(12) UK Patent Application (19) GB (11) 2 182 898 (13) A

(43) Application published 28 May 1987

(21) Application No 8627420

(22) Date of filing 17 Nov 1986

(30) Priority data

(31) 8505446 (32) 18 Nov 1985 (33) SE

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(51) INT CL[4]
B63C 11/52

(52) Domestic classification (Edition I)
B7H NJ
E1H ED
F2N 1A7

(56) Documents cited
None

(58) Field of search
B7H
E1H
Selected US specifications from IPC sub-class B63C

# (54) A robot

(57) The invention relates to a robot, particularly for cleaning, inspection and/or repair of welds on underwater tubular steel sections of off-shore platforms. The robot is carried by front and rear wheels (14, 16) and has at least one forwardly directed leg (20, 22) having an outer support roller (28). The legs (20, 22) are so constructed and so pivotally arranged that the legs together with the body can retentively embrace more than half the perimeter of the tubular section on which the robot is placed.

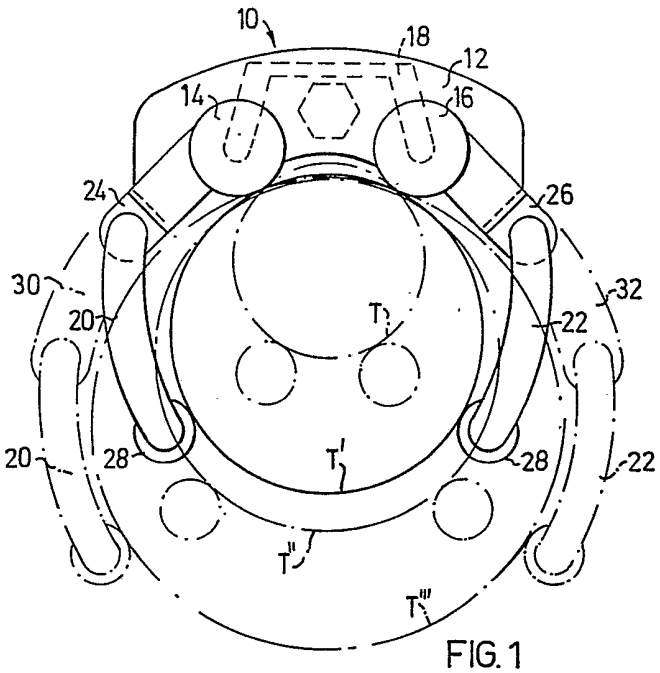


FIG. 1

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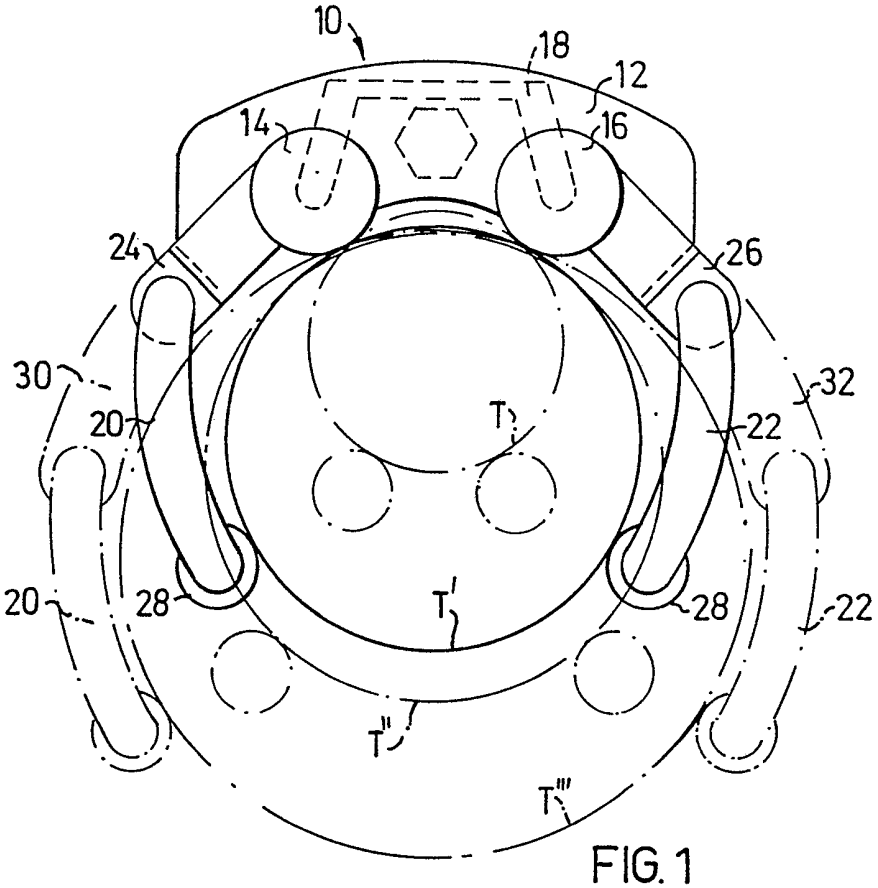


FIG. 1

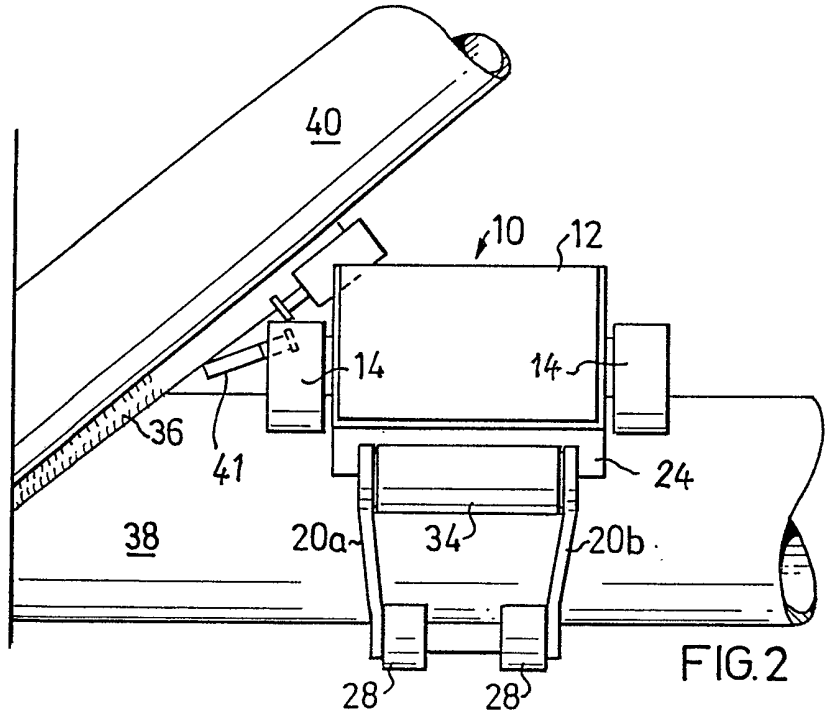


FIG. 2

SPECIFICATION

**A robot**

The present invention relates to a robot, and particularly, but not exclusively, to a robot for use in cleaning, inspection and/or repair of welds on underwater steel-tube sections of off-shore platforms; the robot comprising a body provided with a controllable system of arms for carrying the requisite cleaning, inspection and/or repair equipment.

Sea-anchored or off-shore installations, and in particular off-shore oil and gas installations, need to be inspected for damage periodically, for safety reasons. This is particularly true of the steel-tube underwater structures that support the actual platform. Normally, underwater inspection is restricted to the weak points of the tubular steel sections, namely the welds at the nodes of said sections.

At present, the work of inspecting, cleaning, and repairing underwater tubular steel sections is carried out manually, by divers. These pursuits are extremely hazardous and place the safety of the divers at serious risk, besides being extremely expensive.

In its widest aspect, the invention seeks to develop a remote-controlled inspection system which is capable of performing a large part of the manual work at present carried out by divers in cleaning, inspecting, and/or repairing suspect parts (welds) of the supporting tubular steel sections of off-shore installations.

Apparatus intended for such purposes are known to the art. For example GB-A-2 027 473 describes and illustrates an apparatus which can be attached to a tubular section and which incorporates two semi-circular track sections which, through the agency of a single hinge, can be swung between an open position, in which the track halves can be moved in, over, and away from the tubular section to which the apparatus is to be attached, and a closed position in which the arcuate track halves embrace the tubular section in a manner which enables a trolley, carrying a manipulator for manipulating equipment suitable for the task on hand, to move in a circular path around the perimeter of the tubular section. The apparatus, however, is space consuming when opened to enable it to be placed around the tubular section. Consequently, since the space available is very limited in the case of certain node locations, e.g. where a plurality of tubular sections radiate from one another at mutually different angles, and since sacrificial anodes are often placed obstructively in the vicinity of the nodes, it is sometimes not possible to use this apparatus at all.

Consequently, this invention seeks to avoid the drawbacks of the known apparatus and to provide an improved, more flexible apparatus which can be readily adapted to cylindrical members (e.g. tubular sections) of widely differing diameters, and which is able to move freely around the members concerned while enabling a controllable system of arms mounted on the apparatus and carrying the requisite cleaning, inspection, and/or repair equipment, to follow the structural part (the weld) to be cleaned, inspected and/or repaired.

To this end there is proposed in accordance with the invention a robot of the kind described in the introduction which is characterized in that the body is carried by front and rear wheels, of which at least one is driven, and in that the body has at least one forwardly directed and one rearwardly directed leg provided with an outer support roller, the legs being so constructed and so pivotally arranged that together with the body the legs are able to retentively embrace more than half the peripheral surface of a cylindrical member on which the apparatus is placed.

In accordance with one preferred embodiment of the invention, each leg is pivotally mounted to the outer end of an extension leg attached to the body.

Further features of a robot constructed in accordance with the invention and further advantages afforded thereby will be apparent from the following description, which is given with reference to the accompanying drawing, in which:-

*Figure 1* is a side view of a robot according to the invention, seen in various working positions on cylindrical members of mutually different diameters, and

*Figure 2* is an end view of the robot of Figure 1, attached to a tubular section adjacent a node of a tubular steel structure.

The reference 10 in Figure 1 designates generally a robot which comprises a body or housing 12 which can be moved around the perimeter or periphery of a tubular section with the aid of forwardly located and rearwardly located wheel pairs 14 and 16 respectively. Both pairs of wheels 14, 16 are preferably driven, by means of an endless transmission means 18, shown in broken lines in Figure 1.

To enable the body 12 to be held firmly to a tubular section, the robot is provided with a front and a rear leg 20 and 22 respectively, which are pivotally journalled in a respective attachment 24, 26 on the body 12. The legs are provided at the respective outer ends with a support roller 28, which can be brought into abutment with the tubular section around which the robot is placed. Shown in Figure 1 are two tubular sections T, T′ of mutually different diameter, which can be embraced by the legs 20, 22 of a robot in its simplest form.

When the robot 10 is to work on tubular sections of still larger diameters, such as the tubes T″ and T‴ shown in Figure 1, an extension leg 30, 32 is fitted to either or both of the aforesaid attachments 24, 26, whereafter the legs 20, 22 are pivotally mounted on the outer ends of the extension legs 30, 32.

Each of the legs 20, 22 may comprise two elements that extend substantially parallel to one another. Figure 2 illustrates the elements 20a, 20b of the leg 20. These elements may be mutually hinged, so as to accommodate for irregularities in the peripheral surface of the tubular section concerned. In this case the support roller 28 may be a twin-roller. The extension legs 30, 32 may also each comprise two elements (not shown) which extend substantially parallel with one another. Desirably, such elements of the extension legs are also journalled for individual pivotal movement. Figure 2 illustrates schematically at 34 a means (e.g. a rotational device) for powered move-

ment of a leg relative to the body and thus for pivoting the legs between an open position, which enables the robot 10 to be placed around a cylindrical member and a closed position in which the support rollers 28 and the wheels 14, 16 are held pressed against the cylindrical member, with a force sufficient to enable the wheels 14, 16 to move the robot around the perimeter of the cylindrical member.

Figure 2 illustrates a working position in which the robot can clean, inspect and/or repair a weld 36 located between two mutually intersecting tubular sections 38, 40, with the aid of a controllable manipulator arm system 41, not shown in detail, but used to support the required cleaning, inspection and/or repair equipment.

CLAIMS

1. A robot for movably engaging a cylindrical member, the robot comprising a body having a controllable arm system for carrying requisite cleaning, inspection and/or repair equipment, characterized in that the body is carried by front and rear wheels, of which at least one is driven, and in that the body has at least one forwardly directed and one rearwardly directed leg having an outer support roller, said legs being so constructed and so pivotally arranged that the legs together with the body can retentively embrace more than half the perimeter or periphery of the cylindrical member on which the robot is placed.

2. A robot according to claim 1, in which each leg is pivotally journalled to the outer end of an extension leg attached to the body, thereby to enable the robot to embrace cylindrical members of large diameter.

3. A robot according to claim 1 or 2, in which each leg includes two elements which extend substantially parallel to one another.

4. A robot according to claim 3, in which the elements are mutually connected at their respective end portions.

5. A robot according to claim 4, in which each of the elements is journalled for individual pivotal movement.

6. A robot according to any of claims 1 to 5, in which means for powered movement of a leg relative to the body is provided on at least one leg to facilitate fitting of the robot around a cylindrical member.

7. A robot according to claim 6, in which said means is a rotational device arranged at the inner end of the respective pivotal legs.

8. A robot substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

Printed for Her Majesty's Stationery Office by
Croydon Printing Company (UK) Ltd, 4/87, D8991685.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.