

CONVERTOR ASSEMBLY FOR AN ACTUATOR SYSTEM

FIELD

[0001] The present invention is generally directed to actuation systems used in industrial and other applications, and in particular to a convertor assembly for an actuator system. While the present invention will be described in relation to its application for actuator systems used for controlling valve assemblies, it is to be appreciated that the invention is not restricted to this application, and that other applications are also envisaged.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] The Applicant has developed and marketed hydraulic actuator systems for use with butterfly valve assemblies that require the valve to be moved within an angular range of between 0 to 90 degrees. These hydraulic actuator systems include at least one elongate piston slidably accommodated for linear movement within a supporting passage and having piston faces on either end thereof. Hydraulic fluid under pressure can be alternatively directed to opposing ends of the piston to thereby urge the piston into a reciprocating linear motion within the passage. The body of the piston is provided with gear teeth that mesh with the gear teeth of a pinion gear in a rack and pinion gear drive arrangement. The pinion gear is itself supported on a drive shaft of the actuator. This therefore allows for the linear motion of the piston to be converted into rotary motion of the drive shaft.

[0004] The output torque provided by the actuator system is in part determined by the area of the piston faces of the piston. Increasing the diameter, and therefore overall size of the actuator will increase the maximum output torque of that actuator. Some of the Applicant's hydraulic actuator systems also include separate pistons

located on either side of and having a gear rack meshing with the pinion gear which can also act to increase the output torque provided by the actuator system.

[0005] Other types of valve assemblies require a higher angular range of actuation to operate properly. Globe valve assemblies for example require the valve to be actuated in an angular range of between 0 to 180, or even up to 360 degrees. Such valve assemblies have until now needed to be actuated by means of a hydraulic or electric motor. High torque hydraulic motors are however relatively large in size and expensive to obtain. It is also not always possible to use electric motor actuation systems due, for example, to the hazardous environment that the valve assembly is being used in. It would therefore be advantage to be able to use a hydraulic actuator system as designed by the Applicant which are relatively more compact in size as well as being more cost effective, and notwithstanding the current limited angular range of actuation provided by these actuator systems.

[0006] The Applicant's current product range of hydraulic actuator systems includes nine single piston and nine double piston models to cater for the torque requirements of butterfly valve assemblies that are typically being used by current and potential clients of their actuator range. However, having such a large range of models can lead to both inventory and supply chain issues, and it would be advantageous to be able to significantly reduce the number of models being marketed while still satisfying the different torque requirements of their clients.

[0007] An object of the invention is to ameliorate one or more of the above-mentioned difficulties.

SUMMARY

[0008] According to an aspect of the present disclosure, there is provided a converter assembly for an actuator system having an actuator drive shaft drivable in a reciprocal rotational motion, comprising; a first bevel gear assembly having a first drive shaft, the first bevel assembly being adapted to convert the reciprocal rotary motion of the actuator drive shaft into at least single direction rotational motion of the first drive shaft.

[0009] In some embodiments, the first bevel gear assembly may comprise a first bevel gear having a central bore, the first drive shaft passing through the central bore and rotatably supporting thereon the first bevel gear, the first bevel gear being interconnectable with the actuator drive shaft, a second bevel gear having a central bore, the first drive shaft passing through and rotatably supporting thereon the second bevel gear, at least one intermediate bevel gear rotatably mounted between and meshing with the first and second bevel gears respectively such that rotational motion of the first bevel gear is transferred to the second bevel gear via the at least one intermediate bevel gear, and a clutch arrangement provided between the first drive shaft and at least one of the central bores of the first and second bevel gear for engaging the at least one central bore with the first drive shaft when the first and/or second bevel gear is rotated in one rotational direction, and for disengaging the at least one central bore with the first drive shaft when the first and/or second bevel gear is rotated in an opposing rotational direction. The clutch arrangement may comprise at least one single direction bearing mounted within at least one of the central bores.

[0010] In some embodiments, the convertor assembly may further comprise a second bevel gear assembly having a second drive shaft for converting the rotary motion of the first drive shaft to provide dual direction rotational motion of the second central drive shaft.

[0011] In some embodiments, the second bevel gear assembly may comprise a third bevel gear having interconnectable with the first drive shaft, a fourth bevel gear having a fourth central bore, the second drive shaft passing through the central bore of the fourth bevel gear and rotatably supporting thereon the fourth bevel gear, at least one further intermediate bevel gear rotatably mounted between and meshing with the third and fourth gear teeth of the third and fourth bevel gears respectively such that rotational motion of the third bevel gear is transferred to the fourth bevel gear via the at least one further intermediate bevel gear, and a switch arrangement for selectively connecting the second drive shaft to the third or fourth bevel gear. The switch arrangement may comprise a switch collar located around and moveable together with the second drive shaft and moveable therealong to selectively engage the third bevel gear or fourth bevel gear.

[0012] In some embodiments, the convertor assembly may further comprise a planetary gear assembly having an output connection, and interconnected to the second drive shaft for providing a boost in the output torque initially provided by the actuator system to the output connection. The planetary gear assembly may comprise an outer ring gear, a central sun gear, and intermediate planet gears supported on a planet gear carrier and respectively meshing with the ring and sun gears, the sun gear being interconnected to and drivable by the second output shaft of the second bevel gear assembly, and the planetary gear output connection extending from the planet gear carrier,

[0013] In some embodiments, the convertor assembly may further comprise a planetary gear assembly having an output connection, and interconnected to the first drive shaft for providing a boost in the output torque initially provided by the actuator system to the output connection. The planetary gear assembly may also be adapted to convert the rotary motion of the first drive shaft to dual direction rotary motion of the output connection. The planetary gear assembly may comprise an outer ring gear, a central sun gear, and intermediate planet gears supported on a planet gear carrier and respectively meshing with the ring and sun gears, the sun gear being interconnected to and drivable by the first output shaft of the first bevel gear assembly, and the planetary gear output connection extending from the ring gear.

[0014] According to another aspect of the present disclosure, there is provided an actuator system having an actuator drive shaft drivable in a reciprocal rotational motion, and further comprising a convertor assembly as described above.

[0015] Other aspects and features will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] In the figures, which illustrate, by way of example only, embodiments of the present invention,

[0017] Figure 1 is a side view of a convertor assembly according to an embodiment of the present disclosure together with an associated actuator system;

[0018] Figure 2 is a top view of the actuator system and convertor assembly shown in Fig. 1;

[0019] Figure 3 is a cross sectional view of the actuator system and convertor assembly taken along line AH-AH as shown in Fig. 2; and

[0020] Figure 4 is a perspective phantom view of the actuator system and convertor assembly of Fig. 1.

DETAILED DESCRIPTION

[0021] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0022] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0023] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0024] The convertor assembly 1 according to the present disclosure as shown in Figs. 1 to 4 is adapted to convert the output of a hydraulic actuator system 2 currently marketed by the Applicant, and this actuator system is also shown in Figs. 1 to 4. It is however to be appreciated that the convertor assembly according to the present disclosure is not restricted use with this actuator system and can also be used with other actuator systems.

[0025] The actuator system 2 is specifically adapted for use with butterfly valve assemblies having a range of movement of between 0 to 90 degrees, and the output of the actuator system therefore provides a reciprocal rotational output within this movement range. The actuator system 2 comprises a housing 3 supporting therein a pinion gear 7 supported on an actuator drive shaft 5. The housing 3 further comprises a pair of support passages 11 provided on opposing sides of the pinion

gear 7. Each support passage 11 slidably supports therein an elongate double-sided piston 9 having opposing piston faces 15, and a gear teeth rack 17 extending along the body of the piston 9. Each piston 9 is adapted to move in a lateral direction relative to the rotational axis of the actuator drive shaft 5. Hydraulic pressure is sequentially supplied to the opposing piston faces 15 to drive the piston 9 in a reciprocal linear motion, with the gear teeth rack 17 of each piston 9 meshing with the pinion gear 7 in a rack and pinion gear drive arrangement. The actuator drive shaft 5 can therefore be driven in a reciprocal rotational motion as a result of the linear movement of each piston 9.

[0026] The connector assembly 1 according to the present disclosure comprises first and second bevel assemblies 6, 8 that function together to convert the reciprocal rotational motion of the actuator drive shaft 5 into rotational motion in single and dual rotational directions. The first bevel gear assembly 6 comprises a housing 18, and a first drive shaft 19 located within the housing 18. A first bevel gear 21 having a first central bore 23 is also located within the housing 18, with the first drive shaft 19 passing through the first central bore 23 to rotatably support thereon the first bevel gear 21. The first bevel gear 21 further comprises a rear collar 25 for accommodating therein an end portion 27 of the actuator drive shaft 5. The collar has internal splines (not shown), and the actuator drive shaft end portion 27 has external splines (not shown) that can mesh with the collar 25 such that the reciprocal rotational motion of the actuator drive shaft 5 can be transferred to the first bevel gear 21. The first bevel gear assembly 6 further comprises a second bevel gear 29 located within the housing 18 having a second central bore 31 through which the first drive shaft 19 also passes to thereby rotatably support the second bevel gear 29 thereon. An intermediate bevel gear 33 is rotatably mounted on an axle 34 supported by the housing 19, and located between and meshing with the first and second bevel gears 21, 29 to allow for rotational motion of the first bevel gear 21 to be transferred to the second bevel gear 29.

[0027] A clutch arrangement 35 is provided between the first drive shaft 19 and the central bores 23, 31 of one or both of the first and second bevel gears 21, 29. The clutch arrangement 35 is provided by a plurality of single direction bearings mounted within the first central bore 23 and/or second central bore 31. The clutch

arrangement 35 engages the central bore(s) 23,31 with the first drive shaft 19 when the first and/or second bevel gear 21,29 is rotated in one rotational direction, and disengages the central bore(s) 23, 31 from the first drive shaft 19 when the first and/or second bevel gear 21,29 is rotated in an opposing rotational direction. This clutch arrangement 35 therefore ensures that the first drive shaft 19 will only be rotated in one rotational direction.

[0028] A second bevel gear assembly 8 can also be included in the convertor assembly 1 if dual direction rotational motion is required. The second bevel gear assembly 8 comprises a housing 36 within which is supported a third bevel gear 39 having a splined central bore 40. The first drive shaft 19 has a splined end portion 20 that can mesh with the splined central bore 40 of the third bevel gear 39, and which will therefore rotate together with the first drive shaft 19. The second bevel gear assembly 8 further comprises a second drive shaft 37 located within the housing 36, and upon which is mounted a fourth bevel gear 41. Intermediate bevel gears 43 are provided between the third and fourth bevel gears 39,41 to thereby allow for the transfer of rotational motion of the third bevel gear 39 to the fourth bevel gear 41. The second bevel gear assembly 8 further comprising a switch arrangement 57 that allows the second drive shaft 37 to be selectively driven directly by the third bevel gear 39, or by the fourth bevel gear 41. At least one of the intermediate bevel gears 43 is rotatably mounted on a rotatable key axle 55 which can be rotated within an accommodating bore 44. The rotatable key axle 55 is connected via a connection lug 56 to a switch collar 57 located around and moveable together with the second drive shaft 37. Rotation of the key axle 55 in one direction urges the switch collar 57 upwards towards the third bevel gear 39. The switch collar 57 will engage the third bevel gear 39 in this position so that the second drive shaft 37 can only be driven by the third bevel gear 39. The second drive shaft 37 will then be driven in the same rotational direction as the first drive shaft 19 which is connected to the third bevel gear 39. Rotation of the key axle 55 in the opposite direction urges the switch collar 57 downwardly to engage the fourth bevel gear 41. In this position, the second drive shaft 37 is only driven by the fourth bevel gear 41. As the second bevel assembly 8 works in the same general manner as a conventional differential drive, the second drive shaft 37 is rotatably driven by the fourth bevel gear 41 in the opposite direction to the first drive shaft 19. The location of the switch arrangement 57 in the centre of

the second bevel gear assembly 8 leads to a very compact design than would be the case when using, for example, a more conventional fork and ring design.

[0029] The convertor assembly 1 can also optionally comprise a planetary gear assembly 10 that can be interconnected with an end 38 of the second drive shaft 41. The gear ratio provided by the planetary gear assembly 10 can provide a boost in the output torque initially provided by the actuator system 2. The planetary gear assembly 10 includes an outer ring gear 47, a central sun gear 49, and a series of planet gears 51 respectively supported on a common planet gear carrier 45. The sun gear 49 is interconnected with and driven by the second drive shaft 37, while the output connection 53 of the planetary gear assembly 10 is supported on the planet gear carrier 45.

[0030] It is also envisaged that the planetary gear assembly 10 could replace the role of the second bevel gear assembly 8 in enabling the convertor assembly 1 to provide for dual direction rotation. The first drive shaft 19 of the first bevel gear assembly 6 can then be directly interconnected with the sun gear 49 of the planetary gear assembly 10. The direction of rotation of the output connection 53 can be controlled by selectively holding fixed or allowing rotation of the outer ring gear 47 thereby reversing the direction of rotation of the output connection 53, which would in this application extend from the ring gear 47.

[0031] It is also envisaged that the planetary gear assembly 10 be used to increase the output speed by up to 11 times by connecting the first or second drive shaft 19,38 to the ring gear 47, and extending the output connection from the sun gear 49.

[0032] The convertor assembly according to the present disclosure can therefore convert the Applicant's actuator systems to provide single or dual direction 360-degree multi turn actuation. This then allows the actuator systems to be used on a greater range of valve systems including globe valves requiring 360-degree actuation. Furthermore, the convertor system according to the present disclosure can provide a boost in the output torque provided by their actuator system enabling them to be used in a greater range of valve systems. It is also envisaged that the convertor system can be used in a variety of other applications where hydraulic or pneumatic rotary actuators are typically used. For example, the convertor assembly when used

with the Applicant's actuator systems, can be used to replace a hydraulic, pneumatic or electric motor in many different applications.

[0033] It should be appreciated by the person skilled in the art that the above invention is not limited to the embodiment described. It is appreciable that modifications and improvements may be made without departing from the scope of the present invention.

[0034] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.

CLAIMS

1. A convertor assembly for an actuator system having an actuator drive shaft drivable in a reciprocal rotational motion, comprising; a first bevel gear assembly having a first drive shaft, the first bevel assembly being adapted to convert the reciprocal rotary motion of the actuator draft shaft into at least single direction rotational motion of the first drive shaft.
2. A convertor assembly according to claim 1, wherein the first bevel gear assembly comprises a first bevel gear having a central bore, the first drive shaft passing through the central bore and rotatably supporting thereon the first bevel gear, the first bevel gear being interconnectable with the actuator drive shaft, a second bevel gear having a central bore, the first drive shaft passing through and rotatably supporting thereon the second bevel gear, at least one intermediate bevel gear rotatably mounted between and meshing with the first and second bevel gears respectively such that rotational motion of the first bevel gear is transferred to the second bevel gear via the at least one intermediate bevel gear, and a clutch arrangement provided between the first drive shaft and at least one of the central bores of the first and second bevel gear for engaging the at least one central bore with the first drive shaft when the first and/or second bevel gear is rotated in one rotational direction, and for disengaging the at least one central bore with the first drive shaft when the first and/or second bevel gear is rotated in an opposing rotational direction.
3. A convertor assembly according to claim 2, wherein the clutch arrangement comprises at least one single direction bearing mounted within at least one of the central bores.
4. A convertor assembly according to any one of claims 1 to 3, further comprising a second bevel gear assembly having a second drive shaft for converting the rotary motion of the first drive shaft to provide dual direction rotational motion of the second central drive shaft.
5. A convertor assembly according to claim 4, wherein the second bevel gear

assembly comprises a third bevel gear having interconnectable with the first drive shaft, a fourth bevel gear having a fourth central bore, the second drive shaft passing through the central bore of the fourth bevel gear and rotatably supporting thereon the fourth bevel gear, at least one further intermediate bevel gear rotatably mounted between and meshing with the third and fourth gear teeth of the third and fourth bevel gears respectively such that rotational motion of the third bevel gear is transferred to the fourth bevel gear via the at least one further intermediate bevel gear, and a switch arrangement for selectively connecting the second drive shaft to the third or fourth bevel gear.

6. A convertor assembly according to claim 5, wherein the switch arrangement comprises a switch collar located around and moveable together with the second drive shaft and moveable therealong to selectively engage the third bevel gear or fourth bevel gear.
7. A convertor assembly according to any one of claims 4 to 6, further comprising a planetary gear assembly having an output connection, and interconnected to the second drive shaft for providing a boost in the output torque initially provided by the actuator system to the output connection.
8. A convertor assembly according to claim 7, wherein the planetary gear assembly comprises an outer ring gear, a central sun gear, and intermediate planet gears supported on a planet gear carrier and respectively meshing with the ring and sun gears, the sun gear being interconnected to and drivable by the second output shaft of the second bevel gear assembly, and the planetary gear output connection extending from the planet gear carrier,
9. A convertor assembly according to any one of claims 1 to 3, further comprising a planetary gear assembly having an output connection, and interconnected to the first drive shaft for providing a boost in the output torque initially provided by the actuator system to the output connection.
10. A convertor system according to claim 9, wherein the planetary gear assembly is adapted to convert the rotary motion of the first drive shaft to dual direction rotary motion of the output connection.

11. A convertor assembly according to claim 9 or 10, wherein the planetary gear assembly comprises an outer ring gear, a central sun gear, and intermediate planet gears supported on a planet gear carrier and respectively meshing with the ring and sun gears, the sun gear being interconnected to and drivable by the first output shaft of the first bevel gear assembly, and the planetary gear output connection extending from the ring gear.
12. An actuator system having an actuator drive shaft drivable in a reciprocal rotational motion, and further comprising a convertor assembly as claimed in any one of the preceding claims.