CLAIMS

We claim:

1. An apparatus for assisting in the operation of a gate valve having a linearly movable gate compnsmg:

a bi-directional hydraulic fluid cylinder having an output rod adopted to be coupled to the gate to move the gate linearly;

a rotary to linear translator connected to an input rod of the cylinder for converting rotary motion to linear movement;

an input coupling and an output coupling coupled to each other and to the translator for providing rotary motion to the translator; and

a rotary valve operatively coupled to the input coupling and adapted to be connected between a hydraulic fluid source and the cylinder so that rotation of the input and output couplings in a first direction causes the translator to linearly move the input and output rods of the cylinder in an opening direction, and rotation of the input coupling in the first direction causes the rotary valve to an open command position directing fluid from the source to the cylinder to provide an assisting force to the input and output rods of the cylinder.

2. The apparatus of claim 1, wherein the input coupling and the output coupling are rotationally moveable relative to each other a fractional amount and the rotation relative to each other causes the rotary valve to move to the open command position.

3. The apparatus of claim 2, further comprising a torsion bar disposed between the input coupling and the output coupling to prevent rotational movement between

the input coupling and the output coupling until sufficient torque is applied to the input coupling to cause deformation

of the torsion bar.

4. The apparatus of claim 2, further comprising drive dogs mechanically connected between the input coupling and the output coupling that cause rotation in unison after the fractional amount has been reached.

5. The apparatus of claim 2, wherein the input rod comprises external threads on an outer surface, the translator further comprising:

a tubular drive coupling with an internal bore and a central axis, the tubular drive coupling secured to the output coupling;

a travel nut secured within the internal bore of the drive coupling, the travel nut comprising internal threads which engage the external threads of the input rod, so that rotation of the output coupling causes axial movement of the input rod.

6. The apparatus of claim 1, wherein the cylinder has an internal cavity comprising a nut end compartment and a gate end compartment, the apparatus further comprising:

a piston located within the cylinder, the piston secured between the input rod and the output rod and separating the nut end compartment from the gate end compartment, so that a pressure differential between the nut end compartment and the gate end compartment will encourage the gate to move between the open and a closed position;

an open port located in a side wall of the nut end compartment for supplying hydraulic

fluid to and from the nut end compartment of the cylinder ; and

a close port located in a side wall ofthe gate end compartment of

the cylinder for supplying hydraulic fluid to and from the. gate end compartment of the cylinder.

7. The apparatus of claim 2, wherein the rotary valve further comprises:

a sleeve with a central bore;

a cylindrical inner member rotatable within the sleeve to a fractional amount;

an open port and a close port in the sleeve spaced circumferentially apart;

a supply void on the inner member extending circumferentially;

an input port in the sleeve between the open and close ports to supply hydraulic fluid to the supply void.

8. The apparatus of claim 7, wherein rotation of the inner member relative to the sleeve in the first direction provides unequal communication between the open and close ports and the supply void.

9. The apparatus of claim 7, wherein the circumferential extension of the supply void is less than the circumferential distance between the open and close ports.

10. The apparatus of claim 7, wherein rotation of the inner member relative to the sleeve to the fractional amount in the first direction restricts fluid communication between the close port and the supply void and provides fluid communication between the open port and the supply void.

11. The apparatus of claim 7, further comprising:

a return port on the sleeve; and

a return void extending circumferentially on the inner member in

fluid communication with the return port, wherein rotation of the inner member relative to the sleeve in the first direction blocks fluid communication between the open port and the return void and provides fluid communication between the close port and the return void.

12. A gate valve comprising:

a gate;

a drive train comprising:

a gate rod for linearly moving the gate;

a translator operatively coupled to the gate rod for moving the gate rod linearly in response to rotational motion; and

a coupling device connected to the translator for providing rotational motion; the gate valve further comprising:

a fluid cylinder cooperatively coupled to the drive train for providing an assisting force to

move the gate rod linearly;

a rotary valve cooperatively connected to the coupling device and in a fluid flow path between the cylinder and a fluid pressure source; and

wherein torque applied to the coupling device moves the rotary valve to an open position .to supply fluid pressure to the fluid cylinder.

13. The gate valve of claim 12, wherein the coupling device comprises an input coupling and an output coupling rotationally moveable relative to each other a fractional amount so that the

rotation relativeto each other causes the rotary valve to move to the open command position.

14. The gate valve of claim 13 further comprising a torsion bar disposed between the input coupling and the output coupling to prevent rotational movement between the input coupling and the output coupling until sufficient torque is applied to the input coupling to cause elastic deformation of the torsion bar.

15. The gate valve of claim 13, further comprising drive dogs mechanically connected between the input coupling and the output coupling that cause rotation in unison after the fractional amount has been reached.

16. The gate valve of claim 12, wherein the translator comprises:

a nut rod with external threads on an outer surface;

a tubular drive with an internal bore;

a travel nut secured within the internal bore of the tubular drive, the travel nut comprising internal threads which engage the external threads of the nut rod, so that rotation of the coupling device causes axial movement of the gate rod.

17. The gate valve of claim 12, wherein the cylinder has an internal cavity comprising a nut end compartment and a gate end compartment, the gate valve further comprising:

a piston located within the cylinder, the piston separating the nut end compartment from the gate end compartment, so that a pressure differential between the nut end compartment and the gate end compartment will encourage the gate to move between the open and a closed position;

an open port located in a side wall of the nut end compartment for

supplying hydraulic fluid to and from the nut end compartment of the cylinder ; and

a close port located in a side wall of the gate end compartment of the cylinder for supplying hydraulic fluid to and from the gate end compartment of the cylinder.

18. The gate valve of claim 12, wherein the rotary valve further comprises:

a sleeve with a central bore;

a cylindrical inner member rotatable within the sleeve to a fractional amount;

an open port and a close port in the sleeve spaced circumferentially apart;

a supply void on the inner member extending circumferentially;

an input port in the sleeve between the open and close ports to supply hydraulic fluid to the supply void.

19. The gate valve of claim 18, wherein rotation of the inner member relative to the sleeve in the first direction provides unequal communication between the open and close ports and the supply void.

20. The gate valve of claim 18, wherein the circumferential extension of the supply void is less than the circumferential distance between the open and close ports.

21. The apparatus of claim 18, wherein rotation of the inner member relative to the sleeve to the fractional amount in the first direction restricts fluid communication between the close port and the supply void and provides fluid communication between the open port and the supply void.

22. The apparatus of claim 18, further comprising:

a return port on the sleeve; and

a return void extending circumferentially on the inner member in fluid communication with the return port, wherein rotation of the inner member relative to the sleeve in the first direction restricts fluid communication between the open port and the return void and provides fluid communication between the close port and the return void.

23. A method for assisting in the operation of a gate valve having a linearly moveable gate comprising the steps of:

(a) coupling a piston rod of a bi-directional hydraulic cylinder to the gate; (b) connecting a rotary to linear translator to the piston rod;

(c) connecting an input coupling to the translator and providing the input coupling with a rotary valve that is connected between a hydraulic fluid source and the hydraulic cylinder;

(d) rotating the input coupling in a first direction which causes the translator to move the piston rod and gate to an open position; and

(e) the rotation in step (d) also causing the rotary valve to direct fluid from the source to the cylinder to create an open assisting force on the piston rod.

24. The method of claim 23, further comprising the steps of rotating the input coupling in a second direction which causes the translator to move the piston rod and gate to a closed position and the rotary valve to direct fluid from the source to the cylinder to create a close assisting force on the piston rod.

25. The method of claim 23, wherein the rotary valve has open command ports and close command ports, and the step of rotating the input coupling in a first

direction communicates the open command port with the source and blocks the close command ports from the source.

26. The method of claim 23, wherein the assisting force provided by the cylinder is proportional to an amount of torque imposed on the input coupling.

27. The method of claim 23, wherein the input coupling has an input portion and an output portion and step (d) initially causes the input portion to rotate a fractional amount relative to the output portion.

28. The method of claim 27, wherein the fractional amount of relative rotation causes rotation of one component of the rotary valve relative to another component of the valve.

29. The method of claim 27, wherein after reaching the fractional amount, continued rotation of the input coupling causes the input portion and output portion to rotate in unison.

CLAIM:

1. An apparatus for assisting in the operation of a gate valve having a linearly movable gate comprising:

a bi-directional hydraulic fluid cylinder having an output rod adopted to be coupled to the gate to move the gate linearly;

a rotary to linear translator connected to an input rod of the cylinder for converting rotary motion to linear movement;

an input coupling and an output coupling coupled to each other and to the translator for providing rotary motion to the translator; and

a rotary valve operatively coupled to the input coupling and adapted to be connected between a hydraulic fluid source and the cylinder so that rotation of the input and output couplings in a first direction causes the translator to linearly move the input and output rods of the cylinder in an opening direction, and rotation of the input coupling in the first direction causes the rotary valve to an open command position directing fluid from the source to the cylinder to provide an assisting force to the input and output rods of the cylinder.

2. The apparatus of claim 1, wherein the input coupling and the output coupling are rotationally moveable relative to each other a fractional amount and the rotation relative to each other causes the rotary valve to move to the open command position.

3. The apparatus of claim 1 or claim 2, further comprising a torsion bar disposed between the input coupling and the output coupling to prevent rotational movement between the input coupling and the output coupling until sufficient torque is applied to the input coupling to cause deformation of the torsion bar.

4. The apparatus of any preceding claim, further comprising drive dogs mechanically connected between the input coupling and the output coupling that cause rotation in unison after the fractional amount has been reached.

5. The apparatus of any preceding claim, wherein the input rod comprises external threads on an outer surface, the translator further comprising:

a tubular drive coupling with an internal bore and a central axis, the tubular drive coupling secured to the output coupling;

a travel nut secured within the internal bore of the drive coupling, the travel nut comprising internal threads which engage the external threads of the input rod, so that rotation of the output coupling causes axial movement of the input rod.

6. The apparatus of any preceding claim, wherein the cylinder has an internal cavity comprising a nut end compartment and a gate end compartment, the apparatus further comprising:

a piston located within the cylinder, the piston secured between the input rod and the output rod and separating the nut end compartment from the gate end compartment, so that a pressure differential between the nut end compartment and the gate end compartment will encourage the gate to move between the open and a closed position;

an open port located in a side wall of the nut end compartment for supplying hydraulic fluid to and from the nut end compartment of the cylinder ; and

a close port located in a side wall of the gate end compartment of the cylinder for supplying hydraulic fluid to and from the gate end compartment of the cylinder.

7. The apparatus of any preceding claim, wherein the rotary valve further comprises:

a sleeve with a central bore;

a cylindrical inner member rotatable within the sleeve to a fractional amount;

an open port and a close port in the sleeve spaced circumferentially apart;

a supply void on the inner member extending circumferentially;

an input port in the sleeve between the open and close ports to supply hydraulic fluid to the supply void.

8. The apparatus of any preceding claim, wherein rotation of the inner member relative to the sleeve in the first direction provides unequal communication between the open and close ports and the supply void.

9. The apparatus of any preceding claim, wherein the circumferential extension of the supply void is less than the circumferential distance between the open and close ports.

10. The apparatus of any preceding claim, wherein rotation of the inner member relative to the sleeve to the fractional amount in the first direction restricts fluid communication between the close port and the supply void and provides fluid communication between the open port and the supply void.

11. The apparatus of any preceding claim, further comprising:

a return port on the sleeve; and

a return void extending circumferentially on the inner member in fluid communication with the return port, wherein rotation of the inner member relative to the sleeve in the first direction blocks fluid communication between the open port and the return void and provides fluid communication between the close port and the return void.

12. A gate valve comprising:

a gate;

a drive train comprising:

a gate rod for linearly moving the gate;

a translator operatively coupled to the gate rod for moving the gate rod linearly in response to rotational motion; and

a coupling device connected to the translator for providing rotational motion; the gate valve further comprising:

a fluid cylinder cooperatively coupled to the drive train for providing an assisting force to move the gate rod linearly;

a rotary valve cooperatively connected to the coupling device and in a fluid flow path between the cylinder and a fluid pressure source; and

wherein torque applied to the coupling device moves the rotary valve to an open position to supply fluid pressure to the fluid cylinder.

13. The gate valve of claim 12, wherein the coupling device comprises an input coupling and an output coupling rotationally moveable relative to each other a fractional amount so that the rotation relative to each other causes the rotary valve to move to the open command position.

14. The gate valve of claim 12 or claim 13, further comprising a torsion bar disposed between the input coupling and the output coupling to prevent rotational movement between the input coupling and the output coupling until sufficient torque is applied to the input coupling to cause elastic deformation of the torsion bar.

15. The gate valve of any of claims 12 to 14, further comprising drive dogs mechanically connected between the input coupling and the output coupling that cause rotation in unison after the fractional amount has been reached.

16. The gate valve of any of claims 12 to 15, wherein the translator comprises:

a nut rod with external threads on an outer surface;

a tubular drive with an internal bore;

a travel nut secured within the internal bore of the tubular drive, the travel nut comprising internal threads which engage the external threads of the nut rod, so that rotation of the coupling device causes axial movement of the gate rod.

17. The gate valve of any of claims 12 to 16, wherein the cylinder has an internal cavity comprising a nut end compartment and a gate end compartment, the gate valve further comprising:

a piston located within the cylinder, the piston separating the nut end compartment from the gate end compartment, so that a pressure differential between the nut end compartment and the gate end compartment will encourage the gate to move between the open and a closed position;

an open port located in a side wall of the nut end compartment for supplying hydraulic fluid to and from the nut end compartment of the cylinder ; and

a close port located in a side wall of the gate end compartment of the cylinder for supplying hydraulic fluid to and from the gate end compartment of the cylinder.

18. The gate valve of any of claims 12 to 17, wherein the rotary valve further comprises:

a sleeve with a central bore;

a cylindrical inner member rotatable within the sleeve to a fractional amount;

an open port and a close port in the sleeve spaced circumferentially apart;

a supply void on the. inner member extending circumferentially;

an input port in the sleeve between the open and close ports to supply hydraulic fluid to the supply void.

19. The gate valve of any of claims 12 to 18, wherein rotation of the inner member relative to the sleeve in the first direction provides unequal communication between the open and close ports and the supply void.

20. The gate valve of any of claims 12 to 19, wherein the circumferential extension of the supply void is less than the circumferential distance between the open and close ports.

21. The gate valve of any of claims 12 to 20, wherein rotation of the inner member relative to the sleeve to the fractional amount in the first direction restricts fluid communication between the close port and the supply void and provides fluid communication between the open port and the supply void.

22. The gate valve of any of claims 12 to 21, further comprising:

a return port on the sleeve; and

a return void extending circumferentially on the inner member in fluid communication with the return port, wherein rotation of the inner member relative to the sleeve in the first direction restricts fluid communication between the open port and the return void and provides fluid communication between the close port and the return void.

23. A method for assisting in the operation of a gate valve having a linearly moveable gate comprising the steps of:

(a) coupling a piston rod of a bi-directional hydraulic cylinder to the gate; (b) connecting a rotary to linear translator to the piston rod;

(c) connecting an input coupling to the translator and providing the input coupling with a rotary valve that is connected between a hydraulic fluid source and the hydraulic cylinder;

(d) rotating the input coupling in a first direction which causes the translator to move the piston rod and gate to an open position; and

(e) the rotation in step (d) also causing the rotary valve to direct fluid from the source to the cylinder to create an open assisting force on the piston rod.

24. The method of claim 23, further comprising the steps of rotating the input coupling in a second direction which causes the translator to move the piston rod and gate to a closed position and the rotary valve to direct fluid from the source to the cylinder to create a close assisting force on the piston rod.

25. The method of claim 23 or claim 24, wherein the rotary valve has open command ports and close command ports, and the step of rotating the input coupling in a first direction communicates the open command port with the source and blocks the close command ports from the source.

26. The method of any of claims 23 to 25, wherein the assisting force provided by the cylinder is proportional to an amount of torque imposed on the input coupling.

27. The method of any of claims 23 to 26, wherein the input coupling has an input portion and an output portion and step (d) initially causes the input portion to rotate a fractional amount relative to the output portion.

28. The method of any of claims 23 to 27, wherein the fractional amount of relative rotation causes rotation of one component of the rotary valve relative to another component of the valve.

29. The method of any of claims 23 to 28, wherein after reaching the fractional amount, continued rotation of the input coupling causes the input portion and output portion to rotate in unison.

30. An apparatus substantially as hereinbefore described with reference to the accompanying drawings.

31. A gate valve assembly substantially as hereinbefore described with reference to the accompanying drawings.

32. A method substantially as hereinbefore described with reference to the accompanying drawings.