(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 December 2012 (27.12.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/177964 A2

(51) International Patent Classification:
B21J 7/04 (2006.01)

(21) International Application Number:
PCT/US2012/043679

(22) International Filing Date:
22 June 2012 (22.06.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/499,874 22 June 2011 (22.06.2011) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: TUYERE REMOVER

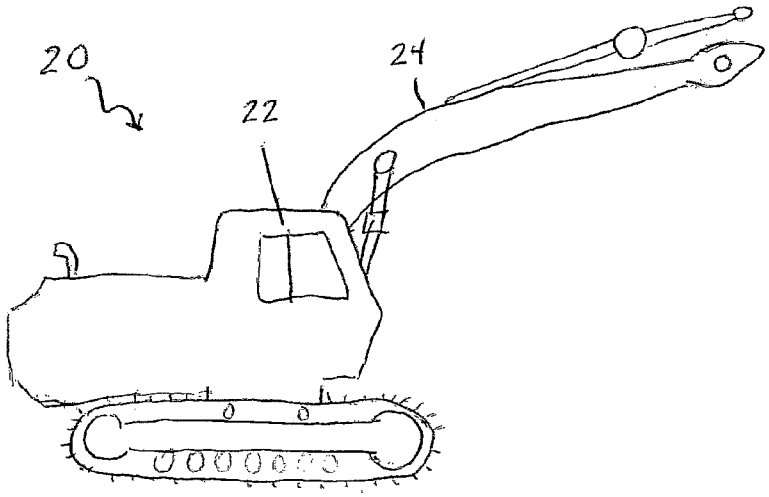

FIG 1

(57) Abstract: A component of a gas injection system (tuyere/tymp) removal apparatus comprising a pneumatic or hydraulic hammer reverse mounted into a hammer frame, the working end of the hammer fixedly attached a first end of a slidable frame. The slidable frame having a second end fixedly attached to an elongated lifting arm means with a component handling means, and two sides slidably attached to the hammer frame. The component handling means may be inserted into the rear of a component of a gas injection system. When activated, the hammer generates a pulling motion on the component handling means engaged with the component of a gas injection system, releasing the component of a gas injection system from the wall of the blast furnace.

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TUYERE REMOVER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims benefit and priority from U.S. provisional application Ser. No. 61/499,874 entitled "**TUYERE REMOVER**", filed June 22, 2011, the disclosure of which is hereby incorporated by reference herein in its entirety for all purposes.

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention relates in general to removal devices for components of a gas injection system, and has more particular reference to removal of a tuyere from blast furnace walls by aid of a reverse mounted hydraulic or pneumatic hammer to provide a pulling motion on the tuyere.

BACKGROUND - FIELD OF THE DISCLOSURE

[0003] Steel makers are increasingly shaped by the forces of globalization. Increasingly, steel companies are turning to maintenance and service companies to help them develop solutions that will reduce furnace downtimes, reduce costs and improve on mill safety. Many of their maintenance systems are manual, time consuming and have an unacceptably high operator injury rate. Improved maintenance techniques and equipment can improve efficiency and advance technology.

[0004] A tuyere is a nozzle through which air and other gases are blown into a blast furnace via a blow pipe under pressure from a blast engine or other device. Injection through the tuyere creates furnace temperatures far higher than could be normally achieved. A modern blast furnace contains 24 to 36 tuyeres. Tuyeres are constructed from pure copper and cooled with internal water pipes to withstand the extreme temperatures. A typical tuyere measures 18 in. in end diameter on the intake end, 6 ¼ in. to 7 ¾ in. diameter at the nose end and are approximately

21 in. in length. They are very heavy and pressed hydraulically into a cooler inserted in a tymp (hollow water-cooled iron cushing) in the furnace wall to a pressure of 5000 lb. The noses can be heavily damaged by the furnace environment and removing a heavy, damaged tuyere press-fit into the cooler is no small task, especially for a manual system.

[0005] Compounding the challenge is the demanding environment of the tuyeres and the often limited space in which to access the tuyeres for installation and maintenance. The life of a tuyere varies (from several days to several months) and can breakdown by burning and deformation of the tuyere walls caused by materials, such as skull, in the furnace environment. The loss can often be catastrophic in the case of water leakage which results in molten iron and gases escaping the pressurized furnace. A ten minute break out can result in a multimillion dollar loss and days of furnace down time. The replacement of one single tuyere without a break out typically interrupts the operation of the furnace for one hour or more, depending on the length of time the tuyere has been in the furnace and the amount of damage, at a downtime cost of several thousand of dollars per minute.

[0006] Lin, et al., U.S. Pat. 5,925,312, describe a device for removing tuyeres. The device utilizes a hydraulic cylinder attached to a rod having an attached hook. The device is moved into position in line with the tuyere, the hook engaged, and the hydraulic cylinder is activated to pull the tuyere from its tymp.

[0007] A hydraulic cylinder or ram is also employed in U.S. Pat. 4,087,084, to Meyers, to aid in the loosening of the tuyere from its tymp. But here, a hydraulic hammer, placed on a parallel axis with the rod, supplies vibration to the rod to aid in loosening the tuyere. The tuyere is then removed by action of the hydraulic cylinder. The hydraulic hammer provides vibration, but does not utilize the force of the hammer to pull the tuyere.

[0008] Malliet describes tuyere removal devices and movable supports to utilize the device. U.S. Pat. 5,127,633 describes the device with an air percussion hammer mounted co-axial with a double-piston ram and cylindrical rod mounted therein. The rod has a notch or hook at the end gripped by the ram. Malleit, in U.S. Pat. 4,266,907, mounts the device onto a self-propelled vehicle. The co-axial arrangement of the hammer and rod provides a reciprocating impact onto the tuyere, but the energy provided by the air percussion hammer is in a forward, pushing direction instead of the desired pulling direction.

[0009] Other existing tuyere removal methods may be entirely manual process and involve multiple operators manoeuvring a charge cart with a counterweighted component handling means and rope system to haul the tuyere out of the furnace wall. This method often takes several attempts and injury to operators is not uncommon. More automated systems for tuyere removal utilize hydraulic cylinders to pull the tuyere, but attached hammers are used either to vibrate the removal tool or push the tuyere.

[0010] A need for a removal device and method that quickly and easily pulls the tuyere from its tymp, reducing downtime, as well as preventing operator injuries, is desired.

SUMMARY OF THE INVENTION

[0011] Hammer means are reverse mounted into a hammer frame. The working end of the hammer is fixedly attached to a slidable frame. The slidable frame is slidably attached to the sides of the hammer frame. The slidable frame is fixedly attached it to an elongated lifting arm means with a component handling means at the end. The component handling means is engaged in the back side of a tuyere.

[0012] The hammer frame may be attached to the boom of a small excavator. As the hammer is activated by an operator of the excavator, the slidable frame moves relative to the hammer frame

and the excavator, applying energy into a pulling motion on the elongated lifting arm means and component handling means and, concomitantly, the tuyere.

[0013] Using the apparatus with the reverse hammer design, tuyere removal time was reduced from 1 hour to a few minutes. Over 24 tuyeres, this represents a significant reduction in downtime costs. The system is much safer than other designs as only the excavator operator is involved in the removal after the blow pipe and other equipment were disconnected.

[0014] In a preferred embodiment, the present invention combines the use of a reverse mounted hammer fixedly attached by means of a slidable frame to a elongated lifting arm means with a component handling means for pulling on a tuyere, generating the force needed to remove a tuyere from a blast furnace wall. These and other advantages of the invention will be appreciated by reference to the detailed description of the preferred embodiment(s) that follow.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0015] **FIG. 1**: Side view of an Excavator with boom, stick, and bucket.

[0016] **FIG. 2**: Side view of Excavator Arm, Hammer Frame, Sliding Frame, Elongated lifting arm means, Component handling means, and Tuyere.

[0017] **FIG. 3**: Top view of Side Plate Hammer, Sliding Frame, Elongated lifting arm means, and Component handling means.

[0018] **FIG. 4**: Cross view of Side Plate Hammer, Sliding Frame, Elongated lifting arm means perpendicular to the axis of the hammer means.

[0019] **FIG. 5**: Rear view of Side Plate Hammer and Sliding Frame.

[0020] **FIG. 6**: Side elevational view of a preferred one-piece Sliding Frame of the present invention.

[0021] **FIG. 7**: Top plan view of a preferred one-piece Sliding Frame of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S) OF THE INVENTION

[0022] In the following detailed description, reference is made to the accompanying examples and figures that form a part hereof, and in which is shown, by way of illustration, specific embodiments in which the inventive subject matter may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice them, and it is to be understood that other embodiments may be utilized and that structural or logical changes may be made without departing from the scope of the inventive subject matter. Such embodiments of the inventive subject matter may be referred to, individually and/or collectively, herein by the term "invention" merely for convenience and without intending to voluntarily limit the scope of this application to any single invention or inventive concept if more than one is in fact disclosed. The following description is, therefore, not to be taken in a limited sense, and the scope of the inventive subject matter is defined by the appended claims and their equivalents.

[0023] **FIGS. 1 & 2** show a preferred embodiment of a tuyere removing apparatus **10** according to the present invention comprising a tractor or other motorized vehicle **20** with an operator cab **22**, a boom **24**, and a tuyere removing attachment **26**. Preferably, in the tuyere removing apparatus **10**, the boom **24** lays flatter to reduce the boom's working height and allows the center of gravity of the tuyere remover apparatus **10** to be closer to the cab **22** to compensate for the weight of a tuyere when carried by tuyere removing apparatus **10** on removal.

[0024] Referring to **FIG. 2**, a preferred embodiment of the tuyere remover **10** of the present invention comprises hammer **40**, hammer frame **46** and one-piece sliding frame **50**. The end **36** of boom **24** may be pivotally attached to a hammer frame **46** having a first end **38** of a hammer frame **46**. A hammer **40** is fixed by attachment means to the second end of the hammer frame **42** so that the longitudinal axis of the hammer **40** is co-linear with the longitudinal axis of the

hammer frame **46.** Preferably, the hammer working end **44** is nearer the first end **38** of the hammer frame **46**, thus in a reversed hammer configuration. The attachment means may be bolts, welding or any other means to temporarily or permanently prevent movement between the hammer **40** and the hammer frame **46**. The hammer **40** may be controlled by hydraulic or pneumatic means **48**.

[0025] The hammer working end **44** is attached to a sliding frame **50** at a sliding frame first end **52**. The sliding frame **50** is of a general rectangular shape with the first end **52**, a second end **54**, and two sides **56** connecting the sliding frame first end **52** and second end **54**. The sliding frame **50** defines an opening of sufficient length and width to accommodate the hammer frame **46**. The sliding frame **50** is slidably attached by sliding means **66** to the hammer frame **46** such that when the hammer **40** is activated by hydraulic or pneumatic means, the sliding frame **50** moves in conjunction with the hammer working end **44** and moves relative to the hammer frame **42**. The sliding means **66** may comprise brackets **64**. The sliding frame second end **54** may be attached to one end an elongated lifting arm means **56** having a component handling means **58** at the other end. The component handling means **58** is designed to fit into the inside of a tuyere **60** which is mounted in the wall of the blast furnace **62**. The component handling means **58** is preferably a hook which preferably engages or hooks onto a rim **63** on the inside of tuyere **60**. The overall length of the device from the first end **38** of the hammer frame **46** to the component handling means **58** is preferably about 7 feet.

[0026] The hammer **40** preferably is designed to deliver a maximum of 200-400 J per blow. More preferably, the hammer **40** is designed to deliver 400 J per blow. As the hammer **40** is reverse mounted, the energy of impact is sharply directed to a pulling motion on the inside of the tuyere **60**.

[0027] **FIG. 3** shows the top view of the tuyere remover **10** of the present invention. The hammer **40** is reverse attached to the second end **42** of hammer frame **46** such that the hammer working end **44** is proximal to the boom **24**. The sliding frame **50** is attached to the hammer working end **44**. The sliding frame sides **56** are slidably attached to the outside of the hammer frame **46**. The elongated lifting arm means **58** is attached to the second end **54** of the sliding frame **50**.

[0028] **FIG. 4** shows the cross view of the tuyere remover **10** midway and perpendicular to the axis of the hammer means **40**. The sliding frame sides **56** are mounted within brackets **64** affixed to the hammer frame **46**.

[0029] **FIG. 5** shows a rear view of the tuyere remover showing the attachment of the sliding frame **50** to the hammer working end **44**.

[0030] During use, an operator in the cab **22** moves the apparatus into position such that the component handling means **58** engages a tuyere **60** to be removed. The hammer **40** is then activated by hydraulic or pneumatic means **48**. The hammer working end **44** moves out and in. The sliding frame **50** attached to the hammer working end **44** moves in conjunction with the hammer working end **44**, and slidably with respect to the hammer frame **46**. The elongated lifting arm means **58** attached to the sliding frame moves in conjunction with the sliding frame and hammer working end **44**. The component handling means **58** vibrates on the tuyere with each movement of the hammer working end **44**. When the tuyere **60** is loose, it is pulled from the blast furnace wall **62** by the tuyere removing device **10**, generally by backing up device to with the tuyere **10** thereon and carried away on the component handling means **58**.

[0031] In the foregoing Detailed Description, various features may be grouped together in a single embodiment to streamline the disclosure. This method of disclosure is not to be

interpreted as reflecting an intention that the claimed embodiments of the invention require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

I claim:

1. An apparatus mountable on a self-propelled vehicle for handling, installing and/or removing a tuyere or tymp from a shaft furnace, comprising:

   a movable frame having first and second ends and an engagement component mounted on the second end of the movable frame for engaging the tuyere or tymp; wherein the movable frame is mounted on a second frame so that the movable frame can move in at least first and second directions;

   a hammer mounted on the second frame wherein a working end of the hammer acts against the movable frame to move the movable frame in a first direction.
2. The apparatus of claim 1 wherein the movable frame comprises a one-piece construction.
3. The apparatus of claim 1 wherein the movable frame comprises a construction of two or more pieces.
4. The apparatus of claim 1 wherein the hammer comprises a hydraulic-powered hammer.
5. The apparatus of claim 1 wherein the hammer comprises a pneumatic-powered hammer.
6. The apparatus of claim 1 wherein the hammer comprises a power hammer.
7. The apparatus of claim 1 wherein the hammer comprises an electric-powered hammer.
8. The apparatus of claim 1 wherein the engagement component is a hook.
9. The apparatus of claim 1 wherein the engagement component is integral with the movable frame.
10. The apparatus of claim 1 wherein the hammer delivers a maximum of about 200-400 J per stroke.
11. The apparatus of claim 1 wherein the hammer delivers a maximum of about 400 J per blow.

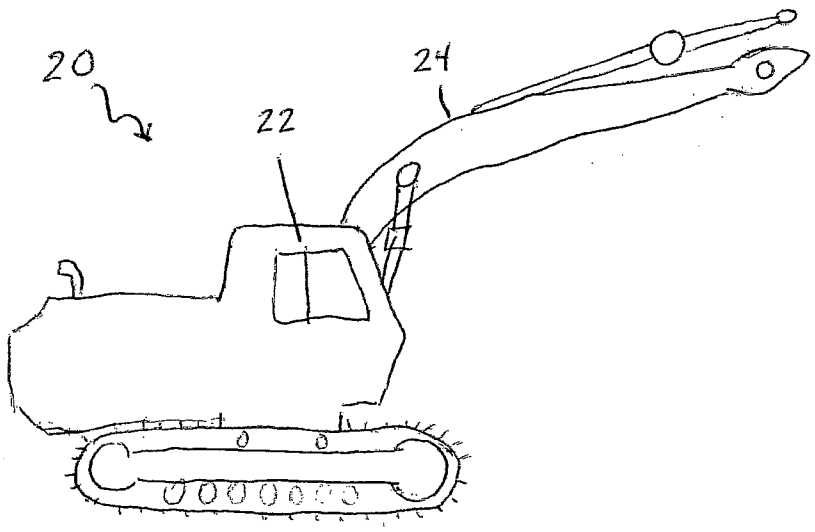


FIG 1

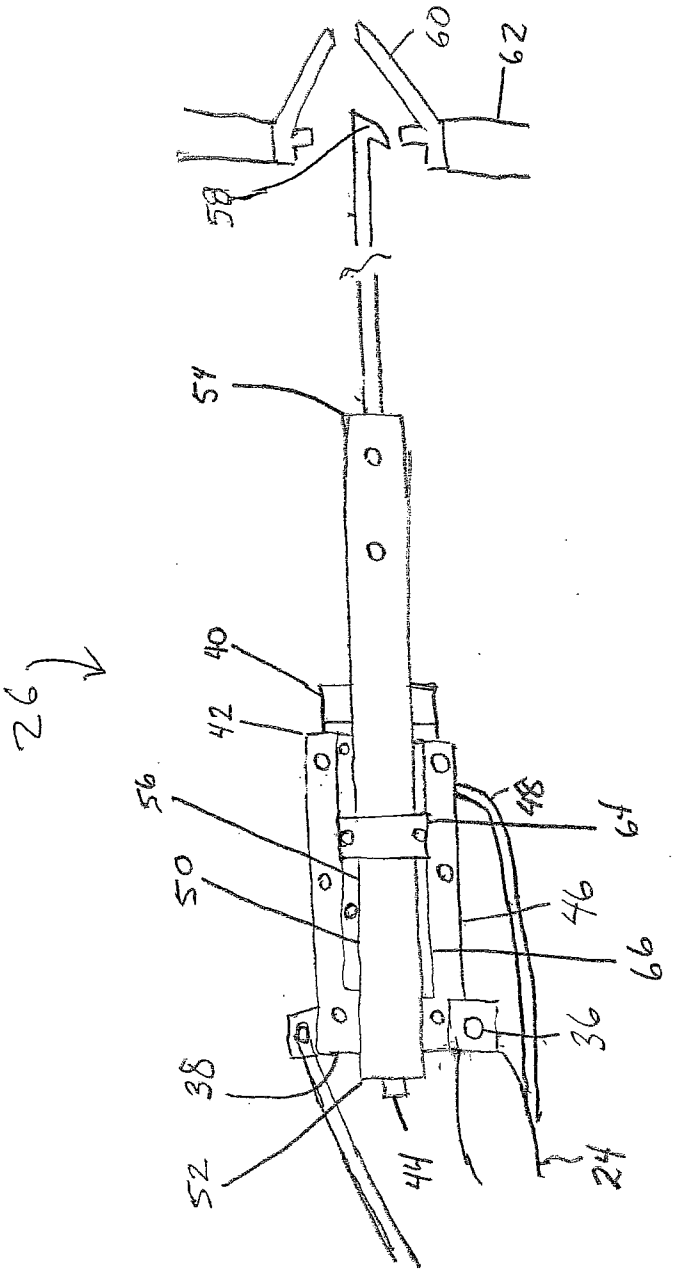


Fig 2

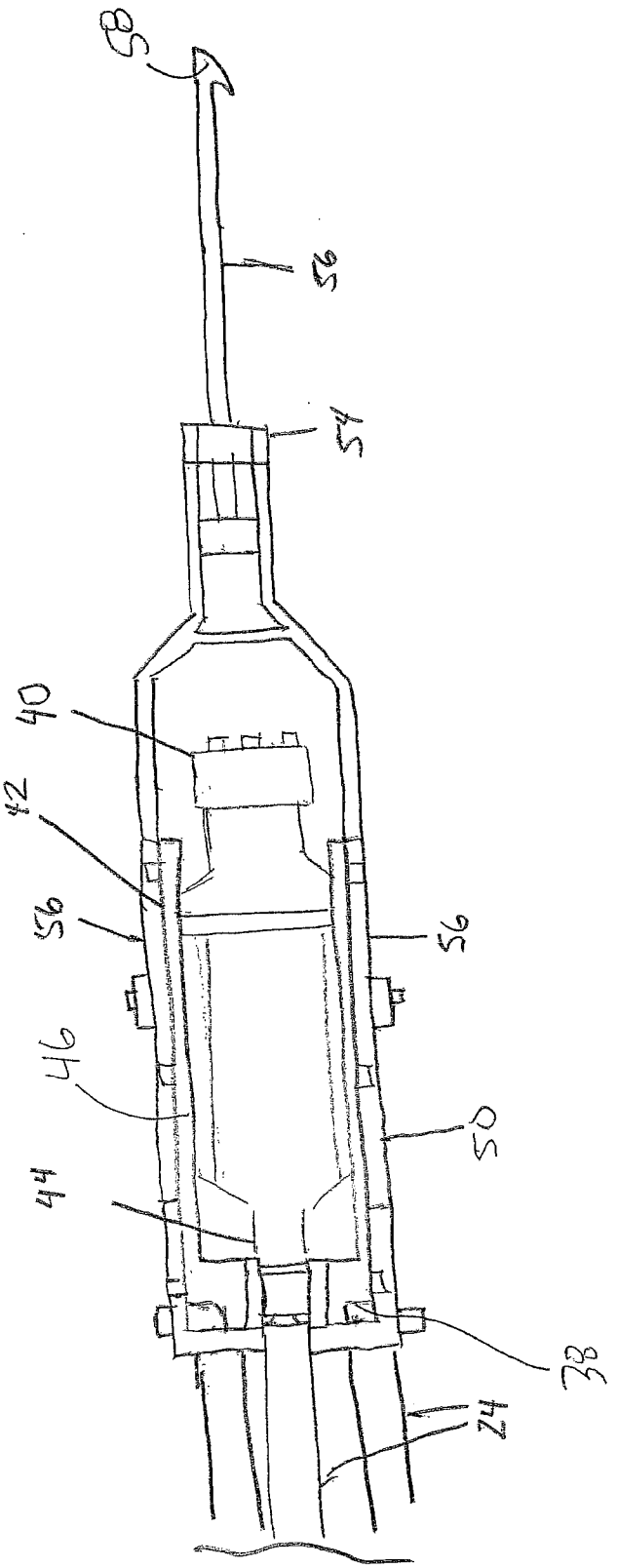


Fig 3

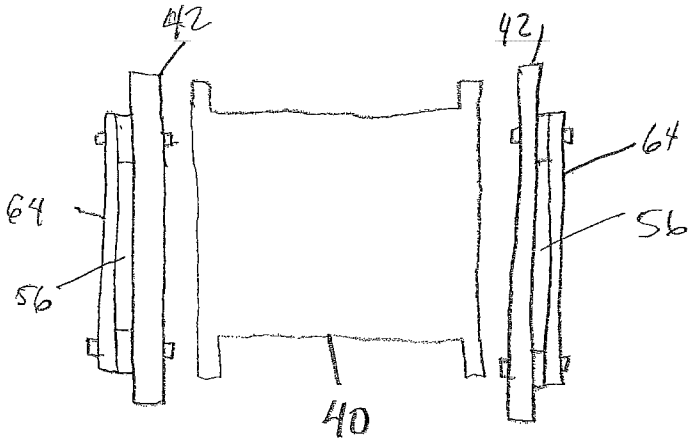


Fig 4

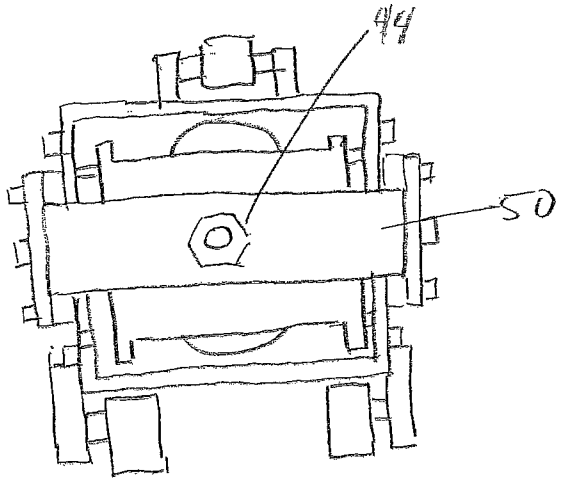


Fig 5

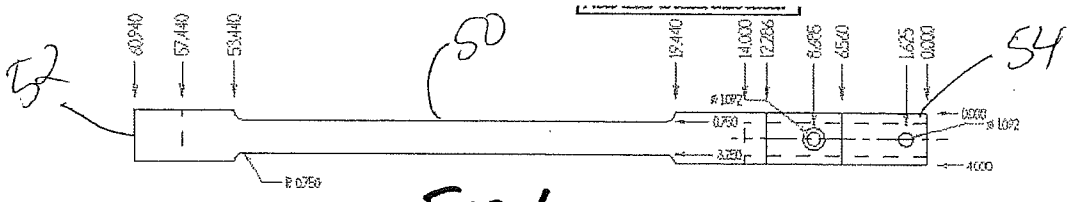
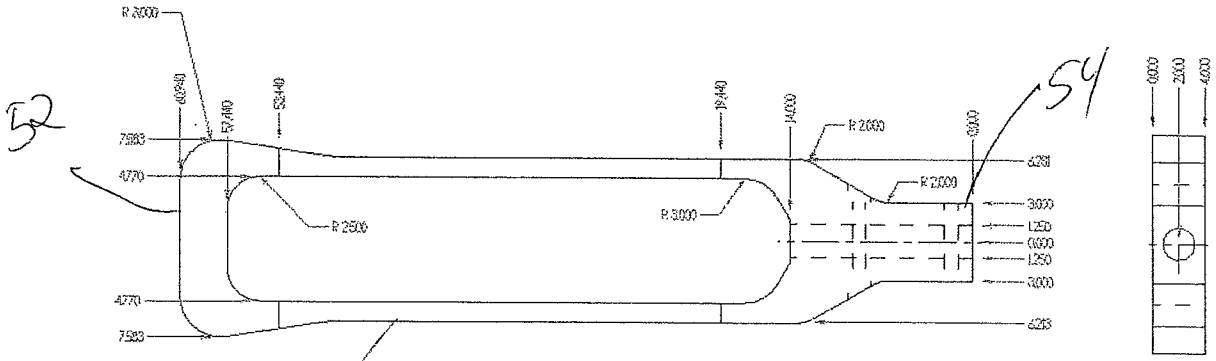

52
50
54
R 0750

FIG 6


52
54
R 3000
R 2500
R 2000
R 3000
7583
4770
4770
7583
6231
3000
1250
1250
3000
6231

50

FIG 7