(12) UK Patent Application (19) GB (11) 2 216 992 (13) A

(43) Date of A publication 18.10.1989

(21) Application No 8907842.2

(22) Date of filing 07.04.1989

(30) Priority data
(31) 8808185 (32) 08.04.1988 (33) GB

(71) Applicant
**Cooper Industries Inc**

**(Incorporated in the USA - Texas)**

**First City Tower, Suite 4000, PO Box 4446, Houston, Texas 77210, United States of America**

(72) Inventor
**Ian Hendry Morgan**

(74) Agent and/or Address for Service
**Cruikshank & Fairweather**
**19 Royal Exchange Square, Glasgow, Scotland, G1 3AE, United Kingdom**

(51) INT CL⁴
**F16K 27/00, F16L 17/06 // F16K 3/30**

(52) UK CL (Edition J)
**F2V** VR6
**F2G** G14C G23 G23B
**U1S** S1884 S1901

(56) Documents cited
**GB 1267540 A GB 0921352 A US 4410186 A**
**US 3698728 A**

(58) Field of search
UK CL (Edition J) **F2B, F2G, F2V**
INT CL⁴ **F16J, F16K, F16L**

# (54) Seal for insert valve for pipelines or the like

(57) A seal 21 for an insert valve for a subsea pipeline is fitted to a groove 20 in each sealing face 19 of the removable valve body 16. The seal 21 is annular and specially profiled having a cone shaped surface 32 which engages a cone-shaped surface 36 in the groove 20. Surfaces 32, 36 have an angular mismatch so that on initial contact therebetween only a radially inward portion of surface 32 engages surface 36 leading to diametrical size reduction of the seal 21 and localised plastic deformation along surface 32 to provide full sealing engagement with surface 36. High pressure fluids flowing through the valve tend to enlarge the diametrical size of the seal 21 and hoop stresses in the seal enable expansive recoil thereof in the groove 20 without loss of sealing effect.

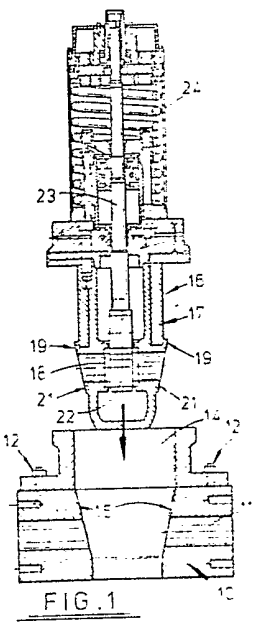


FIG.1

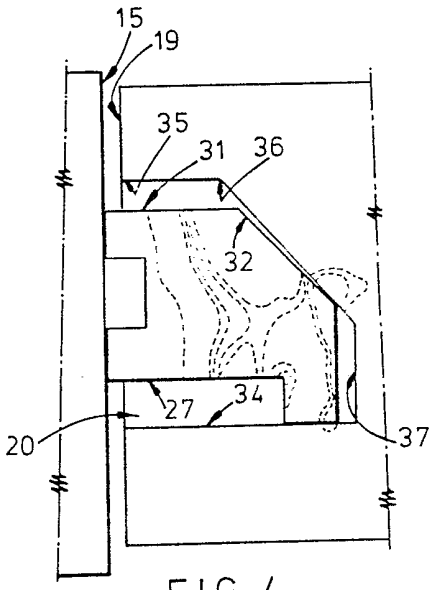


FIG.4

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy

GB 2 216 992 A

2216992

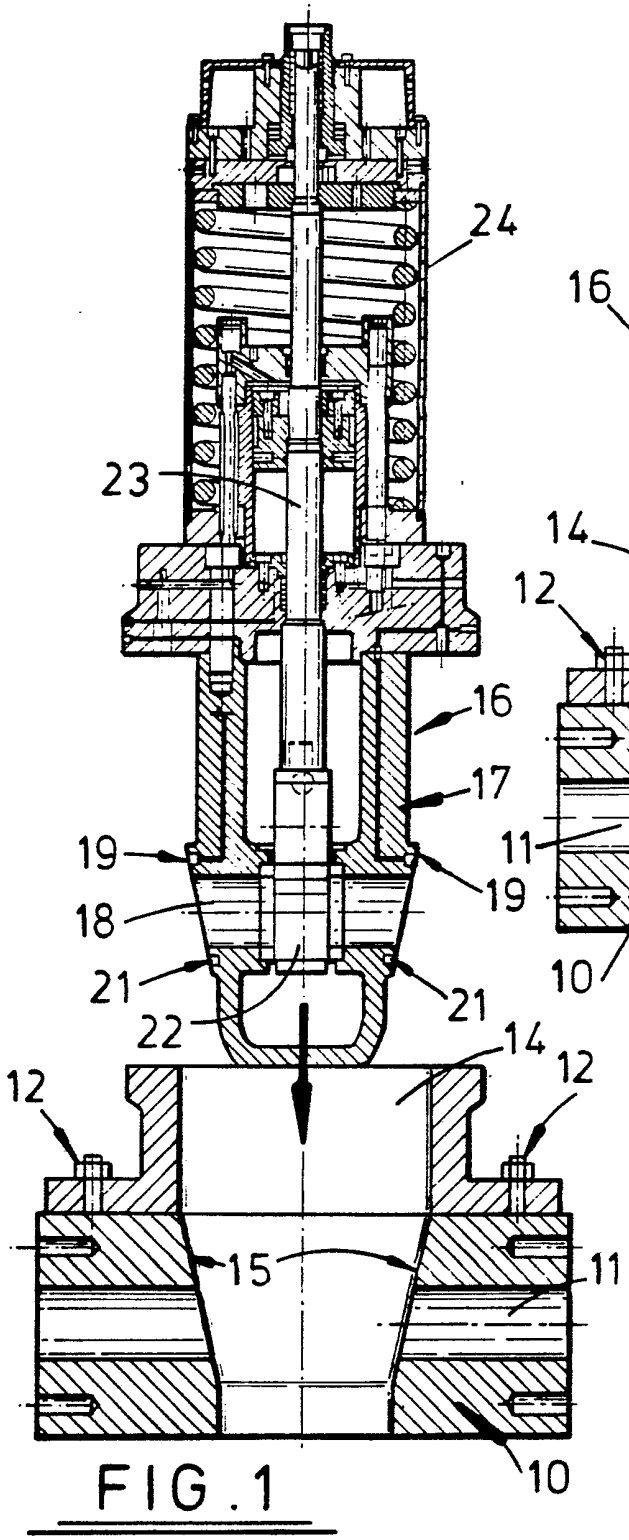


FIG.1

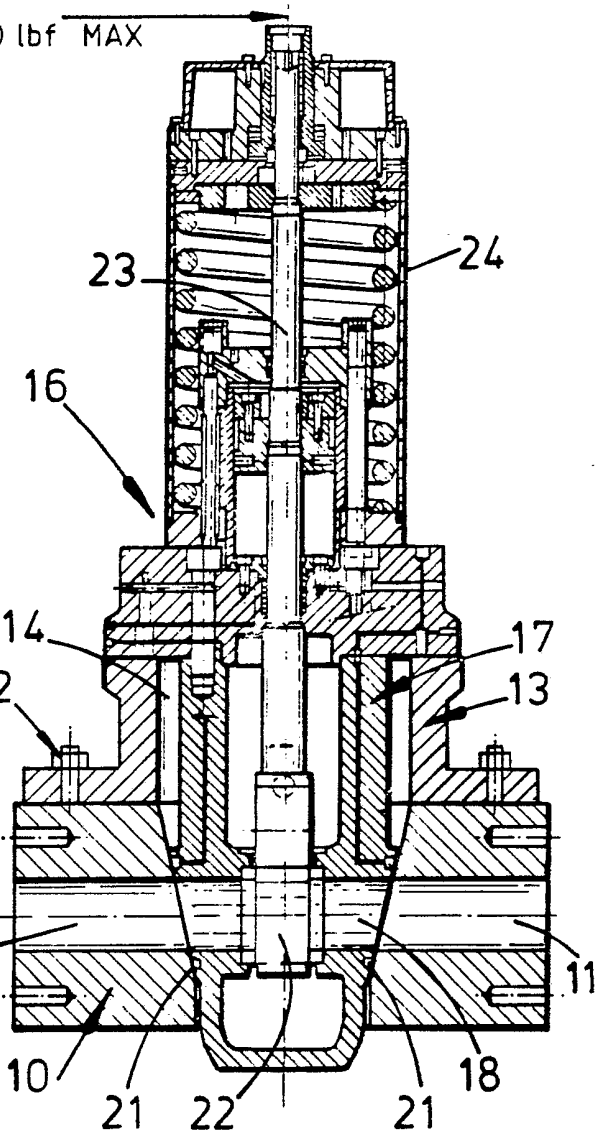


FIG.2

2216992

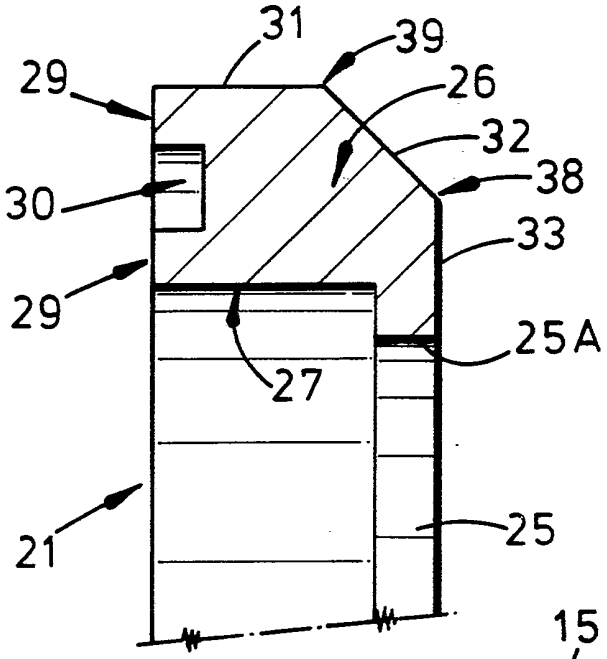


FIG. 3

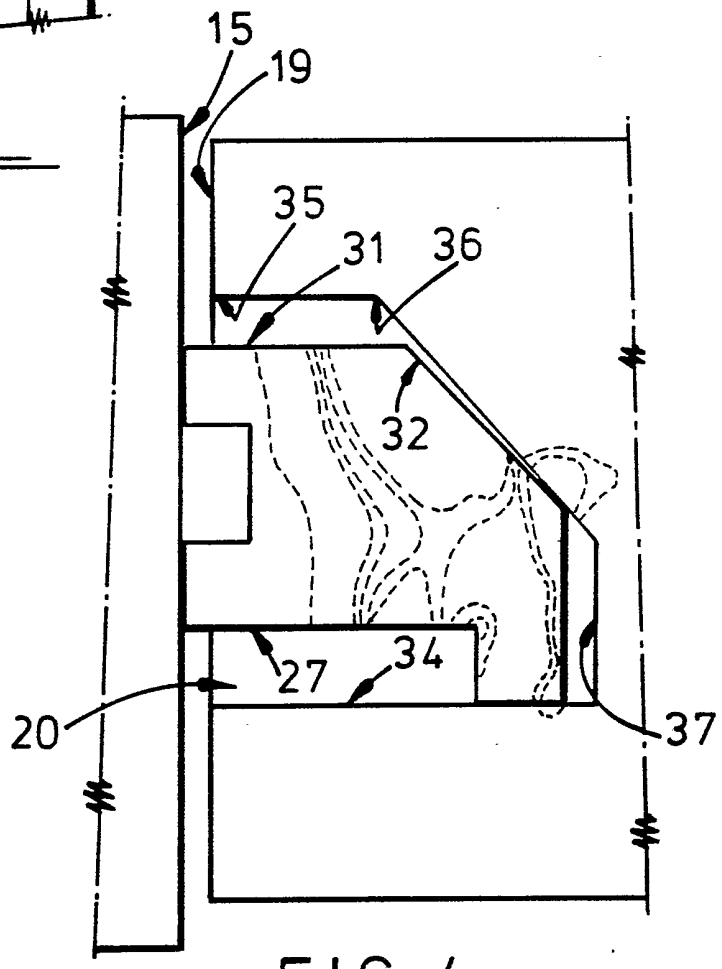


FIG. 4

# SEAL FOR INSERT VALVE FOR PIPELINES OR THE LIKE

This invention relates to a seal for an insert valve for a pipeline or the like.

For subsea pipelines which are used for the conveying of oil, gas or other medium from one location to another, it is necessary to provide valves at selected locations in order to control the movement of the medium being conveyed through the pipeline. Normally such control is effected through a valve such as a butterfly valve located in the pipeline and which can be controlled from a remote location. Such subsea pipelines are frequently located at considerable depths below the sea surface and consequently, in order to facilitate maintenance of the valves, it is common practice for such valves to be located in the pipeline in such a manner that they can be easily inserted into and removed from the pipeline as a unit. In this way the valve units can be withdrawn from the pipeline for maintenance or repair at a location above the sea surface and a replacement valve can be inserted into the pipeline in substitution. Such types of valve are commonly known as insert valves and a pipeline into which each such valve has to be fitted is provided with a permanent fixture fixedly secured in the pipeline for receiving the valve and which forms a seat for reception of co-operating sealing faces on the insert valve.

It is known practice to provide seals in the sealing faces of such insert valves for effecting sealing

engagement between the valve and co-operating sealing faces of the valve receiver.

An object of the present invention is to provide an improved form of seal between the co-operating faces of an insert valve and its receiver.

According to the present invention there is provided a seal for an insert valve or the like, said seal comprising a front sealing face adapted to seal against a co-operating sealing face of a receiver for the insert valve; and an angled rear sealing face adapted to seal against a co-operating angled surface in a groove formed in a sealing face of the insert valve, the angled sealing face of the seal and the co-operating surface of the groove being an angular mismatch whereby on initial contact therebetween, only a radially inward portion of said rear sealing face of the seal engages said co-operating angled surface of the groove.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawing in which:-

Fig. 1 is a sectional view of an insert valve prior to being located within a valve receiver;

Fig. 2 is a sectional view showing the insert valve in operative position within the receiver;

Fig. 3 is a partial sectional view of a seal for incorporation in the insert valve; and

Fig. 4 is a diagrammatic illustration illustrating the

stress distribution of a seal in accordance with the present invention when operatively located within its co-operating groove in a seal face of the insert valve.

Referring to Figs. 1 and 2 of the drawings, a pipeline (not shown) has fixedly fitted thereto a valve receiver body 10 having therethrough a bore 11 which provides a continuation of the bore in the pipeline. Bolted to the upper face of the main body 10 by means of bolts 12 is an upper receiver body portion 13. The body portion 13 co-operates with the main body portion 10 to provide a receiving aperture 14 for an insert valve. The upper portion of the aperture 14 as defined by the upper body portion 13 is rectangular in plan view as is the lower portion of the aperture 14 as defined by the body portion 10. Said lower portion of the aperture 14 has walls disposed longitudinally of the bore 11 which diverge inwardly to provide opposed receiver seal faces 15 adapted to co-operate with co-operating seal faces on the insert valve in a manner which will be further described hereinafter.

The insert valve, indicated generally by the reference numeral 16, comprises a valve body 17 adapted to be inserted into the aperture 14 of the valve receiver body 10. The valve body 17 has a transverse bore 18 extending therethrough and located such that when inserted fully into the aperture 14 the bore 18 is in register with the bore 11 in the valve receiver body. Accurate registration

of the bores 11 and 18 in the receiver body and valve body respectively is effected by accurate angular machining of the seal faces 15 on the receiver body 10 and co-operating seal faces 19 on the valve body.

Provided around the bore 18 in the valve body in each of the seal faces 19 is an annular groove 20 (See Fig. 4) adapted to receive a replaceable seal 21 in accordance with the present invention for preventing passage of fluid past the co-operating seal faces 15 and 19 of the receiver body and valve body respectively.

Projecting into the bore 18 of the valve body is a gate valve element 22 which is connected to a sliding stem 23. The stem 23 is connected to an actuator 24 of known form for effecting closure and opening of the valve element 22 in relation to the bore 18 through the intermediary of the stem 23.

Referring to Figs. 3 and 4 of the drawings, a seal 21, as indicated above, is adapted to be located operatively within the groove 20 in each seal face 19 of the valve body. Each seal 21 is annular having a central aperture 25. The peripheral body 26 of the seal is defined by a radially inner wall 27 which extends outwardly from a shoulder 25A at the boundary of the aperture 25 to a front sealing face constituted by a pair of spaced annular protrusions 29 separated by an annular groove 30. A radially outer peripheral wall 31 extends from the front sealing face to an inclined rear sealing face 32 which is

disposed at an angle to a base wall 33 of the seal.

As shown in Fig. 4, the groove 20 formed in each seal face 19 of the insert valve body 16 has a cross-sectional profile such that when seal 21 is located in its groove 20 radially inner and outer side walls 34 and 35 of the groove are parallel to the walls 31 and 27 respectively of the seal but are spaced therefrom by virtue of shoulder 25A being in abutment with wall 34. An angled wall portion 36 of the groove 20 extends at an angle of 45° from the inner end of wall 35 to a rear wall 37.

The angles of inclination with respect to wall 34 of the seal face 32 and wall portion 36 of the groove are almost the same but are not identical so that radially inner shoulder 38 formed at the junction of the faces 32 and 33 of the seal 21 is in contact with co-operating inclined wall portion 36 of the groove 20, whereas radially outer shoulder 39 formed at the junction of faces 31 and 32 of the seal 21 is close to but spaced from wall portion 36 as shown in Fig. 4. For example faces 32 and 36 may be mutually inclined by about 1°

The seal 21 is made of any suitable resilient metal such as stainless steel and body 26 is formed as a solid of revolution around the axis of aperture 25.

Insertion of the insert valve body 16 into the retainer body 10 in a subsea environment is either by a remote operated vehicle or a dedicated deployment system. The insert valve body 16 is aligned as shown in Fig. 1 and

is inserted into the co-operating receiver body 10 until it reaches a position of final alignment of the bores 11 and 18 of the receiver body 10 and the valve body 17 as shown in Fig. 2. In this position the co-operating sealing faces 15 and 19 of the receiver 10 and valve body 17 are operatively located adjacent each other and the seals 21 in each of the grooves 20 in the sealing faces 19 of the valve body 17 are energised (as will be explained) in order to prevent egress of the medium flowing through the bore 11.

Referring specifically to Fig. 4, it will be appreciated that the two spaced protrusions 29 of the seal 21 initially seal against a co-operating seal face 15 of the receiver body 10. The radially inner shoulder 38 of the seal 21 contacts the co-operating inclined wall portion 36 of the groove 20 within which the seal 21 is received whereas initially the radially outer shoulder 39 does not due to the angular mismatch between the angles of inclination of the seal face 32 and wall portion 36 of the seal 21 and groove 20 respectively. As the seal 21 is finally pressed into its groove 20 by movement of the valve body 16 it is essentially in elastic mode and on contacting inclined wall portion 36 is reduced slightly in diameter until shoulder 25A abuts wall 34, thereby setting up hoop stresses within the seal 21 and at the same time giving rise to local plastic deformation of the seal 21 at protrusions 29 and shoulder 25A and along inclined face 32

which provides metal-to-metal sealing. These stresses also enable the seal 21 to recoil expansively within its groove 20 if there is movement between the insert valve head 16 and the receiver body 10 due to pressure fluctuation or thermal expansion or if high pressure is applied to the bore 11.

Due to the angular mismatch between the seal face 32 of the seal 21 and the wall portion 36 of the groove 20, point contact between these surfaces is initially made enabling high contact stresses to be present at the shoulder 38. The contact stresses are of the order of 100-150% of the yield stress of the seal material but less than 85% of the yield stress of the valve body and of the receiver body. All the points of contact between the seal and their co-operating sealing surfaces are therefore in the plastic region in the seal only which enables the steel material of the seal 21 to deform slightly in order to assume the local shape of the sealing surfaces, thus allowing for small surface imperfections to be accommodated.

The seal 21 in use is energised in two phases, namely mechanical energisation and pressure energisation. As the seal 21 is pressed into its groove 20 on insertion of the valve body 17 into the receiver 10, the 45° conical wall portion 36 in the groove causes the seal 21 to reduce slightly in diameter to set up the aforementioned internal hoop stresses. Furthermore, when pressure is applied in

the bore the seal is extended further into its groove 20 by means of a slight increase in diameter. This additional component increases the contact stress and provides the extra forces required for high pressure sealing.

It will be appreciated that the seal 21, in operation, provides at least a double seal along each potential leakage path from the pipeline. For example, the two protrusions 29 provide a double seal at the front of the seal 21 against co-operating seal face 15 of the receiver. Also the peripheral wall of central aperture 25 and rear sealing face 32 of the seal 21 engage against co-operating walls of groove 20 to provide a double seal at the rear of seal 21. The seal 21 is prevented from falling out of groove 20, prior to insertion of the valve body into the receiver body, by a circlip on surface 34 of groove 20.

CLAIMS:

1. A seal for an insert valve or the like, said seal comprising a front sealing face adapted to seal against a co-operating sealing face of a receiver for the insert valve; and an angled rear sealing face adapted to seal against a co-operating angled surface in a groove formed in a sealing face of the insert valve, the angled sealing face of the seal and the co-operating surface of the groove being an angular mismatch whereby on initial contact therebetween, only a radially inward portion of said rear sealing face of the seal engages said co-operating angled surface of the groove.

2. A seal as claimed in claim 1, wherein the seal is made of a resilient metal having a lower yield stress than the materials of the co-operating faces of the receiver and valve.

3. A seal as claimed in either preceding claim, wherein the seal provides at least two annular engagement surfaces with each of the receiver and valve.

4. A seal as claimed in claim 3, wherein each engagement surface is stressed beyond its yield stress to effect plastic deformation of the engagement surface whereby to accommodate small surface imperfections in the receiver and valve.

5. A method of sealing an insert valve body which is a wedge fit to a receiver body each body having co-operating sealing faces, the method comprising locating annular

seals in grooves in the sealing faces of the valve body, the grooves surrounding the fluid flow passageway through the receiver body, providing each groove and seal with cone shaped engagement surfaces which have an angular mismatch, and forcing the valve body into the receiver body to effect radial compression of the seals due to the cone shaped engagement surfaces with localised plastic deformation of the seals at the cone shaped engagement surfaces.

6. A seal for an insert valve substantially as hereinbefore described with reference to the accompanying drawings.

7. An insert valve comprising a seal as claimed in claim 6.

Published 1989 at The Patent Office. State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office. Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Multiplex techniques ltd, St Mary Cray, Kent. Con. 1/87