

WELLHEAD CONNECTORBackground

This invention relates to devices for connecting well servicing and like equipment to wellheads. The invention particularly relates to remotely actuated connectors especially useful for connecting and disconnecting equipment to and from underwater wellheads.

A number of remotely actuated connectors have been developed and are being used during well servicing operations. These remotely actuated connectors eliminate manual connector operation and repeated requirements for expensive divers when connecting well servicing equipment to and disconnecting it from underwater wellheads.

One of these devices is described in an article entitled "Latch System Speeds Stem Results" on page 43 of the February, 1984 issue of "Drilling Contractor" magazine, which is published in Houston, Texas.

Examples of two riser connectors, remotely operated by shifting tools and used underwater in ocean floor well operations, are disclosed in U.S. Patents 4,307,902 and 4,411,455 to Schnatzmeyer. An example of a hydraulically actuated connector which may be remotely actuated is shown in U.S. Patent 4,337,971 to William D. Kendrick. These connectors can be disconnected with pressure in the connector bore, resulting in possible loss of pressure control of the well and serious disaster.

The wellhead connector of this invention provides a remotely operable connector having male and female members, one of which maybe connected to servicing equipment to be releasably connected to a well head and the other to an underwater wellhead. Pressure may be selectively applied from a remote source to inlets in the female member to move a longitudinally movably sleeve and position this member in released or locked position. An additional lock, responsive to pressure in the female connector bore, prevents the longitudinally movable sleeve from being moved by remote pressure, positively preventing intentional or unintentional release and disconnect of the connector when there is pressure in the female connector bore. Once the connector members are in place, the connector may be operated remotely to easily, quickly and repeatedly connect and disconnect the well servicing equipment to and from the wellhead of the well being serviced.

According to the present invention there is provided a remotely operable connector comprising:

- a. a male tubular connector member having resilient seals and an exterior groove thereon; and
- b. female connector means telescopically and sealingly engageable with said male connector member, including latch means for securely engaging said female connector means in said male member exterior groove, and connecting said male member to said female connector means, pressure responsive locking and release means biased toward locked position, for locking said latch means securely engaged and for releasing said latch means, and

connector lock means, housed in the female connector means wall, responsive to pressure in the female connector for preventing release of the locking and release means.

Various aspects of the present invention are hereinafter described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic drawing of an ocean floor well utilizing the wellhead connector invention of this application, while being serviced.

Figure 2 is a sectional drawing of the connector of this invention showing the members of the connector of the invention connected.

Figure 3 is the drawing of a fragment of a section along lines 3-3 of Figure 2.

Figure 4 is a sectioned drawing of the connector of this invention showing members disconnected and moved slightly apart.

Figure 5 is a fragment of drawing Figure 2, showing the connector lock actuated.

Figure 1 shows schematically an ocean floor wellhead 10, utilizing a remotely operable connector 11 of this invention to connect a lubricator 12 to the wellhead for servicing the well. A service boat 13, on the ocean surface, has a wireline reel 14 and a pressure source 15. Hoses 16 connected to the pressure source and the invention connector, conduct pressured fluid between the pressure source and connector. A wireline 17 is

connected to the reel and passes over a sheave 18 and through a stuffing box 19 into the lubricator and well. A handling cable 20, attached to the lubricator, passes over a cable sheave 21 and is connected to a cable reel 22 on the boat. After connecting a connector member to the wellhead and a connector member to the lubricator or other well servicing equipment, the lubricator may be lowered and the connector operated remotely to connect or disconnect and raise the lubricator or other well servicing equipment as often as required during well servicing operations.

The invention connector 11 shown in Figure 2 includes a male member 23, having an appropriate connection on its upper end for connection to well servicing equipment to be connected to the wellhead. The male member has an external groove 24, a cam surface 24a, and houses resilient seals 25 in grooves near its lower end. An external camming surface 23a is provided between the resilient seals and groove.

The female connector member 26 includes a lower body 27 which has an appropriate connection on its lower end to connect the female member to the wellhead. The upper end of the lower body is connected to body 28 with thread 29 and sealed to the body with resilient seal 30. The body has a through bore 28a, a seal bore 28b, a shoulder 28c, an external flange 31, and openings 32. A longitudinally moveable sleeve 33 is mounted around the lower portion of the body and the flange and has

seal bores 33a and 33b. Bore 33a is slidably sealed to the body with resilient seal 34 and bore 33b is slidably sealed to the flange with resilient seal 35. The lower end of the sleeve has a counterbore 33c which forms a shoulder 33d with bore 33a. The sleeve is fitted with an inlet 36, which is connected to a conduit, to conduct control fluid from a remote pressure source to act on the sealed annular area between resilient seals 34 and 35. Mounted around the body in sleeve bore 33b is a spring 37.

Mounted around body 28 and connected to the upper end of the sleeve with threads 38 is a lock sleeve 39, which is sealed to the sleeve with resilient seal 40 and slidably sealed to the body with resilient seal 41. The lock sleeve retains spring 37 in bore 33b and has bores 39a, 39b, and 39c, which form an internal recess 39d in the lock sleeve. A conical surface 39e, connects bores 39b and 39c and shoulder 39f extends from bore 39a to bore 39c. Sleeve 33 is fitted with another inlet 42, which is connectable to a conduit, to conduct control fluid from a remote pressure source to act on the annular area between seals 35 and 41.

Mounted for radial movement in each body opening 32, is a lug 43 having camming surfaces 43a, 43b and 43c. Connected to the upper end of the female connector body 28 with threads 44 is a frusto-conical guide 45, useful to guide the male member into the female member for connection.

Housed in a recess in the lower wall of body 28 is a connector lock 46. As shown by Figure 3, the lock includes a rod 47 with a through flow passage 47a and an external flange 47b. The rod is connected in the wall recess to body 28 with thread 48 and one end of flow passage 47a in communication with body bore 28a. The rod is sealed to the body with resilient seal 49. Mounted over the rod in a recess in sleeve stop 50 is a piston 51, slidably sealed to the rod with resilient seal 52. Any pressure in bore 28a may act through flow passage 47a on the area sealed by seal 52. The sleeve stop has through holes 50a with internal shoulders 50b. Additionally, the stop has a side surface 50c and an arcuate surface 50d. The diameter of surface 50d is very slightly less than the diameter of bore 33c. Mounted around a shoulder screw 53 in each hole is a spring 54 and each screw is connected to the bottom of the body wall recess by threads 55.

To utilize the connector of this invention and connect the male and female members, as shown in Figure 2, the male member 23 is connected to the lower end of the equipment to be connected to the wellhead and the female member 26 is connected to the wellhead. If desirable, this connector may be inverted and the male member attached to the wellhead. It should be obvious that the connector of this invention is useful to connect pipes, cylindrical shapes and the like, and is operable in air or under

water in any attitude. After connecting the male member, equipment with male member is lowered into guide 45. Pressure is then applied from the remote pressure source through the conduit and inlet 36 to act on the annular sealed area between seals 34 and 35. Sufficient pressure on this area will move sleeves 33 and 39 downwardly, compressing spring 37, until lock sleeve shoulder 39f contacts body shoulder 28c and recess 39d is beside dogs 43, as shown in Figure 4. As the male member is lowered further, camming surface 23a may contact surface 43a on lugs 43 and move the lugs out into lock sleeve recess 39d, clearing the way for male member seals 25 to travel down and sealingly engage body seal bore 28b, and position groove 24 inside the lugs.

Now, pressure at inlet 36 is reduced until spring 37 moves sleeves 33 and 39 upwardly until lock sleeve surface 39e contacts dog surface 43b and cams lugs 43 radially in from recess 39d and into engagement with male member groove 24. On continued upward movement of sleeve 39, bore 39b moves up over the lugs, locking them engaged in groove 24, and the male and female connector members connected. If desired, pressure may now be applied through inlet 42 to act on the sealed annular area between seals 35 and 41 to prevent any downward movement of sleeves 39 and 33 and retain the connector connected and locked connected.

To unlock and disconnect the connector of this invention, when there is no pressure in body bore 28a, pressure in inlet

36 is increased sufficiently to compress spring 37 and move sleeves 33 and 39 downwardly until lock sleeve recess 39d is outside lugs 43. At that time, male member 23 may be lifted disengaging seals 25 from body bore 28b, until groove cam surface 24a contacts lug surface 43c. Further upward movement of the male member will cam lugs 43 into lock recess 39d, as shown in Figure 4 and permit the male member 23 to be freely lifted and disconnected from female member 26.

When there is about 100 psi (7.03 kg per sq. cm) or more pressure in body bore 28a, the connector cannot be unlocked and disconnected even if pressure is increased in inlet 36 to move sleeves 33 and 39 downward to unlock the connector. Pressure in bore 28a acts through flow passage 47a on the area sealed by seal 52 and urges piston 51 and sleeve stop 50 to move out of the body wall recess and compress springs 54. A pressure of about 100 psi or more in bore 28a is sufficient to move the sleeve stop outwardly until stop surface 50d contacts sleeve bore 33c, as shown in Figure 5. After sleeve shoulder 33d contacts stop surface 50c, no further downward movement of sleeves 33 and 39 may occur even if pressure is applied in inlet 36 and the connector cannot be unlocked and disconnected until pressure in bore 28a is reduced to below about 100 psi, and springs 54 move piston 51 and stop 50 back into the body wall recess, disengaging shoulder 33d and surface 50, and allowing sleeve bore 33a to be moved downwardly over sleeve stop 50.

Reference is made to our UK patent application 8811536 (Pub. No. 2205598) which has been divided from this specification. There is described and claimed in UK patent specification 2205598 a system and method for conducting wireline operations in an underwater well.



CLAIMS

1. A remotely operable connector comprising:
 - a. a male tubular connector member having resilient seals and an exterior groove thereon; and
 - b. female connector means telescopically and sealingly engageable with said male connector member, including latch means for securely engaging said female connector means in said male member ~~the~~ exterior groove, and connecting said male member to said female connector means, pressure responsive locking and release means biased toward locked position, for locking said latch means securely engaged and for releasing said latch means, and connector lock means, housed in the female connector means wall, responsive to pressure in the female connector for preventing release of the locking and release means.
2. The connector according to Claim 1 including remote pressure source means connected to the locking and release means for remote operation of said means.
3. The connector according to Claim 1 or 2 wherein the female connector means comprises :
 - a. a body, having a bore therethrough, an external shoulder thereon and openings therein, and
 - b. a lug mounted for radial movement in each opening.
4. The connector according to Claim 3 wherein the body has a frusto-conical guide on one end.



5. The connector according to any preceding Claim wherein the lock and release means comprises:

a. a longitudinally movable sleeve mounted on the female connector latch body in sealing engagement therewith and defining a first pressure chamber on one side of the female connector body shoulder having an inlet therein, and a second pressure chamber on the other side of the female connector body shoulder having an inlet therein, and

b. a spring disposed around said body in said second pressure chamber.

6. The connector according to Claim 5 when dependent on either Claim 2 or Claims 3 or 4 when dependent on Claim 2 wherein the remote pressure source is connected to the first and second pressure chamber inlets for selective introduction of pressure in said inlets.

7. A connector according to any preceding Claim wherein the connector lock means comprise:

a. an exterior recess in the female connector body wall;

b. a lock body, having holes therethrough and a blind hole therein, mounted for radial movement in said recess;

c. a shouldered fastener, disposed in each of said lock body through holes and fastened in said recess;



- d. a spring, disposed around each fastener biasing said lock body inwardly;
 - e. a piston rod, disposed in said lock body blind hole, fastened in said recess and having a hole therethrough communicating with the female connector body bore; and
 - f. a closed end piston sealingly and slidably engaged over said rod and slidably disposed in said lock body blind hole.
8. A remotely operable connector comprising:
- a. a male tubular connector member having resilient seals and an exterior groove thereon;



- b. a female connector, which telescopes over and sealingly engages said male connector, including:
- a body having a bore therethrough, an external shoulder thereon and openings therein,
 - a lug mounted for radial movement in each opening,
 - a longitudinally moveable sleeve mounted on said body in sealing engagement therewith to define a first pressure chamber having an inlet on one side of said body shoulder and a second pressure chamber having an inlet on the other side of said body shoulder, said sleeve biased to an extended position locking said lugs securely connected in said male connector groove, said sleeve being pressure lockable in said extended position on introduction of pressure into said second pressure chamber and said sleeve being movable to a contracted position releasing said lugs from said male connector groove by introducing pressure into said first chamber sufficient to overcome said sleeve bias,
 - a pressure responsive connector lock, housed in said female body wall and responsive to pressure



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in said body bore, for preventing said sleeve from being moved to said contracted position including,
an exterior recess in said body wall,
a lock body, mounted for radial movement in said recess and having holes therethrough and a blind hole therein,
a shouldered fastener, disposed in each of said lock body through holes, and fastened in said recess,
a spring disposed around each fastener, biasing said lock body inwardly not preventing movement of said sleeve to said contracted position,
a piston rod, disposed in said lock body blind hole, fastened in said recess and having a hole therethrough communicating with said female body bore, and
a closed end piston sealingly and slidably disposed over said rod and slidably disposed in said lock body blind hole.

9. The connector of claim 8 including a remote pressure source connected to the first and second pressure chamber inlets for selective introduction of pressure into said pressure chambers.



10. A remotely operable connector comprising:
- a. a male tubular connector member having resilient seals and an exterior groove thereon;
 - b. female connector means telescopically and sealingly engageable with said male connector including,
 - latch means for securely engaging said female connector means in said male member exterior groove and connecting said male member to said female connector means,
 - pressure responsive locking and release means, biased toward locked position, for locking said latch means securely engaged and for releasing said latch means,
 - connector lock means, responsive to pressure in said female connector means, for preventing release of said locking and release means; and
 - c. remote pressure source means connected to the locking and release means for remote operation of said female connector means.
11. A remotely operable connector substantially as described herein with reference to and as illustrated in the accompanying drawings.