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[Continued on next page]

(54) Title: STEEL PIPE DEFECT DETECTOR ASSEMBLY

(57) Abstract: In one embodiment the present invention is an elbow for a transducer actuator comprising a main body defining a top portion, a bottom portion, and a front face and rear face. The top portion defines a first engagement for rotating the elbow on a horizontal axis. The bottom portion defines a second engagement to engage an arm.

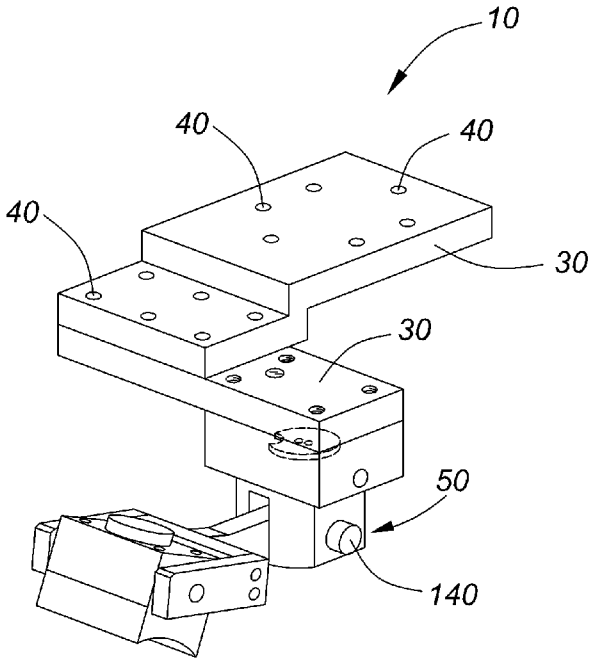

FIG. 1

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

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

TITLE

STEEL PIPE DEFECT DETECTOR ASSEMBLY

FIELD

[0001] The present invention relates to a defect detector assembly, and more specifically, a defect detector assembly to detect defects in steel pipe manufacture.

BACKGROUND

[0002] Steel pipes (hollow tubes) are typically produced by one of two distinct methods, resulting in either a welded or seamless pipe. In both methods, raw steel is first cast into a more workable starting form. It is then made into a pipe by either of a) stretching the steel out into a seamless tube; and b) forcing edges together and sealing the edges together with a weld along a pipe axial length.

[0003] Welded pipe is usually formed by rolling steel strips (unwound from a spool) through a series of grooved rollers that mold the strips into a circular (tube) shape. Just prior to passing the strips over the rollers, the steel is heated, making it more pliable. The tube shaped steel then passes welding electrodes. The electrodes seal the edges together, forming a seam. The welded seam is passed through a high pressure roller to help create a tight weld. The seam is initially very hot and molten, but is later cooled with water to form a scab. The scab is made from excess steel squeezed outside a weld zone. The scab is sliced off and discarded, preferably leaving a smooth, continuous, and defect free seam. The scab is known as a weld bead. The bead is sliced off using a scarfing knife.

[0004] During manufacture a pipe maybe have a variety of defects, including fracture

(not readily visible to a naked eye). Manually inspecting pipes for such defects is impractical and inefficient. Today ultrasound machines are used to assess welded pipe defects. These machines examine and report on weld integrity, and convey other data. They scan pipes to ensure the weld is complete from outside to inside. Ultrasonic inspection occurs nearly immediately after the pipe weld is formed, and while it is still rolling along an automated production line. Defective pipes, once detected, are usually marked with paint further along the production line.

[0005] To inspect the pipe, a transducer, held by a machine arm, gently rests near the pipe surface. The transducer gathers and transmits data to a processor, which in turn determines whether any pipe defects are present, and outputs the transducer data for a user to inspect and evaluate.

[0006] If any beads remain on the pipe, they can catch on the transducer arm. These beads are extremely sharp and rigid, and do not easily break off the pipe surface. These beads easily cut flesh and present a hazard to workers. When these beads catch on the transducer arm, they can drag it out of alignment, and in some cases rip the entire ultrasound machine out of the ground, dragging them along the assembly. This results in millions of dollars of damage, and is a safety threat.

SUMMARY

[0007] In one embodiment the present invention is an elbow for a transducer actuator comprising a main body defining a top portion, a bottom portion, and a front face and rear face. The top portion defines a first engagement for rotating the elbow on a horizontal axis. The bottom portion defines a second engagement to engage an arm.

[0008] In another embodiment the present invention is an arm for transducer actuation

comprising a handle defining a first and second end portion. A fork is attached to the handle second end portion, and a hand engagement is present for attaching a hand to the fork.

[0009] In yet another embodiment the present invention is a hand for transducer actuation comprising a block body defining a centrally disposed opening for passing the transducer therethrough. A fork engagement is provided, to attach the hand to a fork.

[0010] In still yet another embodiment the present invention is an assembly for detecting a pipe defect comprising a housing. An indicator plate is housed in said housing. An elbow having a first engagement for rotating the elbow on a horizontal axis is provided, the elbow first engagement being attached to the plate, and the elbow having a second engagement to engage an arm.

DRAWINGS

[0011] FIG. 1 is a perspective view of an assembly for detecting a pipe defect.

[0012] FIG. 2 is an exploded view of the assembly in FIG. 1.

[0013] FIG. 3 is a perspective view of two assemblies in operation with a pipe.

[0014] FIG. 4 is a transparent perspective view of an elbow.

[0015] FIG. 5 is a transparent perspective view of a hand and transducer.

[0016] FIG. 6 is a cross-section along the line 6-6 in FIG. 2.

[0017] FIG. 7 is an exploded cross-section view of the line 6-6 in FIG. 2, with additional

components.

[0018] FIG. 8 is a cross-section along the line 8-8.

[0019] FIG. 9 is a cross-section view along the line 8-8 with an indicator plate.

[0020] FIG. 10A is a cross-section view along the line 10A-10A.

[0021] FIG. 10B is a cross-section view along the line 10B-10B.

DESCRIPTION

[0022] The present invention is a defect detection assembly (10) for detecting defects in formed steel pipes (20), and component parts for said assembly (10). The assembly (10) is generally mounted to a larger machine (not shown) by way of connection plates (30). These plates (30) define a plurality of openings (40) for passing fasteners (420) therethrough. Fasteners (420) such as bolt screws are used to attach the plates (30) to both the larger machine as well as other plates (30) engaging the component parts of the assembly (10). The larger machine houses various circuitry and processors (not shown) to instruct the assembly (10) with respect to movement, and receive from the assembly (10) data relating to pipes (20) and any defects therein.

[0023] The assembly (10) is comprised of a number of parts, including an elbow (50) (best seen in FIG. 4). The elbow (50) is comprised of a main body (60) defining a top and bottom portion, and a front and rear face. The body (60) top portion defines a first engagement (70) permitting elbow (50) rotation in a horizontal plane. The engagement (70) preferably comprises a head projecting outwardly from the body (60) top portion, and more preferably, a centrally disposed cylindrical head.

[0024] The cylindrical head has two openings (80), to receive bolt screws therein. The head also has indentations (90), preferably four indentations (90) equidistantly disposed around the cylinder circumference. The indentations (90) are shaped to receive a sharpened pin (not shown) to bias the engagement (70) and elbow (50) into a particularly desired orientation.

[0025] The body (60) bottom portion defines a second engagement (100) to engage an arm (160) (best seen in FIG. 2). The second engagement (100) preferably includes a centrally disposed channel extending through the body (60) bottom portion from the front face to the rear face. A portion of the channel slopes downwardly from the front face to the rear face, making an incline (110). The channel rearward portion (120) is, relative to the incline (110), extending horizontally toward the body (60) rear face (it is level or parallel with flat surfaces on the body (60) top and bottom portion). The extending rearward channel portion (120) forms a stop (to limit arm (160) vertical movement). The second engagement (100) also preferably includes a centrally disposed passage (130) spanning the body (60), orthogonal to and communicating with the channel. The passage (130) accepts a pivot pin (140) therethrough. In one embodiment, threading (not shown) circumscribes the passage (130). When threaded, a threaded pivot pin (140) can be used.

[0026] The body (60) has flattened sides (150), to facilitate machining of the elbow (50). The elbow (50) can be generally cylindrical in shape, and in one embodiment the first engagement (70) is a cylindrical shaped head. A mechanism for rotation in the horizontal plane is described herein.

[0027] Another part of the assembly (10) is the arm (160). The arm (160) comprises a handle (170) a defines a first and second end portion. A fork (180) is attached at the handle second end portion. In one embodiment the fork (180) is angled relative to the handle (170).

Angling permits variable diameter pipe (20) accommodation.

[0028] A hand engagement is provided for attaching a hand (230) to the fork (180). In one embodiment the engagement defines openings (190) to receive a fixing pin (200) therethrough (190). Retaining pins (not shown) can be provided at other openings (210) to assemble the fork (180).

[0029] The handle first end portion defines an opening (210) to accept the pivot pin (140). The pin (140) retains the arm (160) in the channel. This permits arm (160) movement in a vertical plane, and movement is downwardly limited by the stop at the channel rearward portion (120) (see FIG. 3).

[0030] The hand engagement (230) connects to the fork (180). In one embodiment the hand comprises a block body (240), defining a centrally disposed opening (250) (best seen in FIG. 5) for accepting a transducer (260) therethrough. The block body (240) defines other openings, including a fixing pin passage (270) to receive a fixing pin (200) therethrough. When the block body (240) is attached to the fork (180) by this pin (200) arrangement, the body (240) is rotatable about a vertical axis. This improves assembly (10) ability to accommodate variable diameter pipes (40), and provides forgiveness if the transducer (260) encounters resistance or a defect.

[0031] The block body (240) defines other openings including a pin screw passage (280), to accept a pin screw (290). The pin screw (290) secures the transducer (260). There are also screw holes (290) to receive screws (not shown) therethrough, to secure a shoe (310) to the block body (240). Preferably these screw holes (290) are asymmetrically disposed, and correspond to aligned shoe (310) screw holes (not shown). When the holes (290) are asymmetrically disposed, directional shoe (310) fitting is permitted, meaning the shoe (310) can be attached to the block body (240) in only one specific direction, configuration, and

orientation. Any other direction, configuration, or orientation prevents the shoe (310) from properly fitting to the block body (240).

[0032] The block body (240) also defines at least one conduit (320) communicating with the central opening (250). The conduit (320) extends from an exposed block body (240) surface to the central opening (250), and terminating adjacent the transducer (260) (when so housed). The conduit (320) accepts and passes liquid (not shown) to the transducer opening (250). This results in laminar flow, and prevents air bubbles from forming when the liquid exits the conduit (320). Laminar flow reduces splashing. The liquid cools the transducer(260), and provides a medium for ultrasound wave travel. To improve laminar flow a widened annular groove (430) is provided at the opening (250) terminus. The widened groove (430) is larger in diameter than the opening (250), and is best seen in FIG. 10.

[0033] The shoe (310) has a curved surface for placement near a pipe (20) and a flat surface for corresponding block body (240) mating. The shoe (310) has openings (not shown) corresponding to the body (240) openings (300), for fasteners (not shown) to attach the shoe (310) to the block body (240). When the shoe (310) is directionally fitted (because of the asymmetrically disposed screw holes (290)), the curved surface corresponds to pipe (20) surfaces, and performs correctly.

[0034] Shoe (310) functions include protecting the transducer (260) from the pipe (20). Without the shoe (310) the transducer would wear quickly from frictional damage (from pipe (20) surface imperfections). The shoe (310) also allows precise positioning of the transducer (260) above the pipe (20) surface. A distance of 2 millimetres between the transducer (260) and pipe (20) is preferable. A constant set distance between the transducer (260) and pipe (20) is critical to ensure correct ultrasound transmission and reception during pipe (20) defect testing.

[0035] The shoe (310) also ensures conduit (320) cooling liquid does not escape away from the transducer (260) too quickly, ensuring transducer (260) cooling (compared to pipe (20) surface temperature).

[0036] A housing (330) is provided to connect the elbow (50) to the larger machine connection plates (30). The housing (330) is box-shaped with a first and second circular chamber (340, 350 respectively), and the first chamber (340) diameter is greater than the second (350). The first chamber (340) houses an indicator plate (360) therein, that does not fall or pass through the second chamber (350).

[0037] In one embodiment the indicator plate (360) has a peripheral arcuate cut-out (370), and centrally disposed openings (380) for fasteners (not shown) (to connect the indicator plate (360) to the elbow head (70)). When connected, the plate (360) and elbow (50) are rotatable as a single rigid unit, and rotatable in a horizontal plane.

[0038] The second chamber (350) is receives the elbow head (70) therein, and permits rotation.

[0039] Sensing pin inlets (390) are provided to receive sensing pins (400). In one embodiment the sensing pins (400) are compression spring pins (400), and in another the pins (400) are brass tipped. The inlets (390) do not intersect with the fastener openings (40), but the inlets (390) do communicate with the second chamber (350). When embedded, the pins (400) engage the head (70) indentations (90). When sufficient rotational force is applied about the elbow (60), the elbow (60) and plate (360) rotate together and the pins (400) pop out of the indentations (90). Without sufficient rotational force, the pins (400) press into the indentations, and hold the elbow (60) relatively steady (in that the elbow (60) does not significantly rotate in a horizontal plane).

[0040] In one embodiment the arcuate cut-out portion (370) is aligned with a sensor (410) housed in a connection plate (30) above the housing (330). The sensor (410) can transmit a signal not impeded by any portion of the plate (360). If the plate (360) is rotated so that the cut-out (370) is no longer aligned with the sensor (410) signal path and a remaining portion of the plate (360) impedes the signal path, the path will be cut short and the sensor (410) will acknowledge and report rotation has occurred.

[0041] In one embodiment the sensor (410) gathers data regarding plate (360) orientation within the housing (330). As the sensor (410) gathers data comprising orientation information, it communicates that data to an associated processor (not shown). The processor can include a display and a terminal for user interaction. The processor can be pre-programmed to behave in a set manner in response to plate (360) rotation.

[0042] For example, when the arm (160) and hand (230) encounter a pipe (20) surface defect, that defect pushes on the arm (160) hand (230), and elbow (60). The elbow (60) is normally fixed in one position with the pins (400) engaging the indentations (90). Force applied by the defect against the hand (230) builds, and on exceeding a threshold, the pins (400) pop out of the indentations (90), and the elbow (60) rotates. The sensor (410) identifies, records, and transmits this change of rotation. As the arcuate cut-out (370) moves away from the sensor (410) signal path and a remaining portion of the plate (360) blocks that path, the sensor (410) can transmit an alert. The processor can process that alert and do any of inform a user, receive manual instructions, and automatically lift the arm (160) vertically upward from its present location, away from the pipe (20).

What is claimed is

1. An elbow for a transducer actuator comprising:

a main body defining a top portion, a bottom portion, a front face and a rear face;

the top portion defining a first engagement for rotating the elbow in a horizontal plane; and

the bottom portion defining a second engagement to engage an arm.

2. The elbow in claim 1 wherein the second engagement includes a centrally disposed channel extending through the bottom portion from the front face to the rear face.

3. The elbow in claim 1 wherein the first engagement comprises a head projecting outwardly from the top portion.

4. The elbow in claim 3 wherein the head is centrally disposed on the body top portion.

5. The elbow in claim 3 wherein the head is a cylinder.

6. The elbow in claim 2 wherein the channel slopes downwardly from the front face to the rear face.

7. The elbow in claim 6 further comprising a stop disposed toward the rear face, to limit downward motion of the arm.

8. The elbow in claim 1 wherein the main body is a cylinder.

9. The elbow in claim 8 wherein the main body further defines opposing flattened sides orthogonal to the front and rear face.

10. The elbow in claim 1 wherein the second engagement further defines a centrally disposed passage spanning the main body orthogonal to and in communication with the channel.

11. The elbow in claim 10 further comprising threading circumscribing the passage.

12. An arm for transducer actuation comprising:
a handle defining a first and second end portion;
a fork attached to the handle second end portion; and
a hand engagement for attaching a hand to the fork.

13. The arm in claim 12 wherein the fork is angled relative to the handle.

14. The arm in claim 12 wherein the handle first end portion defines an opening for passing a fastener therethrough.

15. The arm in claim 12 wherein the hand engagement attaches the hand to the fork rotatably about a longitudinal axis.

16. The arm in claim 12 wherein the hand engagement comprises defined openings for passing a fastener therethrough.

17. A hand for transducer actuation comprising
a block body defining a centrally disposed opening for passing the transducer therethrough; and
a fork engagement to attach the hand to a fork.

18. The hand in claim 17 wherein the block body defines at least one conduit

communicating with the transducer opening, for receiving liquid therein and passing the liquid therethrough to the transducer opening.

19. The hand in claim 17 defining openings to pass fasteners therethrough, for fastening a shoe to the hand.

20. The hand in claim 19 wherein the openings are asymmetrically disposed for directional shoe fitting.

21. The hand in claim 17 further comprising a shoe for retaining a transducer therein and guiding said transducer along a curved pipe surface.

22. An assembly for detecting a pipe defect comprising:

a housing;

an indicator plate housed in said housing;

an elbow having a first engagement for rotating the elbow in a horizontal plane, the elbow first engagement being attached to the plate, the elbow having a second engagement to engage an arm.

23. The assembly in claim 22 further comprising a sensor for communicating data, the sensor being associated with the indicator plate to sense rotation of the plate and elbow and communicate data associated with plate and elbow rotation.

24. The assembly in claim 22 further comprising an arm having a handle with a first and second end portion; a fork attached to the handle second end portion, the handle first end portion engaging the elbow second engagement.

25. The assembly in claim 22 wherein the first engagement comprises a head projecting

outwardly from the top portion.

26. The assembly in claim 22 wherein the elbow defines a top and bottom portion and a front and rear face, and the elbow second engagement includes a centrally disposed channel extending through the bottom portion from the front face to the rear face.

27. The assembly in claim 26 wherein the channel slopes downwardly from the front face to the rear face.

28. The assembly in claim 27 further comprising a stop disposed toward the rear face, to limit downward motion of the arm.

29. The assembly in claim 23 further comprising a processor in communication with the sensor, to receive plate and elbow rotation sensor data.

30. The assembly in claim 29 wherein the processor, on receiving data confirming plate and elbow rotation, instructs the assembly to move vertically upward from its present location, away from the pipe.

31. The assembly in claim 24 further comprising a hand for transducer actuation.

32. The assembly in claim 31 wherein the hand comprises

a block body defining a centrally disposed opening for passing the transducer therethrough; and

a fork engagement to attach the hand to the fork.

33. The hand in claim 32 wherein the block body defines at least one conduit communicating with the transducer opening, for receiving liquid therein and passing the

liquid therethrough to the transducer opening.

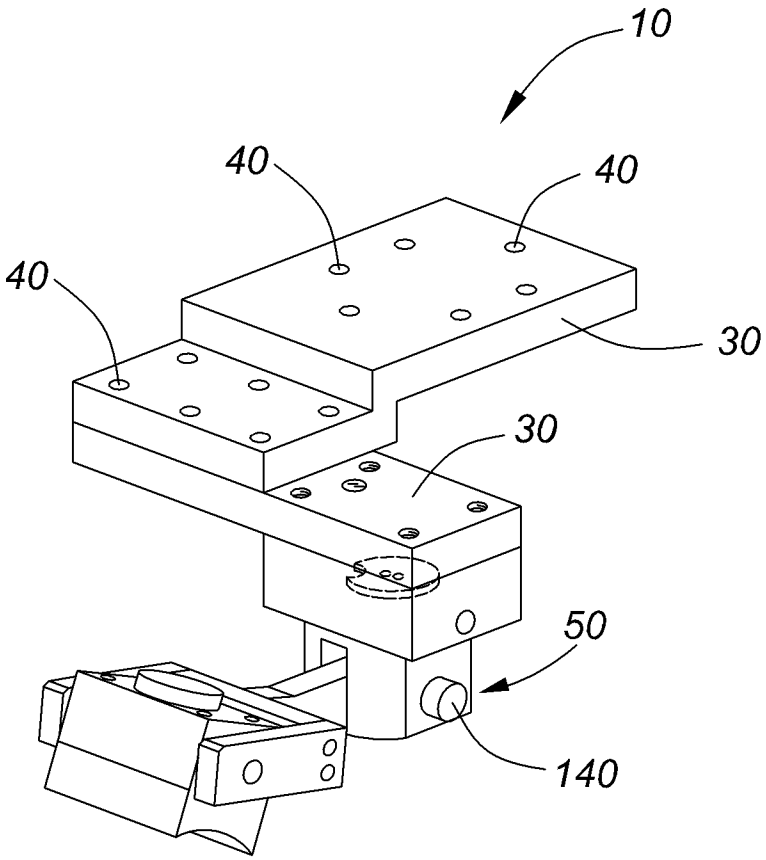
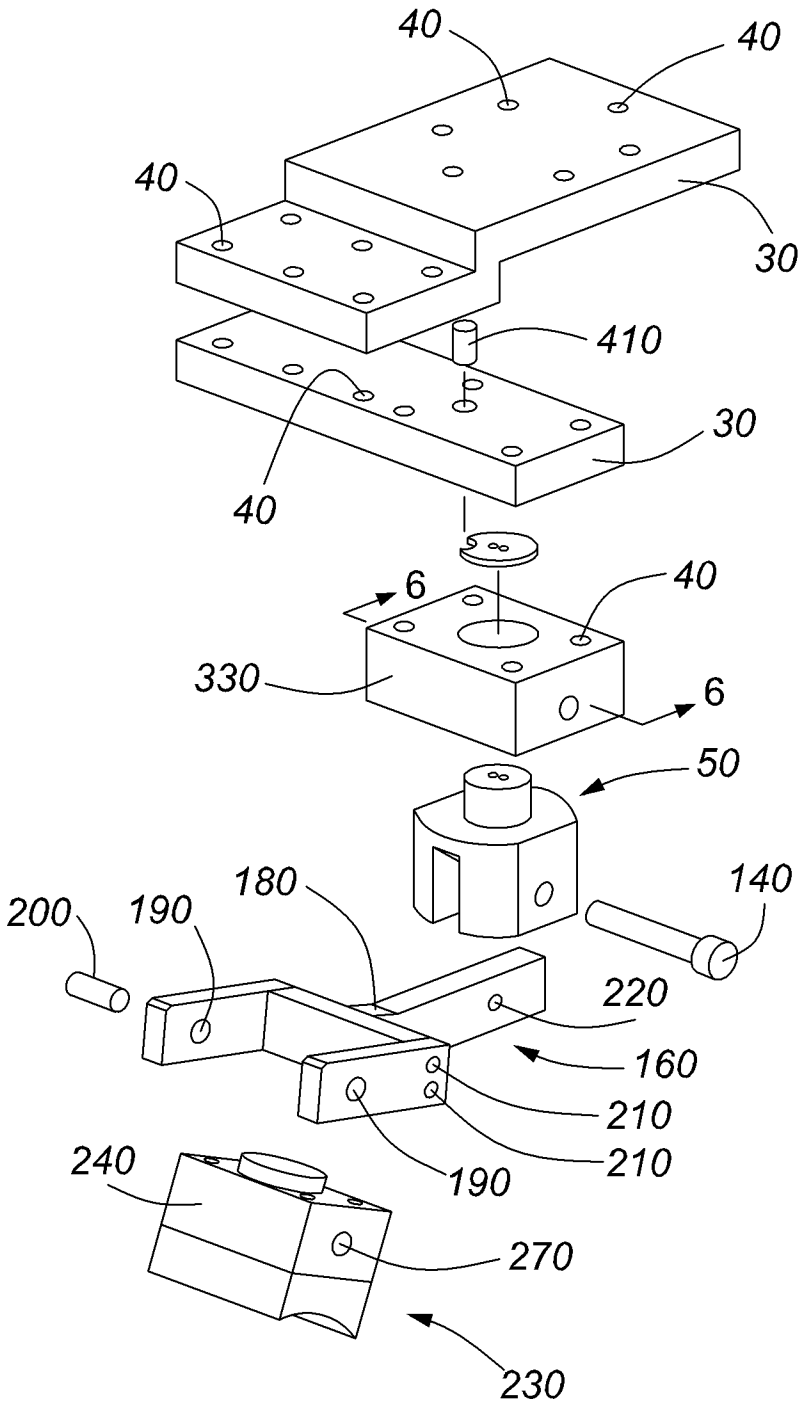


FIG. 1


40
40
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30
410
30
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6
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270
230

FIG. 2

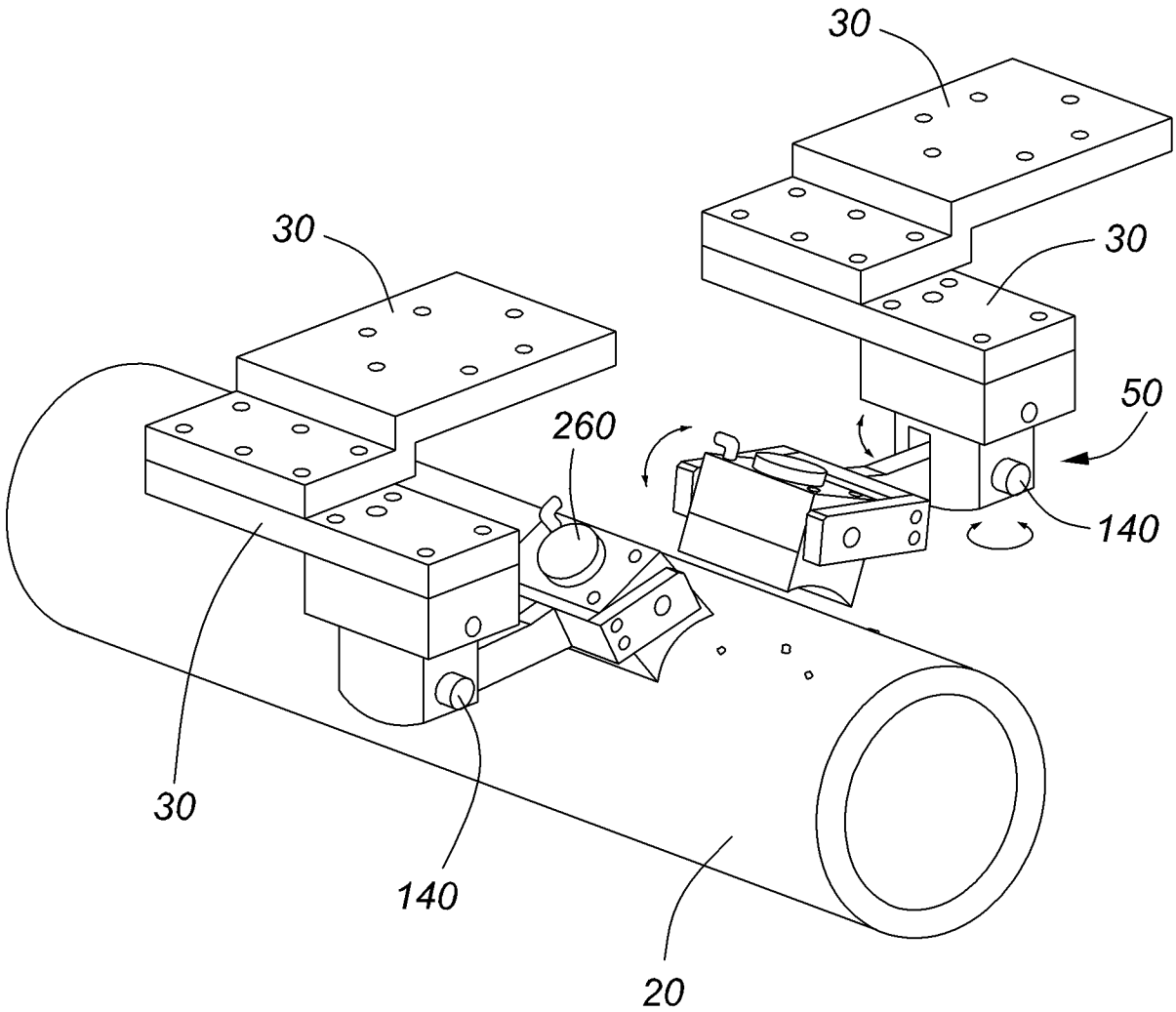
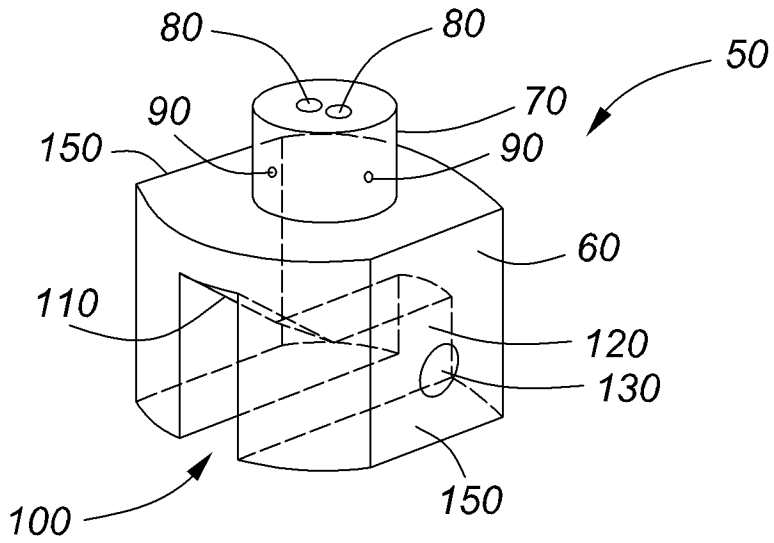


FIG. 3


80
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70
90
150
90
60
110
120
130
100
150

FIG. 4

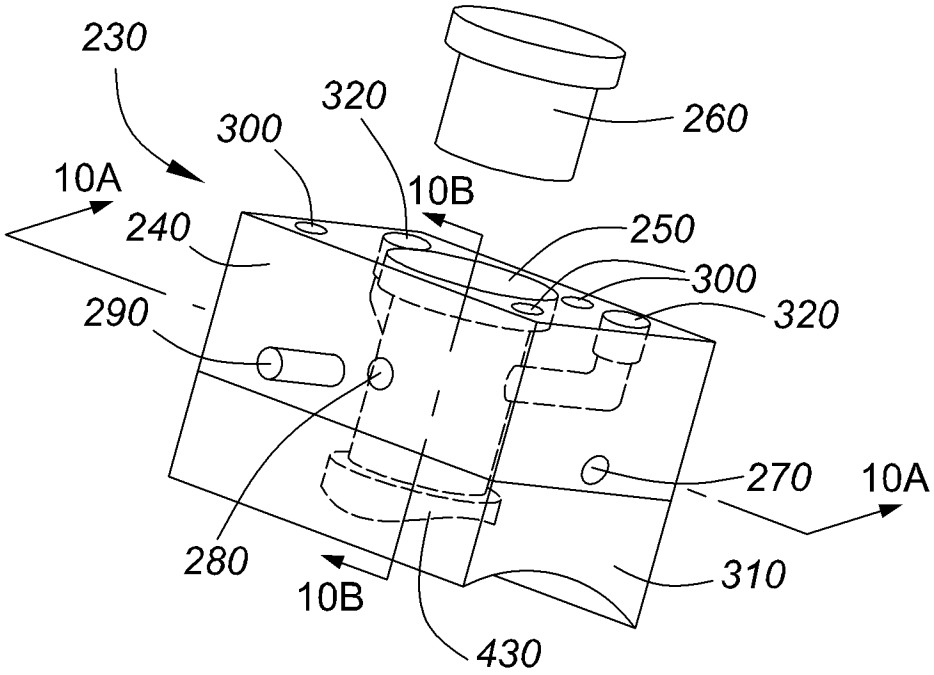
230
320
300
260
10A
10B
240
250
300
290
320
270
10A
280
10B
310
430

FIG. 5

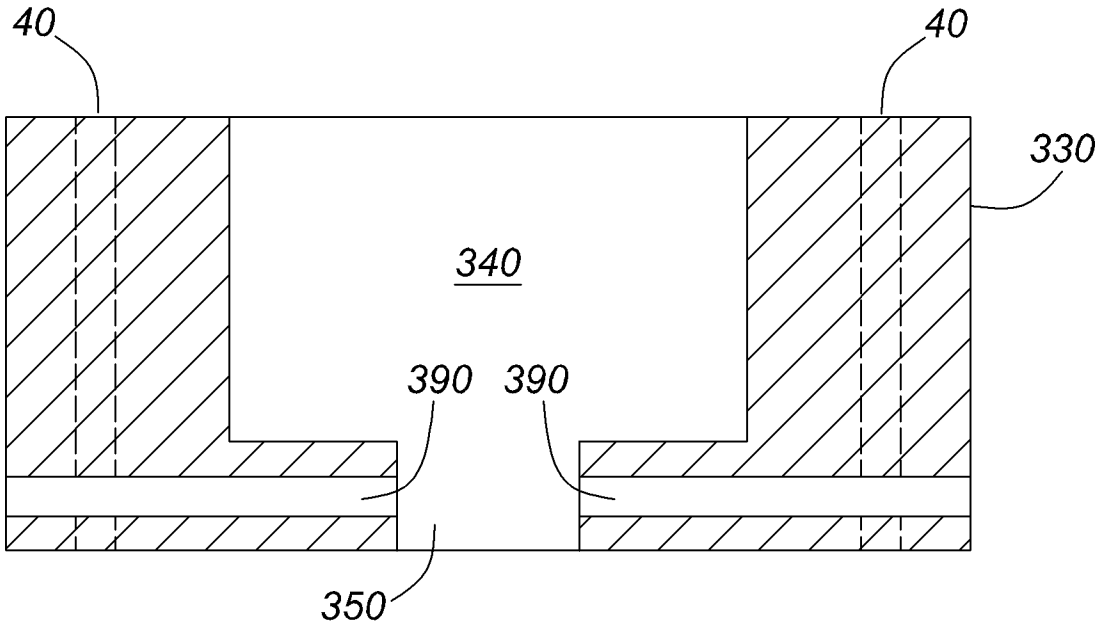

FIG. 6

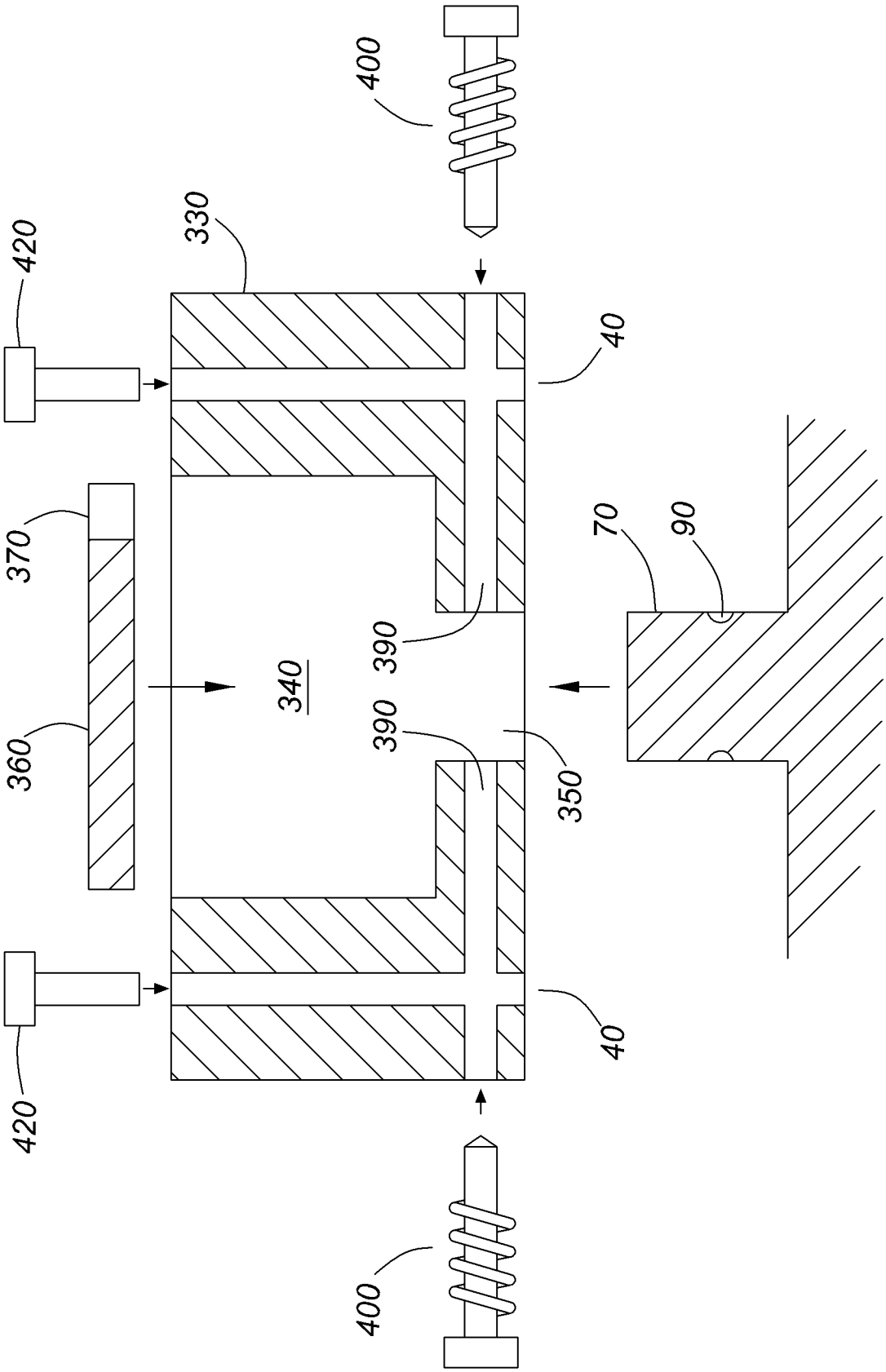

FIG. 7

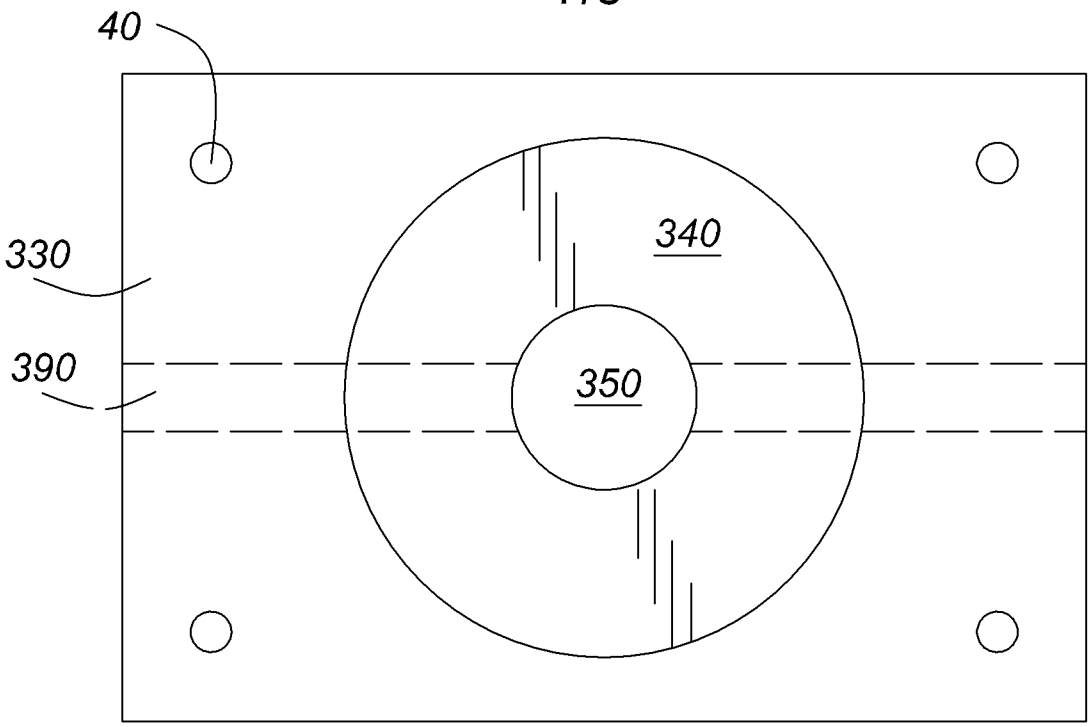

FIG. 8

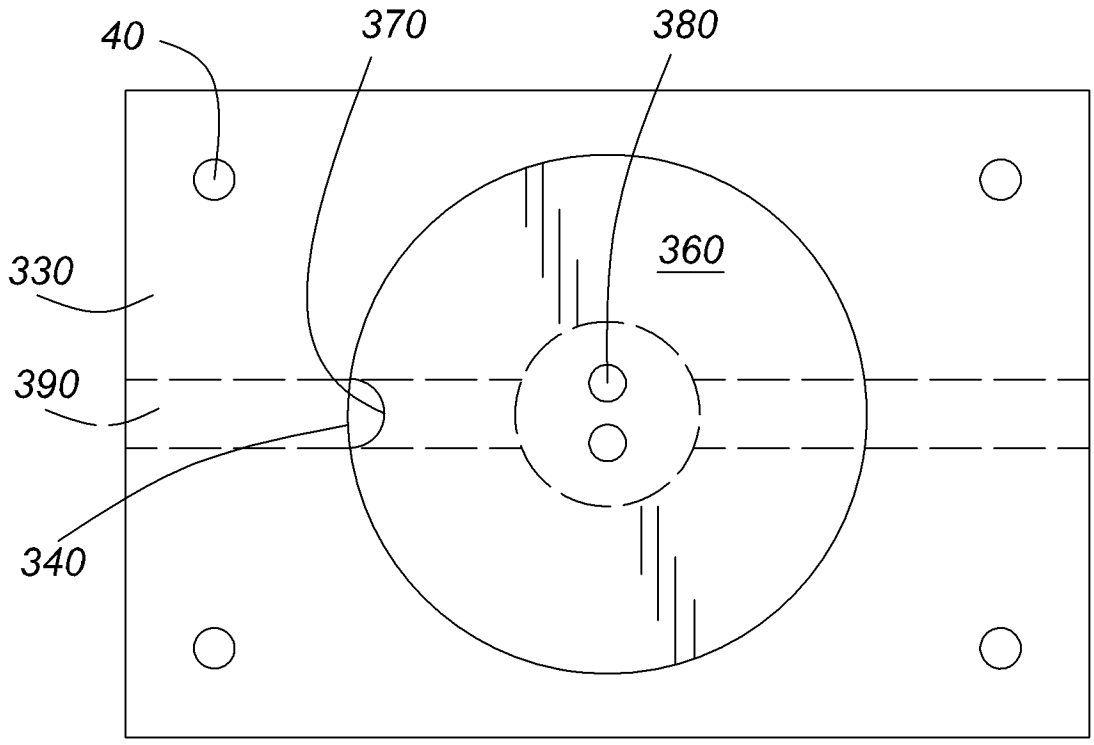

FIG. 9

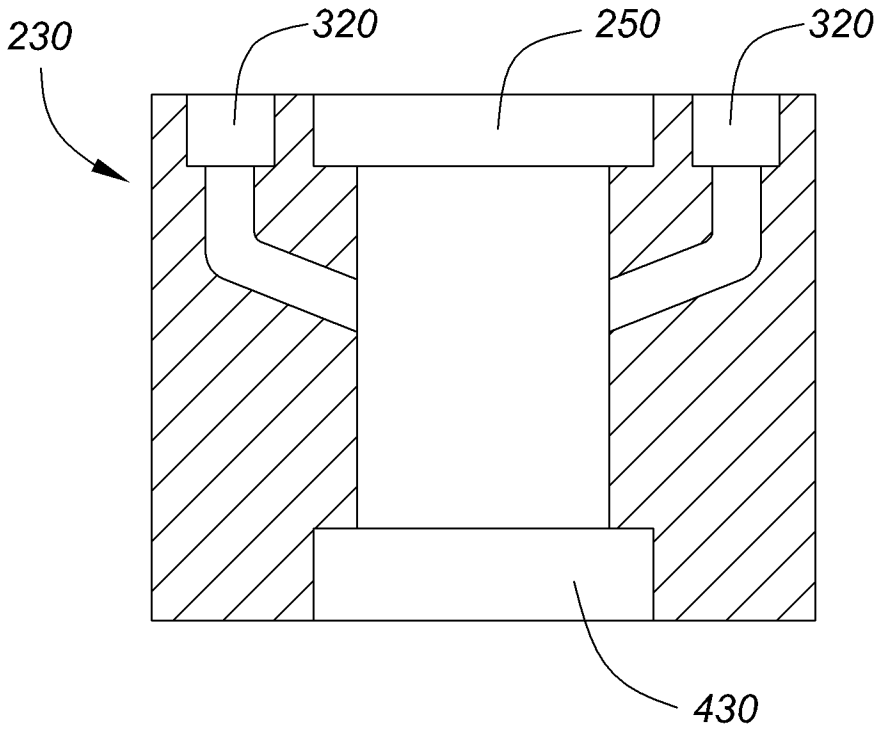

FIG. 10A

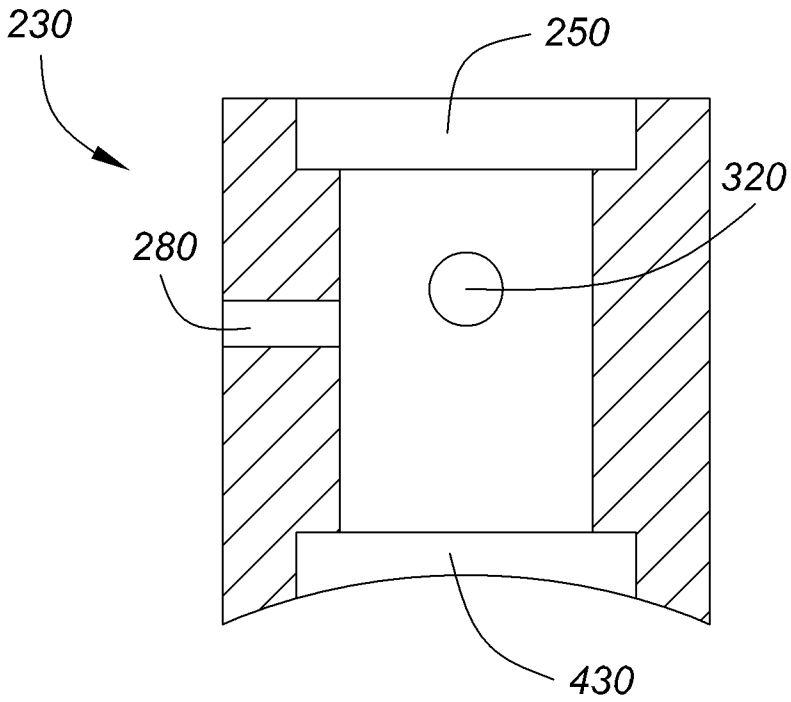

FIG. 10B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/050056

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***F16M 11/06*** (2006.01) , ***B21C 37/06*** (2006.01) , ***G01M 99/00*** (2011.01) , ***G01N 29/265*** (2006.01)

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)

IPC: ***F16M 11/06*** (2006.01) , ***B21C 37/06*** (2006.01) , ***G01M 99/00*** (2011.01) , ***G01N 29/265*** (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)

Database: EPOQUE

Keywords: transducer, attach+, pivot+, rotat+, arm, engag+, detect+, defect, inspect+, displac+, sens+, position, location, line, weld, align+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO2006/034066A2 (GEORGESON et al.) 30 March 2006 (30-03-2006) *Entire document*	1-6 and 8-11 7
X Y	US3002375A (MOFFATT et al.) 3 October 1961 (03-10-1961) *Entire document*	1-6, 8, 10 and 11 7
Y A	WO2004/106802A1 (PIPER) 9 December 2004 (09-12-2004) *Entire document*	7 22-33
Y A	US2009/0178465A1 (ETHRIDGE et al.) 16 July 2009 (16-07-2009) *Entire document*	7 22-33
A	WO00/73774A1 (SMARTT et al.) 7 December 2000 (07-12-2000) *Entire document*	22-33
A	WO01/36908A2 (DUCKETT et al.) 25 May 2001 (25-05-2001) *Entire document*	1-11

[ ] Further documents are listed in the continuation of Box C.

[X] 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	Date of mailing of the international search report
27 October 2011 (27-10-2011)	1 November 2011 (01-11-2011)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
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Facsimile No.: 001-819-953-2476

Authorized officer

Christopher Fitz-Hardy (819) 934-6359

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/050056

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. [ ] Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. [ ] Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :

3. [ ] Claim Nos. :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

Group A - Claims 1-11 are directed to an elbow for a transducer actuator comprising a main body defining a top portion and a bottom portion, the top portion defining a first engagement for rotating the elbow, and the bottom portion defining a second engagement to engage an arm;

Continued on page 5.

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. [X] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. : 1-11 and 22-33

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[X] No protest accompanied the payment of additional search fees.

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Continued from Box No. III.

Group B - Claims 12-16 are directed to an arm for transducer actuation comprising a handle, a fork attached to the handle, and a hand engagement for attaching a hand to the fork;
Group C - Claims 17-21 are directed to a hand for transducer actuation comprising a block body defining a centrally disposed opening for passing the transducer therethrough, and a fork engagement to attach the hand to a fork; and
Group D - Claims 22-33 are directed to an assembly for detecting a pipe defect comprising a housing, an indicator plate housed in said housing, an elbow having a first engagement attached the plate for rotating the elbow and the elbow having a second engagement to engage an arm.

The claims must be limited to one inventive concept as set out in Rule 13 of the PCT.