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EUROPEAN PATENT SPECIFICATION

④⑤ Date of publication of the patent specification:
13.06.90

⑤① Int. Cl.⁵: **B08B 9/02, B24C 3/12,**
E02B 17/00

②① Application number: **86306825.0**

②② Date of filing: **03.09.86**

⑤④ **Apparatus for movably mounting a work head on a structure of circular cross-section.**

③⑩ Priority: **03.09.85 GB 8521896**

④③ Date of publication of application:
18.03.87 Bulletin 87/12

④⑤ Publication of the grant of the patent:
13.06.90 Bulletin 90/24

④④ Designated Contracting States:
DE FR GB IT NL

⑤⑥ References cited:
EP-A- 0 000 808
EP-A- 0 139 596
DE-A- 2 808 337

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EP 0 214 841 B1

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Description

The present invention relates to apparatus for movably mounting a work head on a structure of circular cross-section. Such apparatus are particularly useful for cleaning and descaling the exterior of cylindrical structures such as pipe lines and the jackets of off-shore oil rigs.

U.S. Patent No. 4 177 913 discloses an automatic pipe welding apparatus which comprises an annular base member and three carriages mounted for circumferential movement on the outer periphery of the annular base member. The annular base member comprises three arcuate sections which are pivotably connected to allow the annular base member to be opened and closed for mounting on a cylindrical structure, and the three carriages are adapted to carry respectively a detecting unit adapted to detect the portion on the surface of the structure to be welded, a welding unit, and a drive unit adapted to drive all three carriages about the periphery of the annular base member.

The apparatus of U.S. Patent No. 4 177 913 is not intended for cleaning and descaling the exterior of a cylindrical structure and, therefore, it does not comprise means enabling it to be driven along the structure in either direction. Moreover, it is questionable whether it would be able to operate effectively whilst carrying a cleaning nozzle capable of producing the high pressures required to clean a pipeline or the like forming part of an offshore oil rig.

In our published European Patent Application No. 0 000 808 there is described apparatus for cleaning and descaling the exterior of a cylindrical structure such as a pipe line. The apparatus comprises an annulus mounted on and surrounding the structure and means for driving the annulus along the structure in either direction. The annulus has mounted thereon an arm member which projects from the annulus parallel to the structure and which member carries a nozzle for producing high pressures which nozzle is rotatably reciprocable along the arm. The arm member is around the annulus. By the above described apparatus the exterior of the structure can be cleaned and descaled. The features of the pre-characterising part of the present independent claim are known from this document.

The arm member described above may have a reach of some six feet (2 metres) and to provide adequate support the annulus needs to be of considerable length. Furthermore, it is important that the nozzle is maintained at a predetermined stand-off distance from the cylindrical structure. The above described apparatus is particularly suitable for use on cylindrical structures which are straight. Indeed its construction with the projecting rotatable boom and reciprocating nozzle makes it unsuitable for use on cylindrical structures which incorporate bends. It is unsuitable because it cannot be manoeuvred along cylindrical structures incorporating bends, and even if it could the boom could not be rotated around the annulus to treat the concave sections of the structure.

The cylindrical structures such as pipe lines and the jackets of off-shore oil rigs frequently incorporate bends. The bends may be smooth arcuate curves or curves made up by one or more straight cylindrical sections welded together at angles. Indeed the pipe from the well head may utilise a double S-bend for expansion purposes.

Because the above described apparatus is relatively large it has to be fitted in position by divers, whilst being supported by a crane until it is located on the cylindrical structure. It would be advantageous if such apparatus could be located in position without the use of divers.

The present invention aims to provide an apparatus for movably mounting a work head on a structure of circular cross-section be they straight or curved and an apparatus suitable for cleaning and descaling cylindrical structures be they straight or curved.

It is a further aim of the invention to provide apparatus which can be fitted in position without the use of a crane.

According to the present invention there is provided an apparatus for movably mounting a work head on a structure of circular cross-section, comprising an annulus defined by two or more members which are engagable cooperably and movable between an open position which allows the annulus to be fitted onto the structure and a closed position in which the annulus surrounds the structure, the work head being mounted on the annulus for circumferential movement with respect to the structure, and means for locating the annulus on the structure and for moving it axially along the length thereof, said means comprising three or more support legs mounted on the annulus at spaced circumferential locations, characterised in that at least some of said legs are movable in a radial direction relative to the annulus by actuating means to locate the annulus on the structure, and that each supporting leg is provided with drive means which are controllably independently for moving the annulus along the structure in a plane normal to the axial centre line of the structure.

Preferably two work heads are provided which are mounted diametrically opposite one another on a circumferentially reciprocable mounting plate carried by the annulus. Preferably the annulus comprises a plurality of buoyancy chambers to increase the displacement of the apparatus in relation to its weight to give it a pre-determined neutral buoyancy. More preferably, the annulus is defined by three arcuate members, with two of said members being pivotally secured to the third. Actuating means is provided for moving said two members pivotally with respect to the third to open and close the annulus to allow it to be fitted onto and removed from the structure of circular cross-section. Further actuating means is preferably provided to lock the free ends of the two members together in the close position by means of an overthrow clamp or the like. The actuating means preferably comprise hydraulic rams. In one embodiment said third member is provided with a mounting lug to enable it to be held by a remotely operated vehicle (ROV).

Each support leg preferably comprises two axially spaced wheels or rollers which engage the exterior surface of the structure. One or both of the wheels or rollers may be driven. The circumference of the wheels or rollers are provided with a rubber or plastics coating which exhibits high frictional qualities to provide a good grip on the structure. Preferably, each support leg is movable radially by actuating means to centralise the annulus on said structure. The radial movement is preferably actuated hydraulically by means of an equal flow system which ensures that the annulus is positioned centrally. A mechanical locking mechanism may be provided to lock in support legs in the applied position so that the annulus remains in position in the event of failure of the hydraulic system. A spring mounting system may be employed to compensate for small variations in the diameter of the structure. The use of axially spaced wheels or rollers, approximately 1 foot (30 cm) apart ensures stability of the annulus on the structure. An endless band may be fitted onto the axially spaced wheels or rollers to give an improved grip in certain circumstances. The number of support legs will be determined by the diameter of the structure. Typically four legs will be provided, but the larger sizes may have six or eight.

The third arcuate member of the annulus is preferably at least 180° of arc and its axial end is defined by the mounting plate which carries the two work heads. A drive mechanism is disposed within the third member and comprises an endless chain entrained around sprockets and carrying a pin which is co-operable with a slot in a carriage to which the mounting plate is secured. The carriage runs on rails within said third member and rotation of the chain causes the carriage to be reciprocated through an arc of some 180°. A second carriage is provided diametrically opposite the first and connected thereto by means of the mounting plate. The second carriage thus moves in synchronism with the first on rails formed in the other two arcuate members of the annulus. The two work heads are secured to a respective one of the carriages. The use of two work heads enables the full 360° of the structure to be operated on. The work heads are reciprocated through an arc of slightly more than 180° to ensure complete coverage.

The apparatus of the invention is particularly suitable for cleaning and descaling structures of circular cross-section. The work heads incorporate nozzles by means of which a high pressure water jet or other abrasive material can be trained onto the surface of the structure. The jet can be a pencil jet or a fan jet. Preferably, the nozzle is mounted for rotation in a housing so as to describe a circular path. By this means, movement of the two work heads circumferentially through 180° or slightly more treats the entire circumference of the structure and over an axial length corresponding to the diameter of circle described by the jet from the nozzle. The drive means of the annulus is then used to move the annulus along the structure so that a further section can be treated.

In an alternative embodiment, the work head includes a combined camera and lighting system which

is mounted to be rotatable through 180°, and a twin jet nozzle disposed between the camera and the annulus and mounted so as to be tiltable through 90°. Thus, the camera is mounted for pan and tilt.

5 The apparatus is particularly suitable for treating curves in such structures since the axial length of the apparatus is small. That is to say the distance between the location point (the support legs) and the work heads is short. The stand-off distance can be maintained by a follower mounted on the work head and controlling the position of the nozzle. The follower typically comprises a spherical end which contacts the surface of the cylindrical structure and which is coupled to the nozzle to determine its position from the structure. The arrangement is resiliently biased into contact with the structure. The facility of being able to drive each of the wheels independently enables the attitude of the annulus to be maintained as it moves along a curved section of the structure. That is to say the wheels on the outside of the curve have to travel further than those on the inside. Control of the apparatus is performed remotely by way of an umbilical cord. A camera is employed to monitor the position of the apparatus so that the operator can move the appropriate controls to maintain the desired attitude of the apparatus, ie. with the annulus in a plane normal to the axis of the structure.

30 By incorporating buoyancy chambers in the apparatus, conveniently as part of the annulus, the apparatus can have neutral buoyancy. This makes it easy to manoeuvre into position by a remotely operated vehicle. By using a camera for monitoring purposes, and remote control of the actuating means for opening and closing the arcuate members of the annulus, an ROV can be used to position the apparatus on and surrounding the cylindrical structure. The locking mechanism and the actuation of the support legs are likewise operable remotely to position the apparatus on the structure before the ROV releases it. The ability to use an ROV for manoeuvring the apparatus into position avoids the need to use divers. This is particularly advantageous when the apparatus is required to work at considerable depths where saturation diving would be involved.

45 It is further proposed to add thrusters to the apparatus to convert it into a self-propelled remotely operated vehicle. Preferably, three thrusters are incorporated in the annulus, one in each of the arcuate members.

50 The apparatus according to the invention may carry work heads having a variety of different functions, for example:- water jet nozzles; shot blast nozzles; abrasive blast; paint applicators (brush or spray); non-destructive testing equipment; abrasive; steel cutting heads; remotely controlled articulated robot arm.

55 The present invention will now be described further, by way of example only, with reference to the accompanying drawings, in which:-

60 Fig. 1 is a simplified perspective view illustrating one embodiment of apparatus according to the present invention;

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Fig. 2 is a simplified elevational view showing the apparatus mounted on a structure of circular cross-section;

Fig. 3 is an end view looking in the direction of arrow A in Fig. 2;

Fig. 4 is an end view looking in the direction of arrow B in Fig. 2; and

Fig. 5 is an end view corresponding to that of Fig. 4 but illustrating the annulus in its open position, and

Fig. 6 is a simplified perspective view according to an alternative embodiment of the invention.

Referring to the drawings there is shown apparatus for mounting on a structure of circular cross-section such as off-shore pipelines and the like. The apparatus comprises an annulus which is made up of three arcuate members in the illustrated embodiment. Two of the arcuate members 1,2 are pivotally attached to the third 3 for example by respective pivot pins 4,5 seen in Figs. 3, 4 and 5

The third arcuate member 3 extends over an arc slightly in excess of 180°, whilst the first and second arcuate members 1,2 have an arc of slightly less than 90° each. The first and second arcuate members are pivotable between open and closed positions by any suitable actuator means, but conveniently the actuator means comprises a respective hydraulic ram. One ram is coupled between the first member 1 and the third member 3, and the other ram is secured between the second member 2 and the third member 3. The free ends of the first and second arcuate members 1,2 lie adjacent one another when in the closed position and preferably abut with each other so that the three members define a continuous annulus. Figs. 3 and 4 show the annulus in the closed position, whilst Figs. 1 and 5 show the annulus in the open position. A locking member, not illustrated, is provided to lock the ends of the first and second members together when in the closed position. This preferably comprises an over-throw clamp which is actuated by a further hydraulic ram.

The arcuate members of the annulus carry support legs 6 which serve to locate the annulus on a pipe and to move it along the pipe. The legs are also mounted for radial movement with respect to the annulus and are illustrated in their withdrawn position in Fig. 1. Figs. 3, 4 and 5 show them in extended positions. In the illustration, each of the first and second arcuate members carries a respective support leg 6, whilst the third member 3 carries two support legs 6. Thus, in the illustration, four support legs are provided, spaced circumferentially at 90° to one another. An equal flow hydraulic system is conveniently utilised to move the support legs radially. The purpose of the support legs is two fold:- Firstly to locate the annulus centrally on the structure, and secondly to propel the annulus in either direction along the structure. To achieve these objectives, the end of each leg carries two spaced apart rollers 8 which contact the exterior surface of the structure. The rollers are spaced apart in the axial direction of the structure so as to impart stability to the annulus and prevent twisting thereof on the structure. One or both of the rollers of each leg are rotatably driven, conveniently by a hydraulic motor.

The rollers of each leg are driven independently so that the movement at each leg can be controlled independently. This is necessary to manoeuvre the apparatus along curved structures, where the rollers at the larger radius have to travel further than those at the smaller inner radius if the annulus is to be maintained in the desired attitude in a plane normal to the axis of the structure. The rollers are preferably provided with a plastics or rubber tread to aid their grip on the structure.

An endless band may be placed around the rollers where it is felt this would give an improved grip. Each roller may be replaced by one or more wheels.

The above described construction enables the apparatus to be moved along the structure in either direction. The purpose of attaching such an apparatus to a structure of this nature is to be able to perform operations of numerous types on the structure. One type of operation which has to be tackled is that of cleaning and descaling the structure. This is one type of operation for which the apparatus is particularly suited. To perform such operations a work head - typically a nozzle for directing water at high pressure at the structure - has to be capable of being moved around the structure.

In the illustrated embodiment this is achieved by forming a circular track on the annulus and having two work heads 11, 12 disposed diametrically opposite one another which work heads are each reciprocable through an arc of some 180°. By this means the complete circumference of the structure can be operated on. More particularly, the arcuate members 1, 2 and 3 incorporate concentric rails, shown diagrammatically as 9 and 10 in the drawings. The third arcuate member 3 incorporates a drive mechanism which comprises an endless chain entrained around two sprockets. This is preferably accommodated within the annulus at one axial end thereof. The sprockets are disposed diametrically opposite one another and the chain is constrained to follow an arcuate path by the inner and outer radial walls of the third arcuate member. The chain carries a pin member which engages in a slot in one of two carriages. The said one carriage is constrained axially by the rails 9,10 and circumferentially by the inner and outer walls of the arcuate member 3. Rotation of the chain causes the pin to move and its co-operation with the carriage causes the carriage to reciprocate through an arcuate path as defined by the path of the chain. As the pin passes round the sprockets, the pin moves across the slot in the carriage. This changes the speed of the carriage at the end points where the change of direction occurs.

A mounting plate is secured to the driven carriage and a second carriage is secured to the mounting plate diametrically opposite the first. The mounting plate is arcuate. By means of the mounting plate the second carriage is caused to follow the reciprocal movements of the first carriage. The second carriage runs on a track formed by the first and second arcuate members. A respective work head is mounted on each of the carriages.

Each carriage preferably comprises a plate member having four wheels or rollers journaled for rotation thereon. The wheels or rollers run on the cir-

cular track and take the axial thrust load generated by the work heads.

The described construction gives rise to a short axial length between the support legs 6 and the work heads. This enables the apparatus to move round bends in the structure whilst allowing operations, such as cleaning and descaling to be performed on the bends. The work heads may carry nozzles for high pressure water cleaning; shot blast; abrasive blast or paint applicators by brush or spray. It is further envisaged that the work heads may be provided with abrasive steel cutting heads or probes for use in non-destructive testing.

There will now be described details of apparatus for use in cleaning and descaling for which the apparatus of the invention is particularly suited. In such apparatus, each work head has a nozzle for directing a high pressure water jet with or without any additional abrasive material on to the external surface of the structure. The nozzle has to be positioned at a predetermined distance from the exterior surface of the structure. A positioning device is provided for this purpose which conveniently comprises a spherical member 15 secured to the mounting for the nozzle and biased into contact with the exterior surface. The positioning device is movable in the radial direction to accommodate variations in the distance between the exterior of the structure and the annulus as the work head is moved circumferentially. By this simple means, the nozzle is maintained at a predetermined stand-off distance from the exterior surface of the structure. The nozzle can produce a pencil jet or a fan jet. A pencil jet is preferred for high pressure water cleaning, but to increase the area covered during the circumferential movement, the nozzle is arranged to be rotatable so as to describe a circular path. This means that an axial band on the structure is operated on during circumferential movement of the work head. This is advantageous because not only does it speed up the operation, but it also means that the movement of the apparatus in the axial direction by way of the drive means in the support legs is less critical. It will be appreciated that this "band cleaning" simplifies the procedure when bends are involved because overlap between bands ensures that all sections of the bend can be thoroughly cleaned.

A further feature of the invention which has not yet been described is the provision of buoyancy chambers within the annulus. The members of the annulus are provided with sealed chambers 18 between the support legs which effectively increase the displacement of the apparatus disproportionately in relation to the weight so that the apparatus is given a predetermined buoyancy or even a variable buoyancy. This enables the apparatus to be manoeuvred more easily under water by remotely operated vehicles (ROV's). These vehicles cannot handle heavy objects and so if the buoyancy can be set at a fixed level for a particular depth of operation the apparatus can be manoeuvred into position using such vehicles and thus avoid the use of divers.

For handling purposes the annulus is illustrated

as having a T-shaped mounting slot 20 for engagement by a correspondingly shaped member of an ROV. The hole 21 serves to receive a hydraulically actuated locking pin. The shape of the mounting member may be varied to suit other designs or may simply comprise a conveniently shaped projecting lug which can be grabbed by the jaws of an articulated arm. As a further development, it is proposed that the apparatus be provided with its own thrusters, so that it can be self-propelled.

In positioning the apparatus onto the structure it will be understood that cameras will be utilised to monitor the operation. These may be mounted directly on the apparatus itself or be those of the ROV. The apparatus is controlled remotely and for this purpose an umbilical cord connects with the apparatus from the remote control station, be it a surface vessel or the oil rig - depending on the nature of the structure involved. The umbilical cord has the necessary hydraulic and electrical lines to provide the required control signals and power supply to the various motors.

The apparatus is manoeuvred up to the structure in a direction substantially normal to the axis thereof, with the first and second arcuate members in the open position as illustrated in fig. 1. The support legs 6 are preferably fully withdrawn at this stage. Thus, the apparatus is manoeuvred so that the structure is positioned within the third arcuate member 3. The hydraulic rams controlling the first and second members 1,2 are then remotely operated to move these members into their closed position, whereupon the hydraulic ram controlling the overthrow lock is actuated so that the ends of the members 1 and 2 are held closed. Hydraulic fluid is then admitted to the rams controlling the position of the support legs 6 and this causes them to move radially inwardly. An equal flow system is employed to ensure that each of the legs moves the same distance so that the annulus is centralised on the structure. The rollers thus contact the structure to locate the annulus. The drive means to the rollers incorporates a brake mechanism which prevents rotation of the rollers when the drive motor is not operating. Thus, the loading of the legs against the structure ensures that the annulus remains in position. A mechanical locking mechanism is conveniently employed to locate the support legs in the extended position so that the annulus remains located in the event of hydraulic failure. The legs may be resiliently mounted so that small variations in the surface configuration do not result in a loss of grip by the support legs. Once the legs have been extended the ROV can be disconnected from the mounting point.

By operating the drive motors of the support legs 6 the annulus can be caused to move in either direction along the structure. By controlling the drive motors of each leg individually the annulus can be manoeuvred round bends in the structure.

In order to perform the described cleaning and descaling operation water under high pressure is fed into the nozzle at each of the two work heads, the nozzles are rotated to describe the circular path, and the work heads are reciprocated circumferentially through the arc determined by the path

of the endless chain. In practice the arc covered by each nozzle is just in excess of 180° to ensure that the two nozzles together cover the full 360° of the structure. Thus, an axial band is cleaned by the described method. The apparatus is then moved axially along the structure and the reciprocal movement of the work heads repeated. Thus, the apparatus works its way along the structure, and around any bends which it encounters. It will be noted that the axial length of the apparatus is short so that it can be easily manoeuvred round bends.

The embodiment of apparatus for cleaning and descaling has the advantage that it is of short axial length which enables it to be moved along structures which are curved to perform cleaning and descaling on such structures. The independent control of the support leg drive means enables the apparatus to be manoeuvred along the structure and round curves. The use of bouyancy chambers enables the apparatus to be easily manoeuvred into position by means of an ROV.

An apparatus of the above described type can also be used for performing other operations on such structures simply by attaching the appropriate type of work head. It is also envisaged that the annulus could be provided with an articulated work arm. Such an articulated work arm could carry a non-destructive testing probe or a camera for checking welded joints on such structures. The articulated arm being remotely operated. The articulated arm could be attached to the circumferentially movable work head or secured to another part of the annulus. The annulus preferably has secured thereto a camera for monitoring movement of the annulus and operations being performed by the work heads.

Referring now to Fig. 6 there is shown another embodiment of the invention which is of the same basic construction of the apparatus described with reference to Fig. 1. However, it differs in the construction and mounting of the work heads and in the provision of built-in thrusters. These features will be described further hereinafter. It will be understood that the earlier described embodiments could be provided with the thruster system or jet and/or camera system described hereafter.

The same reference numerals as used in the description of Fig. 1 have been used in Fig. 6 and the description of Fig. 1 applies to the construction of Fig. 6 in these respects.

The work heads 11 and 12 each comprise two jet nozzles 100,102 which are mounted on a member 104 which is movable through approximately 90° with respect to a mounting member 106. The mounting member 106 is secured to the drive means for moving the work head on the 180° arcuate path. The member 104 is movable in a plane which is perpendicular to the plane of movement of the mounting member 106.

A combined camera 108 and light 110 is mounted in a housing 112 on the member 104. The housing 112 is mounted for movement through approximately 180° with respect to the member 104 and in a plane parallel to a plane passing through the two jet nozzles 100,102. The fact that the member 104 is tiltable means that the camera and light are likewise tiltable. The possible movements of the camera enables the

operator to view the job being cleaned (for example) and to make an appraisal of the position of the apparatus when approaching the tubular structure.

The apparatus also includes three thrusters, each of which is mounted in the annulus. A main thruster 120 is mounted in the third arcuate part 3 and comprises a rotor disposed within a tubular sleeve 122 and driven by a motor. The motor may be driven in either direction so that thrust is generated in either the direction of the arrow A or the direction of the arrow B. The sleeve passes through the annulus. Two positional thrusters 124,126 are also provided one in each of the first and second arcuate parts 1 and 2. These are likewise received in a tubular sleeve which passes through the member and the rotors are driven by reversible motors.

The thrusters 120,124,126 are employed to manoeuvre the apparatus into position about a tubular structure. The neutral buoyancy enables this to be done with only low powered thrusters and being self-propelled, a diver is not required. Accordingly, the device can be easily manoeuvred into position. The first and second members will usually be in the position illustrated in Fig. 6 when manoeuvring is taking place.

Claims

1. An apparatus for movably mounting a work head (11, 12) on a structure of circular cross-section, comprising an annulus defined by two or more members (1, 2, 3) which are engagable co-operably and movable between an open position which allows the annulus to be fitted onto the structure and a closed position in which the annulus surrounds the structure, the work head (11, 12) being mounted on the annulus for circumferential movement with respect to the structure, and means (6) for locating the annulus on the structure and for moving it axially along the length thereof, said means (6) comprising three or more support legs (6) mounted on the annulus at spaced circumferential locations, characterised in that at least some of said legs (6) are movable in a radial direction relative to the annulus by actuating means to locate the annulus on the structure, and that each supporting leg (6) is provided with drive means (8) which are controllable independently for moving the annulus along the structure in a plane normal to the axial centre line of the structure.

2. Apparatus according to claim 1, characterised in that the annulus is defined by three arcuate members (1,2,3) with two of said members (1,2) being pivotally secured to the third (3).

3. Apparatus according to claim 1, characterised in that actuating means is provided for moving said two members (1,2) pivotally with respect to the third (3) to open and close the annulus to allow it to be fitted onto and removed from the structure of circular cross-section.

4. Apparatus according to claim 2 or 3, characterised in that actuating means is provided to lock the free ends of the two members (1,2) together in the closed position by means of an overthrow clamp or the like.

5. Apparatus according to claim 4 and 5, characterised in that said actuating means and the lock actuating means each comprise hydraulic rams.

6. Apparatus according to any preceding claim, characterised in that each support leg (6) comprises two axially spaced wheels or rollers (8) which engage the exterior surface of the structure and one or both of the wheels or rollers (8) may be driven.

7. Apparatus according to any preceding claim, characterised in that each support leg (6) is movable radially by actuating means to centralise the annulus on said structure and the radial movement is actuated hydraulically by means of an equal flow system which ensures that the annulus is positioned centrally.

8. Apparatus according to claim 7, characterised in that a mechanical locking mechanism is provided to lock the support legs (6) in position on said structure.

9. Apparatus according to claim 6, 7 or 8, characterised in that a spring mounting system is employed on each support leg (6) to compensate for small variations in the diameter of the structure.

10. Apparatus according to any preceding claim, characterised in that two work heads are provided which are mounted diametrically opposite one another on a circumferentially reciprocable mounting plate carried by the annulus.

11. Apparatus according to claim 10, characterised in that the third arcuate member (3) of the annulus is at least 180° of arc and its axial end is defined by the mounting plate which carries the two work heads (11,12).

12. Apparatus according to claim 11, characterised in that a drive mechanism is disposed within the third member (3) and comprises an endless chain entrained around sprockets and carrying a pin which is co-operable with a slot in a carriage on which is mounted one of the two work heads (11,12) and to which the mounting plate is secured.

13. Apparatus according to claim 12, characterised in that the carriage runs on rails (9,10) within said third member (3) and rotation of the chain causes the carriage to be reciprocated through an arc of some 180°.

14. Apparatus according to claim 13, characterised in that a second carriage on which is mounted the other work head (11,12) is provided diametrically opposite the first and is connected thereto by means of the mounting plate such that the second carriage thus moves in synchronism with the first on rails (9,10) formed in the other two arcuate members (1,2) of the annulus.

15. Apparatus according to any preceding claim, characterised in that the work heads (11,12) incorporate nozzles by means of which a high pressure water jet or other abrasive material can be trained on to the surface of the structure.

16. Apparatus according to claim 15, characterised in that each nozzle (11,12) is mounted for rotation in a housing so as to describe a circular path.

17. Apparatus according to any preceding claim, characterised in that each work head (11,12) comprises a combined camera and lighting system which

is mounted so as to be able to view the work done and the work ahead of the apparatus.

18. Apparatus according to any preceding claim, characterised in that the annulus comprises a plurality of bouyancy chambers (18) to increase the displacement of the apparatus in relation to its weight to give it a predetermined neutral buoyancy.

19. Apparatus according to any preceding claim, characterised in that thrusters (120,124,126) are connected to the apparatus to allow it to operate as a self-propelled remotely operated vehicle.

20. Apparatus according to claim 19, characterised in that the thrusters (120,124,126) are incorporated in the annulus, one in each of the members (1,2,3).

Patentansprüche

1. Eine Vorrichtung zum bewegbaren Anordnen eines Arbeitskopfes (11, 12) an einer Struktur mit kreisförmigem Querschnitt, mit einem Ring, der durch zwei oder mehr Teile (1, 2, 3) gebildet wird, die in Wirkungsverbindung zusammenfügbar sind und zwischen einer offenen Stellung, die es erlaubt, den Ring auf der Struktur anzubringen und einer geschlossenen Stellung bewegbar sind, in der der Ring die Struktur umgibt, wobei der Arbeitskopf (11, 12) auf dem Ring relativ zu der Struktur in Umfangsrichtung bewegbar angeordnet ist, und mit Mitteln (6), um den Ring auf der Struktur in Stellung zu bringen und ihn axial längs der Struktur zu bewegen, wobei die Mittel (6) drei oder mehr Tragfüße (6) enthalten, die an dem Ring an in Umfangsrichtung voneinander in Abstand befindlichen Stellen angebracht sind, dadurch gekennzeichnet, daß wenigstens einige der Füße (6) in einer radialen Richtung relativ zu dem Ring durch Betätigungsmittel bewegbar sind, um den Ring auf der Struktur zu positionieren, und daß jeder Tragfuß (6) mit Antriebsmitteln (8) versehen ist, die unabhängig steuerbar sind, um den Ring längs der Struktur in einer Ebene zu bewegen, die senkrecht zur axialen Mittellinie der Struktur liegt.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß der Ring durch drei bogenförmige Teile (1, 2, 3) gebildet ist, von denen zwei Teile (1, 2) schwenkbar an den dritten (3) befestigt sind.

3. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß ein Betätigungsmittel zum schwenkbaren Bewegen der beiden Teile (1, 2) relativ zu dem dritten Teil (3) vorgesehen sind, um den Ring zu öffnen und zu schließen, um seine Anbringung und Entfernung von der Struktur mit kreisförmigem Querschnitt zu erlauben.

4. Vorrichtung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß ein Betätigungsmittel vorgesehen ist, um die freien Enden der beiden Teile (1, 2) miteinander in der geschlossenen Stellung mittels einer Überwurfklemme od. dgl. zu verriegeln.

5. Vorrichtung nach Anspruch 4 und 5, dadurch gekennzeichnet, daß das Betätigungsmittel und das Riegelbetätigungsmittel Hydraulikzylinder aufweisen.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jeder Tragfuß (6) zwei in axialem Abstand angeordnete

Räder oder Rollen (8) enthält, die an der Außenfläche der Struktur anliegen und daß eine oder beide der Räder oder Rollen (8) angetrieben sein können.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jeder Tragfuß (6) durch Betätigungsmittel radial bewegbar ist, um den Ring auf der Struktur zu zentrieren und die Radialbewegung hydraulisch mittels eines Gleichstromsystems betätigt wird, um die zentrierte Positionierung des Ringes zu gewährleisten.

8. Vorrichtung nach Anspruch 7, dadurch gekennzeichnet, daß ein mechanischer Verriegelungsmechanismus vorgesehen ist, um die Tragfüße (6) in Position auf der Struktur zu verriegeln.

9. Vorrichtung nach Anspruch 6, 7 oder 8, dadurch gekennzeichnet, daß ein Federanbringungssystem an jedem Tragfuß (6) verwendet wird, um kleine Variationen im Durchmesser der Struktur auszugleichen.

10. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß zwei Arbeitsköpfe vorgesehen sind, die diametral einander gegenüber auf einer von dem Ring getragenen, in Umfangsrichtung hin und her beweglichen Montageplatte angebracht sind.

11. Vorrichtung nach Anspruch 10, dadurch gekennzeichnet, daß der dritte bogenförmige Teil (3) des Ringes wenigstens 180 Bogengrad einnimmt und sein axiales Ende von der Montageplatte gebildet wird, die die beiden Arbeitsköpfe (11, 12) trägt.

12. Vorrichtung nach Anspruch 11, dadurch gekennzeichnet, daß ein Antriebsmechanismus in dem dritten Teil (3) angeordnet ist und eine endlose Kette enthält, die um Kettenräder läuft und einen Stift trägt, der mit einem Schlitz in einem Wagen oder Schlitten zusammenarbeitet, auf dem ein oder die beiden Arbeitsköpfe (11, 12) montiert sind und an dem die Montageplatte befestigt ist.

13. Vorrichtung nach Anspruch 12, dadurch gekennzeichnet, daß der Wagen oder Schlitten auf Schienen (9, 10) in dem dritten Teil (3) läuft und das Drehen der Kette den Wagen oder Schlitten veranlaßt, um einen Winkel von etwa 180° hin und her bewegt zu werden.

14. Vorrichtung nach Anspruch 13, dadurch gekennzeichnet, daß ein zweiter Wagen oder Schlitten vorgesehen ist, auf dem der andere Arbeitskopf (11, 12) diametral entgegengesetzt zu dem ersten angeordnet ist und mit diesem mittels der Montageplatte befestigt ist, so daß der zweite Wagen oder Schlitten sich mit dem ersten synchron auf Schienen (9, 10) bewegt, die in dem oder den anderen beiden bogenförmigen Teilen (1, 2) gebildet sind.

15. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Arbeitsköpfe (11, 12) Düsen enthalten, mittels derer ein Hochdruckwasserstrahl oder anderes abtragendes Material auf die Oberfläche der Struktur aufgebracht werden kann.

16. Vorrichtung nach Anspruch 15, dadurch gekennzeichnet, daß jede Düse (11, 12) so drehbar an einem Gehäuse angeordnet ist, daß sie einen kreisförmigen Pfad beschreiben kann.

17. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jeder Ar-

beitskopf (11, 12) ein kombiniertes Kamera- und Beleuchtungssystem enthält, das so angebracht ist, daß es in der Lage ist, die getane Arbeit und die vor der Vorrichtung liegende Arbeit zu betrachten.

18. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Ring mehrere Auftriebskammern (18) enthält, um die Verdrängung der Vorrichtung im Vergleich zu ihrem Gewicht zu erhöhen, um ihr einen vorgegebenen neutralen Auftrieb zu geben.

19. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß Triebwerke (120, 124, 126) mit der Vorrichtung verbunden sind, um es ihr zu ermöglichen, als selbstangetriebenes fernbedientes Fahrzeug zu arbeiten.

20. Vorrichtung nach Anspruch 19, dadurch gekennzeichnet, daß die Triebwerke (120, 124, 126), eines in jedem der Teile (1, 2, 3), in den Ring einbezogen sind.

Revendications

1. Appareil pour le montage de façon amovible d'une tête de travail (11, 12) sur une structure de section circulaire, comprenant un anneau défini par deux ou plus de deux membres (1, 2, 3) qui peuvent s'engager de façon coopérante et se déplacer entre une position ouverte qui permet à l'anneau d'être mis en place sur la structure et une position fermée dans laquelle l'anneau entoure la structure, la tête de travail (4, 12) étant montée sur l'anneau pour se déplacer périphériquement par rapport à la structure et des moyens (6) pour positionner l'anneau sur la structure et pour le déplacer axialement sur la longueur de celle-ci, lesdits moyens (6) comprenant trois ou plus de trois jambes de support (6) montées sur l'anneau en des emplacements espacés périphériquement, caractérisé par le fait qu'au moins certaines des dites jambes (6) sont déplaçables en direction radiale par rapport à l'anneau par des moyens d'actionnement pour positionner l'anneau sur la structure et que chaque jambe de support (6) est munie de moyens d'actionnement (8) qui sont commandables de façon indépendante pour déplacer l'anneau le long de la structure dans un plan normal à la ligne centrale axiale de la structure.

2. Appareil selon la revendication 1, caractérisé par le fait que l'anneau est défini par trois membres courbés en arc (1, 2, 3), deux de ces membres étant fixés pivotants au troisième (3).

3. Appareil selon la revendication 1, caractérisé par le fait qu'il est prévu un moyen d'actionnement pour faire pivoter lesdits membres (1, 2) par rapport au troisième (3) afin d'ouvrir et fermer l'anneau et lui permettre d'être mis en place sur et enlever de la structure à section circulaire.

4. Appareil selon la revendication 2 ou 3, caractérisé par le fait qu'il est prévu un moyen d'actionnement pour verrouiller l'une à l'autre les extrémités libres des deux membres (1, 2) en position fermée grâce à une bride de serrage à retournement ou analogue.

5. Appareil selon la revendication 4 ou 5, caractérisé par le dit moyen d'actionnement et le moyen

d'actionnement de verrouillage comprennent chacun un piston hydraulique.

6. Appareil selon l'une des revendications précédentes, caractérisé par le fait que chaque jambe de support (6) comprend deux roues ou galets (8) espacés axialement qui sont en prise avec la surface extérieure de la structure et l'un des deux ou les deux roues ou galets (8) peuvent être actionnés.

7. Appareil selon l'une des revendications précédentes, caractérisé par le fait que chaque jambe de support (6) est déplaçable radialement par des moyens d'actionnement pour centrer l'anneau sur la dite structure et le mouvement radial est actionné hydrauliquement au moyen d'un système d'écoulement égal qui assure le positionnement centré de l'anneau.

8. Appareil selon la revendication 7, caractérisé par le fait qu'il est prévu un mécanisme de verrouillage mécanique pour verrouiller les jambes de support (8) en position sur la dite structure.

9. Appareil selon la revendication 6, 7 ou 8, caractérisé par le fait qu'un système de montage à ressort est employé sur chaque jambe de support (6) afin de compenser les faibles variations de diamètre de la structure.

10. Appareil selon l'une des revendications précédentes, caractérisé par le fait qu'il est prévu deux têtes de travail qui sont montées diamétralement opposées l'une à l'autre sur une plaque de montage portée par l'anneau et susceptible d'être animée d'un mouvement de va-et-vient.

11. Appareil selon la revendication 10, caractérisé par le fait que le troisième membre arqué (3) de l'anneau est un arc d'au moins 180 et son extrémité axiale est définie par la plaque de montage qui porte les deux têtes de travail (11, 12).

12. Appareil selon la revendication 11, caractérisé par le fait qu'un mécanisme d'entraînement est disposé dans le troisième membre (3) et comprend une chaîne sans fin entraînée autour de pignons et portant un tenon qui peut coopérer avec une fente dans un chariot sur lequel est montée une des deux têtes de travail (11, 12) et auquel est fixée la plaque de montage.

13. Appareil selon la revendication 12, caractérisé par le fait que le chariot se déplace sur des rails (9, 10) dans ledit troisième membre (3) et la rotation de la chaîne fait déplacer le chariot d'un mouvement de va-et-vient sur un arc d'environ 180.

14. Appareil selon la revendication 13, caractérisé par le fait qu'il est prévu un second chariot, diamétralement opposé au premier, sur lequel est montée l'autre tête de travail (11, 12), et qui est relié au premier par l'intermédiaire de la plaque de montage, de sorte que le second chariot se déplace aussi en synchronisme avec le premier sur des rails (9, 10) formés dans les autres deux membres en arc (1, 2) de l'anneau.

15. Appareil selon l'une des revendications précédentes, caractérisé par le fait que, dans les têtes de travail (11, 12) sont incorporés des ajutages grâce auxquels un jet d'eau à haute pression ou autre matériau abrasif peut être projeté sur la surface de la structure.

16. Appareil selon la revendication 15, caractérisé

par le fait que chaque ajutage (11, 12) est monté rotatif dans un boîtier de façon à décrire une trajectoire circulaire.

17. Appareil selon l'une des revendications précédentes, caractérisé par le fait que chaque tête de travail (11, 12) comprend un système de caméra et d'éclairage combinés qui est monté de façon à pouvoir visionner le travail fait et le travail en avant de l'appareil.

18. Appareil selon l'une des revendications précédentes, caractérisé par le fait que l'anneau comprend une pluralité de chambres de flottabilité (18) pour augmenter le déplacement de l'appareil par rapport à son poids et lui donner une flottabilité neutre prédéterminée.

19. Appareil selon l'une des revendications précédentes, caractérisé par le fait que des impulseurs (120, 124, 126) sont connectés à l'appareil pour lui permettre d'opérer comme véhicule autopulsé télécommandé.

20. Appareil selon la revendication 19, caractérisé par le fait que les impulseurs (120, 124, 126) sont incorporés à l'anneau, un dans chacun des membres (1, 2, 3).

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