

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

PIPE CLAMP, PINCH VALVE AND METHOD OF USE

Technical Field of the Invention

This invention relates to the field of clamps and valves for inhibiting fluid flow in pipework.

Background to the Invention

Pipework is widely used for transporting fluids (for instance liquids and gases) between locations. For instance it is used domestically and commercially, in water and fuel gas distribution. Pipework can be unsightly and is therefore frequently concealed in the walls of buildings, or indeed underground, making access for service and repair difficult.

Access is a particular problem during emergencies when fluid is rapidly leaking from a pipe or pipework joint. To mitigate excess fluid loss a large section of pipework can be shut off at major valves or stopcocks positioned along the pipework routing. However in doing this, multiple users of the fluid being transported may unnecessarily lose their supply as a result of a relatively localised fault.

Alternatively a section of pipework can be excavated and the fault location identified. Fluid flow to the pipe can then be shut off using manually operated pipe squeezing tools. Once a pipe has been 'squeezed' or 'pinched' closed either side of the leak, the faulty section of pipe can be repaired or replaced. Whilst this approach has the benefit of being localised, the time elapsed in excavating and then needing to manually pinch closed the pipework, can result in significant fluid loss.

Therefore it is an aim of the present invention to provide an alternative clamp and valve that allow for faster inhibition of fluid flow in pipework.

Summary of the Invention

According to a first aspect of the invention there is provided a pipe clamp for inhibiting fluid flow through a flexible pipe, comprising first and second contact members for positioning on opposing sides of a flexible pipe, and actuation means for automatically urging the contact members together, such that in-use a flexible pipe can be pinched closed. The pipe clamp allows pipework to be pinched closed (so as to substantially stop fluid flow in the pipe) without excessive use of manual effort as required in prior art manually operated devices such as turn screw-squeeze-off tools. Furthermore the time required to pinch closed pipework can be significantly reduced by using the automated means for urging, thereby reducing fluid loss.

The term 'flexible pipe' is intended to mean pipe that can be compressed without permanently compromising the integrity of the pipe (and therefore its ability to continue to be used to transport fluid). The first and second contact members provide the interface to the flexible pipe and may therefore take a number of constructions, provided that in use they can be urged together about a flexible pipe.

In preferred embodiments the actuation means is electrically initiated. This allows the pipe clamp to be operated remotely. In such embodiments the pipe clamp may be pre-deployed with new pipework or retrofitted around current pipework (for instance when excavated for other reasons) and wired to a central control centre, such that future leaks can be isolated by remotely triggering the actuation means, at selected clamp locations. Even more preferable is that the pipe clamp comprises a wireless receiver electrically connected to the actuation means. This allows wireless communication to a control centre for remote activation of the clamp. The wireless receiver may be positioned above ground and wired to an underground pipe clamp for instance.

Whilst the actuation means may in some embodiments comprise triggered springs or high pressure gas cylinders, it is preferable that the actuation means comprises a pyrotechnically driven piston actuator. Pyrotechnically driven piston actuators are relatively quick to respond to an external trigger, such as an electrical initiation through a bridge wire. This

means the pinching closed effect of the pipe clamp can be initiated responsively. The pyrotechnically driven piston actuators can also offer rapid thrust urging of the contact members together for some embodiments, or alternatively can provide the initiation of a more powerful component of the actuation means such as an impact initiated propellant cartridge. Furthermore the pyrotechnically driven piston actuator may readily be removed and replaced from the pipe clamp once it has been used, such that the clamp can remain in position around a flexible pipe ready for repeat use. Pyrotechnically driven piston actuators can be manufactured to be deemed non-explosive devices, further diversifying the applications for which these embodiments of the pipe clamp can be used.

It is preferable that the actuation means comprises locking means for fixing the separation of the contact members. This ensures that once the pipe clamp has been initiated and has pinched closed a flexible pipe, the contact members are maintained in their pinched closed configuration, such that pressure inside the flexible pipe does not cause the pipe to re-open. The locking means is preferably releasable so the flexible pipe can be returned to operation once a repair or replacement has been carried out. The locking means may comprise a ratcheting means or hoop structure attached to one contact member that hooks over the second contact member during use.

In some embodiments the first contact member is fixed within a housing, the second contact member being configured to slide within the housing towards the first contact member by action of the actuation means. In these embodiments the actuation means need only operate on one contact member, the second contact member being immovable. This allows the pipe clamp to be manufactured to be compact and have minimal components to operate. Furthermore in these embodiments the pipe clamp does not require positioning on the ground or against a wall for the squeezing effect on the flexible pipe to be realised, and so can be used on hanging or suspended pipework.

In even more preferred embodiments, means for clasping together the contact members at their respective static ends is provided, such that only a clamping end of the second contact member can slide within the housing. The static ends do not move during operation of the clamp, instead they are clasped together such that the clamp can open and close by pivoting

at the position of the clasp. The opposite end (to the static end) of the first contact member is held fixed in the housing such that it cannot move either. Only the opposite end (to the static end) of the second contact member, referred to as the clamping end, moves within the housing along an arc permitted by the housing. In these embodiments the number of degrees of freedom on the contact members is minimised such that the action of the actuation means can be efficiently transferred into a pinching effect. In these embodiments it is even more preferably that the actuation means is positioned to act on the clamping end of the second contact member. This ensures the urging effect is directly exerted on the moveable end of the contact member.

In alternative embodiments of the pipe clamp, the housing comprises a pair of elongate apertures within which the second contact member is arranged to slide, such that the second contact member can slide towards the first contact member whilst remaining parallel thereto. In these embodiments the entirety of the second contact member can slide. The elongate apertures may be elliptical and configured to only allow motion in a single axis (towards or away from the first contact member). By allowing the entirety of the second contact member to slide, the first and second contact members can remain parallel when a flexible pipe is being squeezed. This ensures a uniform application of force across the width of the flexible pipe, mitigating only part of the pipe being effectively pinched closed. In these embodiments it is even more preferred that the actuation means is configured to act centrally upon the second contact member. This ensures the second contact member is not urged in a manner causing it to tilt in use and thereby exert a non-uniform squeezing effect on a flexible pipe. In some embodiments the actuation means comprises a pusher plate arranged to urge against the second contact member. This ensures further that an urging force is uniformly applied across the extent of a flexible pipe.

In some embodiments comprising a pusher plate, the actuation means comprises a propellant housing for holding a propellant, the propellant housing being arranged such that in use propellant gases can urge against the pusher plate. A Hilti cartridge may be used for this purpose. The propellant housing and pusher plate may be arranged within a channel or conduit of the housing, such that propellant gases are trapped between the propellant housing and the pusher plate. The propellant gases generate a pressure increase urging

against the pusher plate, causing it to slide and urge against the second contact member. These embodiments may be used for heavy duty applications (for instance to clamp thicker flexible pipe, or pressurised flexible pipe). Even more preferred is that the propellant housing is impact initiated. This allows fast initiation from electrically initiated pyrotechnically driven actuators.

In some embodiments of the pipe clamp the contact members are rods. The curvature of a rod mitigates the contact members perforating, scratching or gouging the flexible pipe being pinched-closed, as may occur with non-rounded designs. This allows the flexible pipe to be reinstated to operations with minimal damage.

According to a second aspect of the invention there is provided a pinch valve, comprising the pipe clamp of the first aspect of the invention; and a length of flexible pipe received between the contact members, and having an inlet end and an outlet end for coupling to pipework. The pinch valve can be deployed with new pipework or retrofitted to older pipework at predetermined pipe shut off locations in a pipe network. The provision of a length of flexible pipework allows the valve to be used with pre-existing non-flexible pipework (such as PVC or copper water pipe). Following the example of a domestic water supply network, the pinch valve may be fitted onto the inward supply of water to each road or avenue or houses, such that in the event of a water leak, only the relevant group of houses can have their water supplies shut off while the leak is fixed. The automatic nature of the pinch valve means the supply can be shut off quickly to mitigate excessive water loss.

In preferred embodiments of the pinch valve, the flexible pipe is formed from a resilient material such that it returns to its original shape after the pinch valve has been operated and released. This ensures that the entire pinch valve does not need replacement after use (instead merely the disposable parts of the actuation means need replacement).

In some embodiments of the pinch valve, a valve housing is provided for environmental protection of the pipe clamp. These embodiments can be used in outdoor or buried conditions (underground or underwater) and the environmental damage to the operable components of the pinch valve (corrosion for instance) will be minimised.

According to a third aspect of the invention there is provided a method of remotely inhibiting fluid flow in flexible pipe, comprising the steps of: providing a pipe clamp comprising first and second contact members, and actuation means for automatically urging the contact members together; positioning the first and second contact members on opposing sides of a flexible pipe; and then triggering the actuation means, such that the flexible pipe is pinched closed. The method of the invention allows a flexible pipe to be pinched-closed with reduced manual effort and if pre-deployed with pipework, an ability to pinch-closed a pipe without requiring excavation. The step of triggering the actuation means may comprise electrically initiating the means using wired or wireless communication.

Brief Description of the Drawings

Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 illustrates a prior art pipe clamp;

Figure 2 illustrates an embodiment of a pipe clamp in perspective view;

Figure 3A illustrates an alternative embodiment of a pipe clamp in side view;

Figure 3B illustrates the embodiment in Figure 3A in side cutaway view;

Figure 3C illustrates the embodiment in Figure 3A and 3B in plan view; and

Figure 4 illustrates an embodiment of a pinch valve.

Detailed Description

Figure 1 illustrates a prior art pipe clamp 10 for squeezing off a pipe 11. The clamp 10 has runners 12a and 12b on which contact member 13 can slide. The contact member 13 can be translated downwards onto pipe 11 by a user turning turn-key 14 through a threaded slot 15. To use the clamp 10 requires direct access to a pipe 11 and significant manual effort.

Figure 2 illustrates an embodiment of a pipe clamp 20 in perspective view. The pipe clamp 20 has a relatively low number of parts and therefore is considered a lightweight

embodiment. A first contact member 21 and second contact member 22 are shown clasped at respective static ends 23a and 23b using a partially arcuate clasp 24 that surrounds and is screwed to the contact members 21 and 22. The contact members 21 and 22, are therefore in abutment at their static ends 23. At the opposite ends of contact members 21 and 22, there is provided a housing 25 through which the contact members 21 and 22 are received. The contact members 21 and 22 reside in a channel 26 within housing 25, however the first contact member 21 is screwed 27 to the housing 25 such that it cannot move. First contact member 21 blocks the channel 26 such that second contact member 22 can slide within the channel 26 between the bottom of channel 26 and an abutment with first contact member 21. The first and second contact members 21 and 22 are rods. Between the contact members 21 and 22, their abutment at static ends 23, and the housing 25, there is defined an aperture 28 through which a flexible pipe can be received. An actuation means 29 for automatically urging the contact members together is provided in the form of a pyrotechnically driven piston actuator mounted into housing 25 so as to be operable upon the second contact member 22. The various components of the pipe clamp 20 are formed from metal in this embodiment. In use the first contact member 21 is unscrewed from the housing 25 and rotated out of the channel 26. A flexible pipe is received between the first and second contact members 21 and 22, and then first contact member 21 is screwed to housing 25. This seals the pipe within the aperture 28 defined by the components of the clamp 20. The piston actuator 29 is then initiated by providing an electrical signal. The piston actuator 29 urges against the second contact member 22 which itself urges against the flexible pipe being pinched-closed. The flexible pipe is squeezed between the first and second contact members 21 and 22, thereby constricting the fluid flow of the flexible pipe.

Figure 3A, 3B and 3C illustrate an alternative embodiment of a pipe clamp 30 more suited to heavy duty applications. Figure 3A shows the clamp 30 in side view. A first contact member 31 and second contact member 32 in the form of rods are shown residing in a housing 33. The housing 33 defines a channel 34 for receiving a flexible pipe. First contact member 31 is held fixed in the housing 33 within conformal apertures (not visible) at the end of channel 34 so as to seal the channel. Outwardly biased trunnions 35 prevent first contact member 31 sliding from the conformal apertures. Second contact member 32 is slidable within housing 33 in a pair of elongate apertures (not visible) between abutment with the housing

33 and the first contact member 31. First contact member 31 further comprises a hoop 36 that rests upon but is not hooked over the second contact member 32, and serves to further prevent first contact member 31 moving. An electrically initiated piston actuator 37a is also shown as part of the actuation means 37 for automatically urging the contact members 31 and 32 together. The contact members 31 and 32 are formed from metal. The housing 33 in this embodiment is also formed from metal, with titanium offering particular resilience to the explosive pressures generated during use.

Figure 3B illustrates the clamp 30 of Figure 3A in cutaway side view. First contact member 31 and second contact member 32 are shown defining the channel 34 with the housing 33 through which a flexible pipe can be received. The actuation means 37 is shown comprising the electrically initiated piston actuator 37a, arranged to impact a propellant housing 37b that is internal to housing 33. The propellant housing 37b is impact initiated, resulting in-use in propellant gases generated and contained within housing 33. The resultant increase in pressure urges against a pusher plate 37c that is adjacent the propellant housing 37b. The pusher plate 37c abuts the second contact member 32, such that in-use pusher plate 37c urges the second contact member 32 towards the first contact member 31.

Figure 3C illustrates the embodiment of Figure 3A and 3B in plan view. The first contact member 31 is shown received into conformal aperture 40 in housing 33 and retained therein by hoop 36. Second contact member 32 resides in elongate aperture 41, elongate in the direction of first contact member 31. Hoop 36 rests upon second contact member 32.

In use the first contact member 31 is removed from housing 33 by depressing outwardly biased trunnion 35 whilst pulling hoop 36. The hoop 36 is configured to receive a finger of a user, allowing ease of insertion and removal. The channel 34 of housing 33 is placed around a flexible pipe and first contact member 31 reinstated to seal flexible pipe in the channel 34 now closed by housing 33 and first contact member 31. The actuation means 37 is electrically initiated and propellant gases inside the housing 33 urge against pusher plate 37c. The pusher plate 37c applies uniform force across the length of second contact member 32. Second contact member 32 slides towards first contact member 31 in elongate apertures 41. Second contact member 32 maintains a parallel alignment to first contact

member 31. The hoop 36 may be arranged to drop under gravity and hook over second contact member 32. This prevents first and second contact members 31 and 32 separating without manual intervention. Alternatively the pusher plate 37c may be configured to slide in one direction only i.e. such that it cannot return towards piston housing 37b. The flexible pipe is squeezed between the contact members 31 and 32, and the fluid flow within the pipe is pinched-closed.

Figure 4 illustrates an embodiment of a pinch valve 41. In the embodiment shown the pinch valve 41 comprises the pipe clamp 30 of Figure 3A and a length of flexible pipe 42. The flexible pipe 42 extends through channel 34 of pipe clamp 30. The flexible pipe 42 is formed from resilient rubber and has an inlet end 43 and an outlet end 44 for coupling to pipework. In use the pinch valve 41 is coupling to pipework at the inlet and outlet ends 43 and 44 to provide a sealed fluid connection. When the requirement arises (for instance during emergency pipe repair) the clamp 30 is electrically initiated to pinch-close the flexible pipe 42 and thereby stop fluid flow between the ends 43 and 44.

The precise shape and material composition of the embodiments shown is not intended to be limiting. However the first and second contact members require sufficient rigidity so as to not be deformed themselves significantly by the actuation means. The application of force to the contact members may therefore be preferably spread using a suitable intermediate material or pusher plate.

CLAIMS

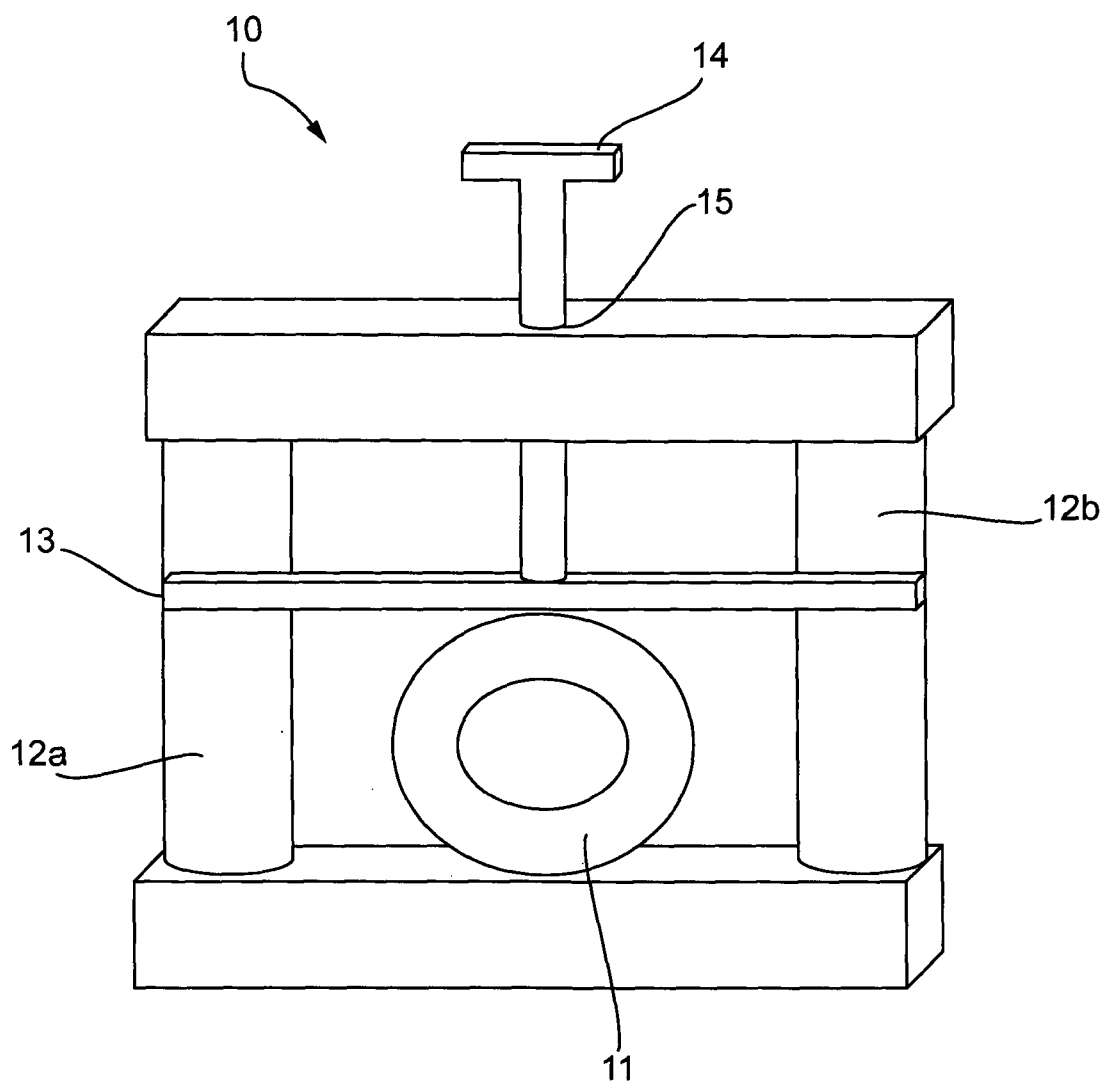
1. A pipe clamp for inhibiting fluid flow through a flexible pipe, comprising first and second contact members for positioning on opposing sides of a flexible pipe, and actuation means for automatically urging the contact members together, such that in-use a flexible pipe can be pinched closed.
2. The pipe clamp of claim 1, wherein the actuation means is electrically initiated.
3. The pipe clamp of claim 2, further comprising a wireless receiver electrically connected to the actuation means.
4. The pipe clamp of any one of claims 1-3, wherein the actuation means comprises a pyrotechnically driven piston actuator.
5. The pipe clamp of any one of claims 1-4, wherein the actuation means comprises locking means for fixing the separation of the contact members.
6. The pipe clamp of any one of claims 1-5, wherein the first contact member is fixed within a housing, the second contact member being configured to slide within the housing towards the first contact member by action of the actuation means.
7. The pipe clamp of claim 6, further comprising means for clasping together the contact members at respective static ends, such that only a clamping end of the second contact member can slide within the housing.
8. The pipe clamp of claim 7, wherein the actuation means is positioned to act on the clamping end of the second contact member.
9. The pipe clamp of claim 6, wherein the housing comprises a pair of elongate apertures within which the second contact member is arranged to slide, such that the second contact member can slide towards the first contact member whilst remaining parallel thereto.

10. The pipe clamp of claim 9, wherein the actuation means is configured to act centrally upon the second contact member.
11. The pipe clamp of claim 10, wherein the actuation means comprises a pusher plate arranged to urge against the second contact member.
12. The pipe clamp of claim 11, wherein the actuation means comprises a propellant housing for holding a propellant, the propellant housing being arranged such that in use propellant gases can urge against the pusher plate.
13. The pipe clamp of claim 12, wherein the propellant housing is impact initiated.
14. The pipe clamp of any preceding claim, wherein the contact members are rods.
15. A pinch valve, comprising:
 - a. the pipe clamp of any preceding claim; and
 - b. a length of flexible pipe received between the contact members, and having an inlet end and an outlet end for coupling to pipework.
16. The pinch valve of claim 15 wherein the flexible pipe is formed from a resilient material.
17. The pinch valve of any one of claims 15-16, further comprising a valve housing.
18. A method of remotely inhibiting fluid flow in flexible pipe, comprising the steps of:
 - a. Providing a pipe clamp comprising first and second contact members, and actuation means for automatically urging the contact members together;
 - b. Positioning the first and second contact members on opposing sides of a flexible pipe; and then
 - c. Triggering the actuation means, such that the flexible pipe is pinched closed.

1/5

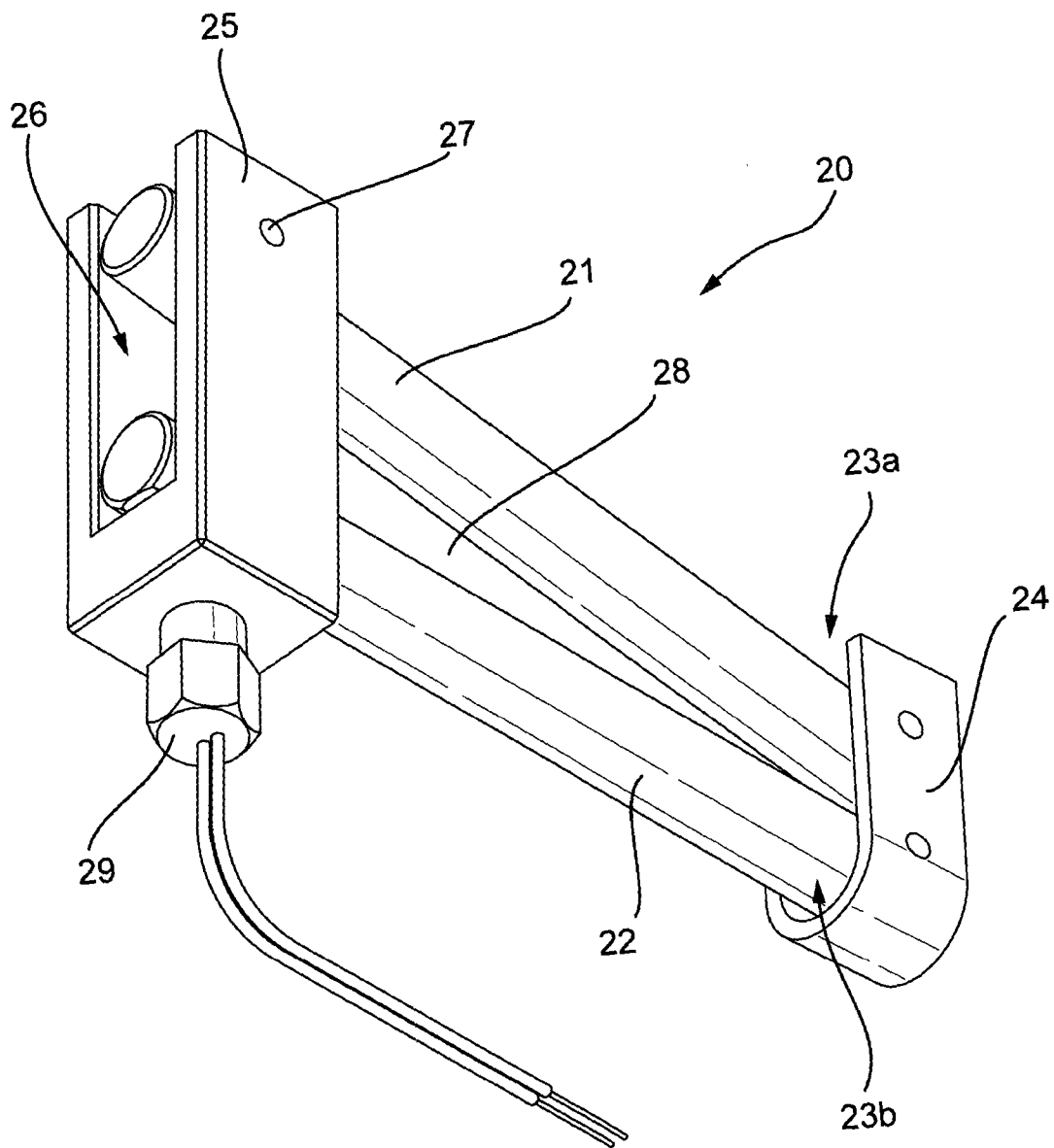
Fig. 1

Prior art



2/5

Fig. 2



3/5

Fig. 3A

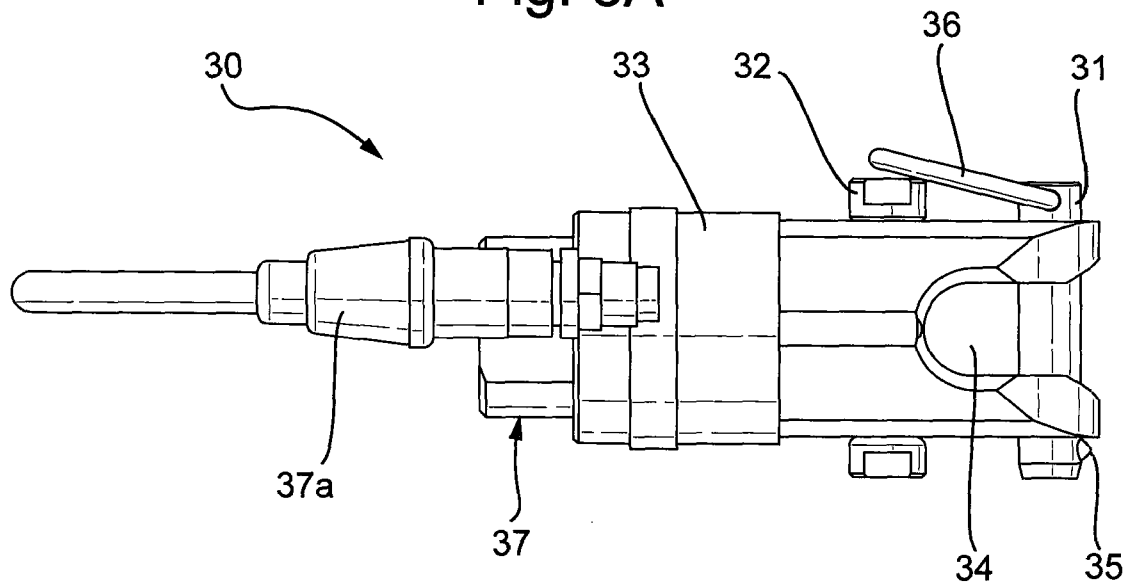
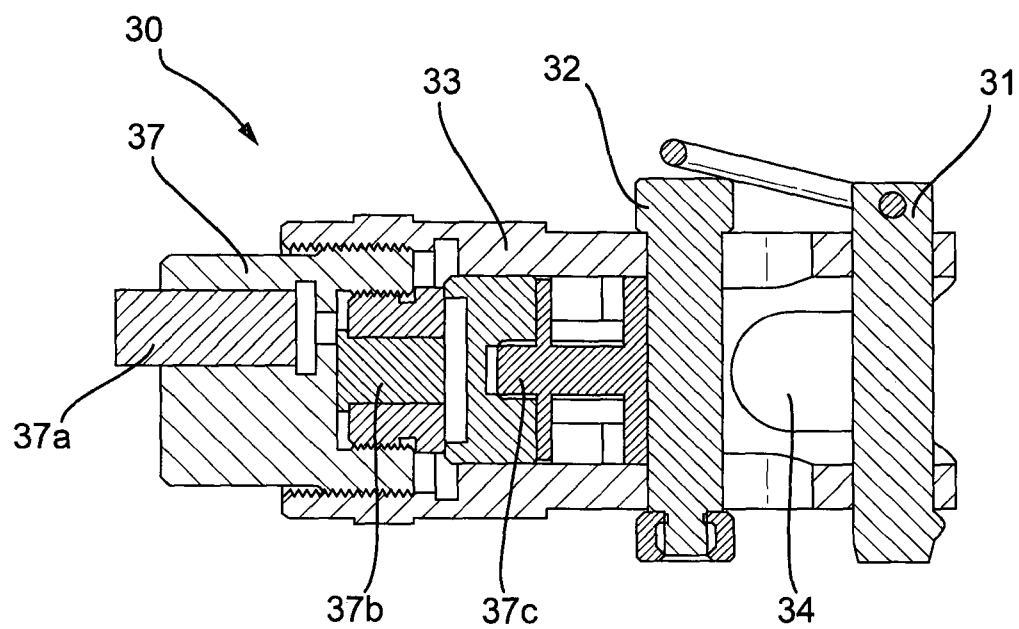
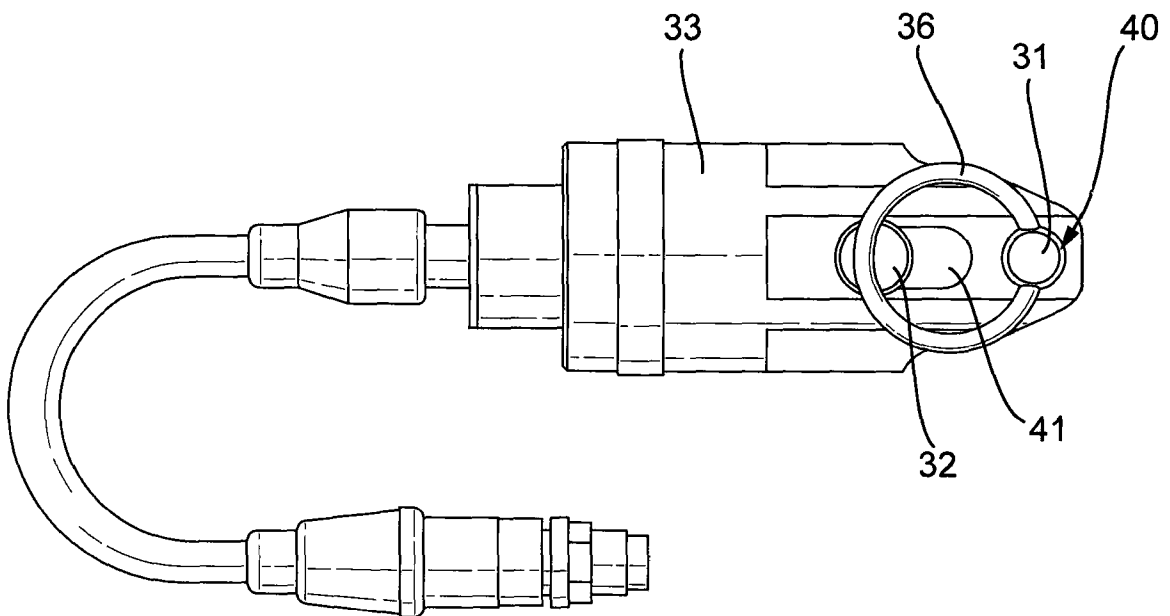


Fig. 3B

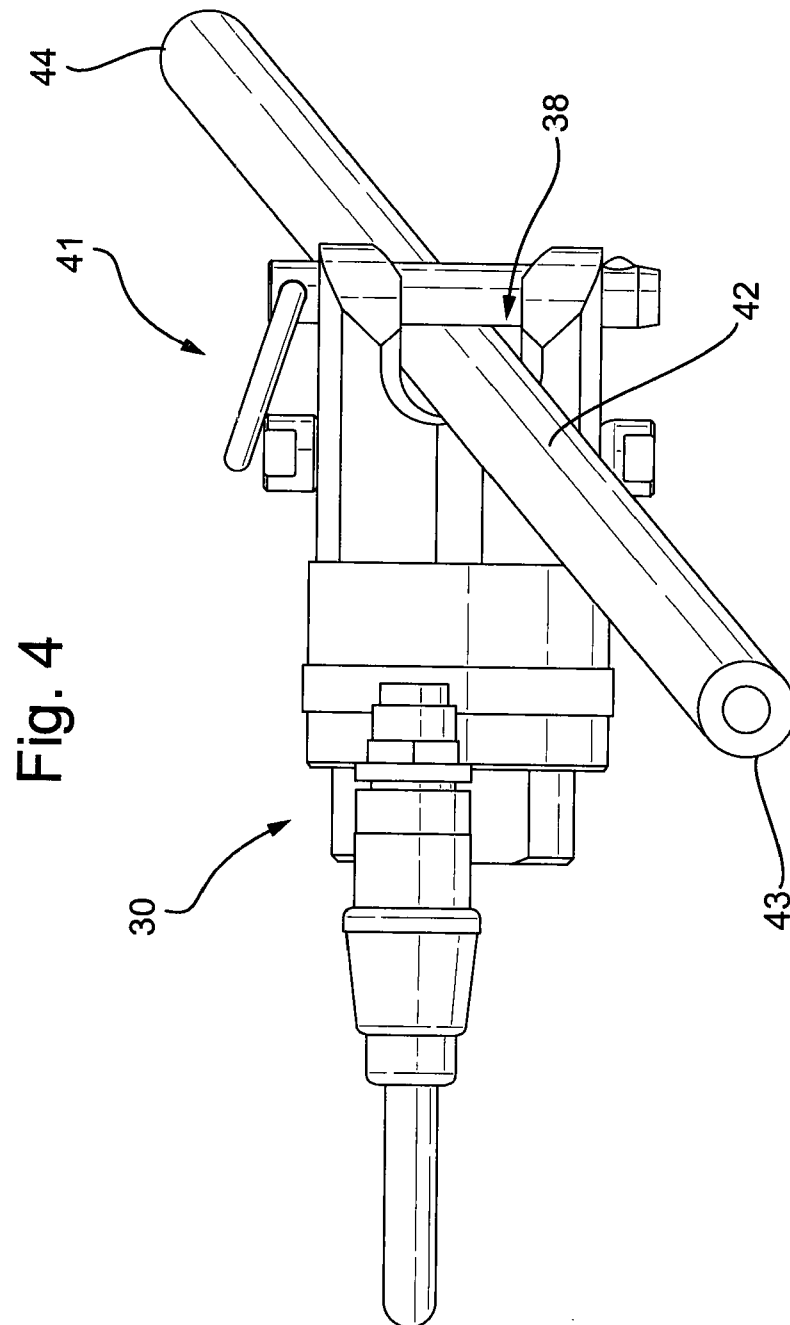


4/5

Fig. 3C



5/5



INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/000171

A. CLASSIFICATION OF SUBJECT MATTER		
INV. F16L55/10	F16K7/02	F16K7/04 F16K7/06 F16K7/07
ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) F16L F16K		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 322 054 A (CAMPBELL JAMES A) 30 March 1982 (1982-03-30) column 4, line 63 - column 8, line 11 figures -----	1-18
X	FR 2 362 332 A1 (COMMISSARIAT ENERGIE ATOMIQUE [FR]) 17 March 1978 (1978-03-17) page 3, line 16 - page 5, last line figures -----	1-14, 16-18
X	FR 2 075 401 A5 (FISHER CONTROLS CO) 8 October 1971 (1971-10-08) page 3, line 17 - page 13, last line figures -----	1-18
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 17 February 2020		Date of mailing of the international search report 25/02/2020
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Durrenberger, Xavier

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2019/000171

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4322054	A	30-03-1982	NONE

FR 2362332	A1	17-03-1978	DE 2718357 A1 17-11-1977
			FR 2362332 A1 17-03-1978
			GB 1545350 A 10-05-1979
			IT 1073620 B 17-04-1985
			JP S607160 B2 22-02-1985
			JP S52133116 A 08-11-1977
			NL 7704576 A 01-11-1977
			SE 427574 B 18-04-1983
			US 4140041 A 20-02-1979

FR 2075401	A5	08-10-1971	CA 934740 A 02-10-1973
			FR 2075401 A5 08-10-1971
			US 3695576 A 03-10-1972
