

PATENT SPECIFICATION (11)

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(54) A CLAMPING DEVICE

(71) We, HUMES LIMITED, a company incorporated under the laws of the State of Victoria, of 185 William Street, Melbourne, in the State of Victoria, Commonwealth of Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a clamping device which may be used for securing an element with respect to a member of uniform cross-section such as a shaft or pipe by hydraulic pressure, and an object of the invention is to provide a device that can be accurately located, firmly secured and easily and quickly unclamped and relocated and secured as desired.

According to the invention, there is provided a clamping device for releasably clamping an element to a member of uniform cross-section by means of a collet defining with the element first and second fluid pressure chambers which in the non-clamped position are in fluid communication, means for introducing fluid under pressure to the second chamber and thereby, in the non-clamped position, pressurizing the first chamber *via* said communication, which pressure moves the parts into the clamping position and closes said communication, and pressure release means in the first chamber allowing the clamping to be released when the pressure is released in the first chamber and said fluid under pressure is again applied to the second chamber.

After an interval of time (usually several minutes) it will be found that the radial forces exerted on the collet extrude any fluid lubricating film from between the element and collet, giving rise to intimate unlubricated contact between these components, and hence the element is effectively fixed to the shaft or other member to which the element is applied.

The supply of fluid under pressure can be stopper as soon as the desired measure of interference or force fit has been attained be-

tween the element and collet and/or between the collet and member. The element may be released from the member by releasing the chamber pressure, and admitting fluid under pressure to the interface between the mating surface of the collet and element, giving a resultant thrust and consequential relative movement between the collet and element in the direction opposite from that in which fixing took place. The angle of taper may be so chosen that the taper is "self-releasing".

But in order that the invention may be better understood, reference will now be made to the accompanying drawings. In the drawings:

Figure 1 shows a preferred form of mounting means in accordance with the invention sectioned in a plane containing the axis of a uniform circular section shaft to which it is being applied, and

Figure 2 is a section taken across line II—II in Figure 1.

Referring to the drawings in detail, an element in the form of hub 3 is shown being clamped to a member which is a shaft 4 of uniform circular cross-section. The hub 3 has an internal wall adapted to define with shaft 4 an annular cavity for pressurized fluid. A part 10 of the internal wall forms a tapered bore of substantially circular cross-section coaxially cooperable with a complementarily tapered frustoconical collet 5 which has a bore adapted to form a close, but sliding fit on shaft 4.

A first surface part 6a of the collet defines with a first part 10a of the internal wall a first fluid pressure chamber 11 in which increase of pressure tends to move collet 5 relatively to hub 3 in a direction axially of the shaft 4 (as indicated by the arrows) so that a tapered surface 6 of collet 5 tends to move into mating relationship with the tapered bore of hub 3. Surfaces 6 and 10 may be parts of right circular cones tapered with a diameter change per unit length of about one in thirty, and the clearance between shaft 4 and the bore of collet 5 may advantageously be of the order of 0.0015 inch, affording a fluid film lubrication space

allowing free relative sliding (and rotational, where appropriate) movement between the collet and shaft when these are not clamped together.

Surfaces 6 and 10 define a second fluid chamber having restricted communication with the first and in which increase of pressure tends to separate the hub 3 and the collet 5.

To clamp the hub 3 to shaft 4, a pressure-release valve 7 is closed by rotating its spindle, and high-pressure fluid is admitted to the system through a connecting pipe 8 which may lead to an external high pressure fluid pump (not shown). The fluid is forced along a channel 9 to establish fluid film lubrication of collet 5. Leakage of fluid between the outer surface 6 of collet 5 and the inner surface 10 of the hub 3 pressurizes first chamber 11 and forces collet 5 in an axial direction towards its smaller end, resulting in an interference fit between it and the hub 3. This fit produces a tensile "hoop" stress in the hub 3 and an opposing compressive "hoop" stress in collet 5.

The hub and collet may be so dimensioned that under the relevant stresses the inward radial strain of the collet firmly grips the shaft or other member to which the mounting is being applied. Any fluid film between the collet and shaft is extruded into chamber 11 and surfaces 6 and 10 are forced together into intimate unlubricated contact.

Further application of high pressure fluid continues to force collet 5 to the left thereby increasing the hoop stress in the hub 3 to a state where a force fit is achieved between the collet and shaft. The flow of high pressure fluid may be cut off once the desired interference fit has been obtained.

After a few minutes, the radial forces exerted on the collet extrude any fluid remaining between surfaces 6 and 10, and intimate unlubricated contact is achieved, whereupon the hub 3 is effectively clamped to shaft 4.

The direction and peripheral distribution of the fluid flow from the tapered annular region defined by surfaces 6, 10 to the chamber 11 are assisted by passage 13 which helps to reduce irregularities in the flow which may result in canting of collet 5 on the shaft due to the larger diameter end portion of the collet contacting the surface 10 and thereby restricting the flow in one angular position.

To release hub 3 from shaft 4, the first pressure chamber 11 is depressurized by opening valve 7, with which may be associated a spring and ball valve arrangement adapted to limit the maximum pressure in chamber 11, valve 7 desirably being provided with a safety retaining cap on the valve spindle.

When chamber 11 has been depressurized, high pressure fluid may again be admitted to

the system through the pipe 8 and the channel 9. The fluid re-establishes fluid film lubrication between surfaces 6 and 10 and, chamber 11 no longer having the pressure to resist separation between the hub 3 and the collet 5, these two components move relatively in an axial direction and thereby remove the "hoop" stresses that had previously produced the interference fit between the hub 3, the shaft 4 and the collet 5. Preferably the taper angle of 6 and 10 is chosen to be small so that clamping does not depend on pressure in chamber 11 and the taper is self-releasing.

The mounting provided by this invention has the advantage over prior forms of oil injection mounting that it can be positioned anywhere along a shaft or other element of constant cross-section, and accurate location of the position may be achieved by regulating the flow of high pressure fluid. When positioned it remains clamped in that position until the pressure in the chamber be released and fluid re-injected between the element and collet. In the particular case of the relevant parts being of circular cross-section, hub 3 may be rotated through any desired angle and there fixed to the shaft.

Clamping and releasing generally takes substantially less time (often as little as half a minute) with the present invention than with prior forms of mounting.

Furthermore, the process of clamping and releasing are both carried out by a single source of pressurized fluid, and the process may be controlled by a single control device. The system does not require the continued application of fluid pressure to maintain the fixing since sealing rings 12 and 12a prevent leakage of fluid. Fluid pressure from the supply is required only during clamping and releasing of the relevant parts.

WHAT WE CLAIM IS:—

1. A clamping device for releasably clamping an element to a member of uniform cross-section by means of a collet defining with the element first and second fluid pressure chambers which in the non-clamped position are fluid communication, means for introducing fluid under pressure to the second chamber and thereby, in the non-clamped position, pressurizing the first chamber via said communication, which pressure moves the parts into the clamping position and closes said communication, and pressure release means in the first chamber allowing the clamping to be released when the pressure is released in the first chamber and said fluid under pressure is again applied to the second chamber.

2. A clamping device as claimed in Claim 1, wherein the collet has a first surface defining with a first part of an internal wall in the element, said first fluid chamber in which



allowing free relative sliding (and rotational, where appropriate) movement between the collet and shaft when these are not clamped together.

5 Surfaces 6 and 10 define a second fluid chamber having restricted communication with the first and in which increase of pressure tends to separate the hub 3 and the collet 5.

10 To clamp the hub 3 to shaft 4, a pressure-release valve 7 is closed by rotating its spindle, and high-pressure fluid is admitted to the system through a connecting pipe 8 which may lead to an external high pressure fluid pump (not shown). The fluid is forced along a channel 9 to establish fluid film lubrication of collet 5. Leakage of fluid between the outer surface 6 of collet 5 and the inner surface 10 of the hub 3 pressurizes first chamber 11 and forces collet 5 in an axial direction towards its smaller end, resulting in an interference fit between it and the hub 3. This fit produces a tensile "hoop" stress in the hub 3 and an opposing compressive "hoop" stress in collet 5.

25 The hub and collet may be so dimensioned that under the relevant stresses the inward radial strain of the collet firmly grips the shaft or other member to which the mounting is being applied. Any fluid film between the collet and shaft is extruded into chamber 11 and surfaces 6 and 10 are forced together into intimate unlubricated contact.

30 Further application of high pressure fluid continues to force collet 5 to the left thereby increasing the hoop stress in the hub 3 to a state where a force fit is achieved between the collet and shaft. The flow of high pressure fluid may be cut off once the desired interference fit has been obtained.

40 After a few minutes, the radial forces exerted on the collet extrude any fluid remaining between surfaces 6 and 10, and intimate unlubricated contact is achieved, whereupon the hub 3 is effectively clamped to shaft 4.

45 The direction and peripheral distribution of the fluid flow from the tapered annular region defined by surfaces 6, 10 to the chamber 11 are assisted by passage 13 which helps to reduce irregularities in the flow which may result in canting of collet 5 on the shaft due to the larger diameter end portion of the collet contacting the surface 10 and thereby restricting the flow in one angular position.

55 To release hub 3 from shaft 4, the first pressure chamber 11 is depressurized by opening valve 7, with which may be associated a spring and ball valve arrangement adapted to limit the maximum pressure in chamber 11, valve 7 desirably being provided with a safety retaining cap on the valve spindle.

65 When chamber 11 has been depressurized, high pressure fluid may again be admitted to

the system through the pipe 8 and the channel 9. The fluid re-establishes fluid film lubrication between surfaces 6 and 10 and, chamber 11 no longer having the pressure to resist separation between the hub 3 and the collet 5, these two components move relatively in an axial direction and thereby remove the "hoop" stresses that had previously produced the interference fit between the hub 3, the shaft 4 and the collet 5. Preferably the taper angle of 6 and 10 is chosen to be small so that clamping does not depend on pressure in chamber 11 and the taper is self-releasing.

70 The mounting provided by this invention has the advantage over prior forms of oil injection mounting that it can be positioned anywhere along a shaft or other element of constant cross-section, and accurate location of the position may be achieved by regulating the flow of high pressure fluid. When positioned it remains clamped in that position until the pressure in the chamber be released and fluid re-injected between the element and collet. In the particular case of the relevant parts being of circular cross-section, hub 3 may be rotated through any desired angle and there fixed to the shaft.

80 Clamping and releasing generally takes substantially less time (often as little as half a minute) with the present invention than with prior forms of mounting.

85 Furthermore, the process of clamping and releasing are both carried out by a single source of pressurized fluid, and the process may be controlled by a single control device. The system does not require the continued application of fluid pressure to maintain the fixing since sealing rings 12 and 12a prevent leakage of fluid. Fluid pressure from the supply is required only during clamping and releasing of the relevant parts.

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2. A clamping device as claimed in Claim 1, wherein the collet has a first surface defining with a first part of an internal wall in the element, said first fluid chamber in which

- increase of pressure tends to move the collet relative to the element in a direction axially of the member so that a tapered surface of the collet tends to move into mating relationship with a second, complementary internal wall part of the element to clamp the element to the member, said tapered surface and complementary wall part defining a second fluid chamber which communicates, in the non-clamped position, with said first chamber and in which increase of pressure tends to separate the element and collet, means for introducing fluid under pressure to the second pressure chamber, and means for releasing pressure from the first chamber, the mounting being arranged such that when fluid is so introduced and the pressure release means closed, fluid passes from the second to the first chamber and the consequent increase of pressure so stresses the components as to achieve a secure interference fit between the element and the collet, and the collet and the member, respectively, which is releasable by opening the pressure release means and again introducing fluid under pressure through said fluid pressure introduction means.
3. A clamping device substantially as herein described with reference to the accompanying drawings.
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