature cycles—the compressive contact of the disc with the TFE seat should result in a permanent indentation of the seat in these two areas. When the valve is then closed, these two indentations in the TFE seat would not resume their former shape and leakage would eventually be experienced [in] the two areas. The "double-off[set]" design eliminates this problem.

Figure 2



Recent improvements in HPBV's have also been made in bearings and stem seals—all of which have made it possible to achieve reliable valve operation through 100,000 or more valve cycles. And the use of exotic body and trim materials—such as Stainless Steel 316, 17-4PH, Alloy 20, Monel and aluminum bronze—have extended use of these valves into a great many corrosive applications.

Conclusion

All butterfly valves in today's market are not alike. There are several distinct types, each having its own performance characteristics and preferred applications. It is anticipated that continuing advances in technology will further enhance butterfly valve performance and broaden applications. Even so, no single type can fully satisfy every application. There will always be need for all types of butterfly valves mentioned in this article.

As industries strive to reduce construction and operating costs, however, butterfly valves seem certain to appear more frequently in the notebooks of applications engineers. And continuing favorable user experience will no doubt open many new applications for hi[gh] performance butterfly valves.

For more information on butterfly valves, contact Rockwell International, Flow Control Division, Pittsburgh, PA, or circle 512