

- (21) Application No. 39669/74 (22) Filed 11 Sept. 1974 (19)  
 (31) Convention Application No. 2 347 608  
 (32) Filed 18 Sept. 1973 in  
 (33) Fed. Rep. of Germany (DT)  
 (44) Complete Specification published 28 Sept. 1977  
 (51) INT. CL.<sup>2</sup> F16H 35/06 E02F 3/42 F16H 1/46  
 (52) Index at acceptance

F2Q 7A3C1E 7A3C2A 7A3X  
 E1F 3AX



## (54) A MECHANISM FOR DRIVING A WORK-SHAFT

(71) We, MANNESMANN AKTIENGESellschaft, a German body corporate of 4 Düsseldorf, Mannesmannufer 2, Germany, 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:—

The invention relates to a mechanism for driving, at slow speed, a deflectably mounted shaft by means of the drive output shaft of a transmission driven by one or more driving motors. More particularly the invention concerns the driving of suction excavator cutting heads wherein there is secured at one end of the deflectably mounted shaft the cutting head itself whereas the driving means act on the other end of the shaft. These means comprise a transmission which is usually driven by a plurality of driving motors.

Underwater cutting head transmissions of hitherto known construction have usually been constructed with a drum type of constructional form with a thrust bearing, that is to say the individual single-stage or multi-stage spur reduction gear units with the hydraulic or electrical driving motors were arranged concentrically round the drive output shaft of the transmission. The transmission units are connected to the so-called ladder, which is an arm carrying the drive unit and the shaft provided with the cutting head. Between the thrust bearing, which has to accept the axial forces acting on the driving shaft, and the transmission there is arranged a coupling with crowned teeth in order to compensate for the angle between the drive output shaft of the transmission and the deflectably mounted shaft. These angles result from the fact that the shaft provided with the cutting head is additionally mounted directly in the region of the cutting head by a very elastic rubber bearing. This known solution does in fact meet the requirements as regards economy when using driving motors with considerable torque and small rotational speeds, since there are small reduction ratios and thus re-

latively small gear unit diameters ("VDI-Zeitschrift" 1965, No. 6, pages 270 to 274, Heinz M. Hiersig "Hydraulic drive for suction excavator cutting heads"). But if it is desired to obtain high driving torques with many small high-speed driving units, when using known cutting heads transmissions it is unavoidable that the gear unit diameter becomes very large owing to the need to have a multistage arrangement for the individual driving lines up to a collective wheel. A gear unit of this kind can be arranged on the ladder construction only with considerable outlay.

The aim of the invention is to provide a mechanism for driving a slowly rotatable and deflectable work-shaft, which drive is capable of being secured in a space-saving arrangement with simple means on a frame supporting the device, more particularly on the ladder of a suction excavator.

The invention provides a mechanism for driving a work-shaft, the mechanism comprising a transmission including a housing and an output shaft, at least one driving motor being connected to the input of the transmission, the work-shaft being rigidly connected to the output shaft which supports the transmission housing by means of a first and a second bearing attached to the housing, the output shaft being mounted in a self-aligning bearing having a stationary part carried firmly by a support structure, the housing being connected with the stationary part by means of a torque reaction means whereby the work-shaft is both rotatable and deflectable.

For driving an excavator cutting head the work-shaft carries the cutting head at its end remote from the transmission, and is additionally held in the region of the cutting head in an elastic bearing.

The part of the output shaft between the first and the second bearing may be in the form of a planet wheel carrier of a first planetary stage of the transmission.

The first planetary stage may be coupled with a second planetary stage and the device may have a multi-motor drive.

Preferably the collective gear stage comprises a collective wheel with which a plurality of pinions engage which are each driven by a driving motor, there being arranged on the collective wheel shaft the sun wheel of the second planetary stage whose planet wheel carrier drives the sun wheel of the first planetary stage the gear annuli of the first and second planetary stages being connected fixedly to the transmission housing.

In a preferred embodiment the torque reaction means is a toothed sleeve coupling which connects the transmission housing with the stationary part of the self-aligning bearing and whose internal teeth on the one hand engage with a circle of teeth arranged on the transmission housing and on the other hand with a circle of teeth of the stationary part of the self-aligning bearing, both circles of teeth comprising crowned teeth.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawing showing one embodiment of the invention for driving a suction excavator cutting head.

The drawing shows in a diagrammatic manner a ladder 30 firmly connected to the excavator (not shown). The ladder 30 carries a self-aligning bearing 7 whose stationary part 8 is connected securely to the ladder 30. In the self-aligning bearing 7 is mounted a drive output shaft 2 of a transmission 3. A work-shaft 1 is at its upper end connected rigidly to the shaft 2, and at its bottom end carries a cutting head 32. A plurality of driving motors 11, 12 are arranged at the input side of the transmission 3. Above the bearing 7 there is provided a thrust bearing 10. The bearing 7 and the thrust bearing 10 have a common centre point about which the shaft 2 can be deflected in swingable manner.

Due to this arrangement the entire drive unit, including elements 11, 12 3 and 2, and also the workshaft 1 carrying the cutting head 32, are deflectably mounted on the ladder 30 and are deflectable relative thereto.

A radially yieldable elastic bearing 31 supports the deflectably mounted shaft 1 in the region of the cutting head 32.

Since the drive output shaft 2 is connected fixedly to the workshaft 1 carrying the cutting head 32, the drive output shaft 2 follows the movements of the shaft 1. Thus the entire transmission rides in a freely mobile manner on the drive output shaft 2 and thus also accompanies the movements of the drive output shaft, that is to say the movements of the shaft 1 relatively to the stationary part 8 of the self-aligning roller bearing 7. As a torque support 9 there is provided in this case a gear coupling with crowned teeth which connects the stationary part of

the bearing 8 with the housing 4 of the transmission 3. This gear coupling is sealed since the drive unit is under water during operation.

The transmission 3 itself, to which the driving motors 11 and 12 are flange-connected, comprises a transmission housing 4 in which there are provided a collective gear stage 33 and two planetary stages, namely a first planetary stage 35 and a second planetary stage 34.

Motor shafts 13 and 14 drive directly pinions 15 and 16 which engage on a collective wheel 17. The collective wheel shaft 18 carries the sun wheel 19 of the second planetary stage comprising the sun wheel 19, a planet wheel carrier 20, planet wheels 21 and a gear annulus 22. The planet wheel carrier 20 of the second planetary stage 34 is connected to a shaft 23 which carries the sun wheel 24 of the first planetary stage 35, comprising the sun wheel 24, a planet wheel carrier 25, planet wheels 26 and a gear annulus 27.

The planet wheel carrier 25 has a top part, formed by a hollow shaft 28, and a bottom part to which is directly and rigidly attached the drive output shaft 2. The bottom part of the carrier 25 is mounted in a first bearing 5, mounted externally of the transmission 3, and its top part is mounted in a second bearing 6, mounted internally of the transmission 3.

The invention can also be used in another case with a similar bearing condition, that is to say wherever a slow-running shaft is to be driven which undergoes more or less regularly during its operation certain shaft misalignments which are cause from the outside. But the use of the invention for cutting head excavator drives is particularly pointed out and the invention is of particular technical advantage there since it is now possible for shaft misalignments which result from distortion of the ladder itself, to be easily kept from having any significant effect on the securing of the transmission on the ladder itself, since direct securing of the kind is dispensed with.

#### WHAT WE CLAIM IS:—

1. A mechanism for driving a work-shaft, the mechanism comprising a transmission including a housing and an output shaft, at least one driving motor being connected to the input of the transmission, the work-shaft being rigidly connected to the output shaft which supports the transmission housing by means of a first and a second bearing attached to the housing, the output shaft being mounted in a self-aligning bearing having a stationary part carried firmly by a support structure, the housing being connected with the stationary part by means of

a torque reaction means whereby the work-shaft is both rotatable and deflectable.

2. A mechanism according to Claim 1, wherein the or each driving motor is flange connected to the transmission housing.

3. A mechanism according to Claim 1 or 2 for driving an excavator cutting head, wherein the work-shaft carries the cutting head at its end remote from the transmission, and is additionally held in the region of the cutting head in an elastic bearing.

4. A mechanism according to Claim 3 wherein the part of the output shaft between the first and the second bearing is in the form of a planet wheel carrier of a first planetary stage of the transmission.

5. A mechanism according to Claim 4 wherein the first planetary stage is coupled with a second planetary stage.

6. A mechanism according to Claim 5, having a multi-motor drive, wherein a collective gear stage is interposed between the first and second planetary stage and the multi-motor drive.

7. A mechanism according to Claim 6, wherein the collective gear stage comprises a collective wheel with which a plurality of pinions engage which are each driven by a

driving motor, there being arranged on the collective wheel shaft the sun wheel of the second planetary stage whose planet wheel carrier drives the sun wheel of the first planetary stage the gear annuli of the first and second planetary stages being connected fixedly to the transmission housing.

8. A mechanism according to any one of Claims 1 to 7, wherein the torque support is a toothed sleeve coupling which connects the transmission housing with the stationary part of the self-aligning bearing and whose internal teeth on the one hand engage with a circle of teeth arranged on the transmission housing and on the other hand with a circle of teeth of the stationary part of the self-aligning bearing, both circles of teeth comprising crowned teeth.

9. A mechanism for driving a work-shaft substantially as herein described with reference to and as shown in the accompanying drawing.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1977.  
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,  
from which copies may be obtained.

