

June 20, 1944.

H. V. STEADMAN

2,351,887

POWER ACTUATED SPIDER AND SLIPS

Filed May 10, 1943

2 Sheets-Sheet 1

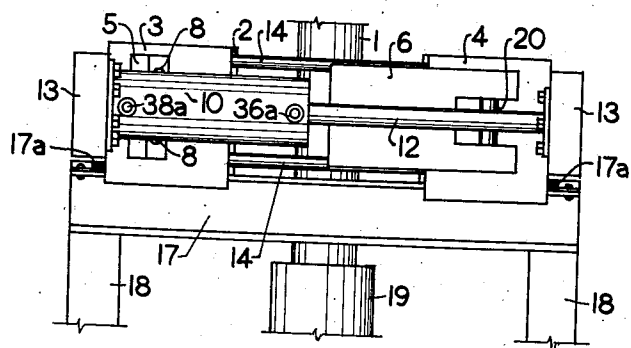
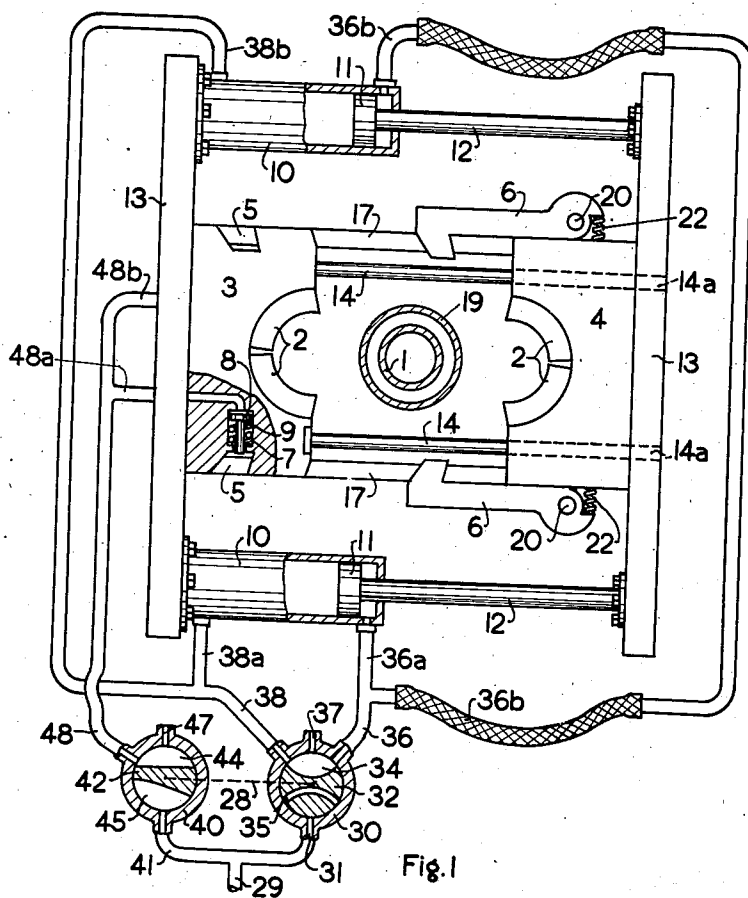


Fig. 2

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2 Sheets-Sheet 2

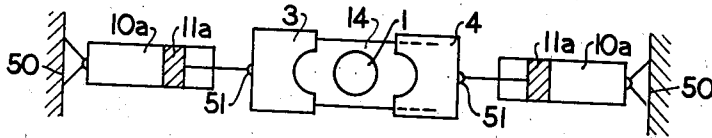


Fig. 3

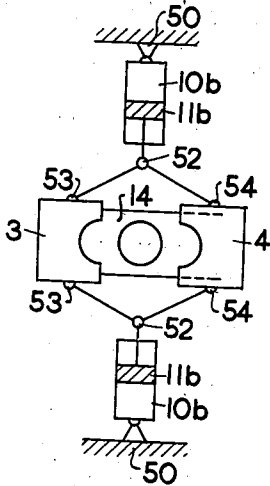


Fig. 4

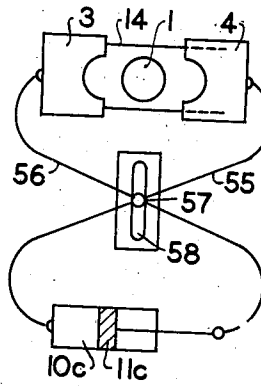


Fig. 5

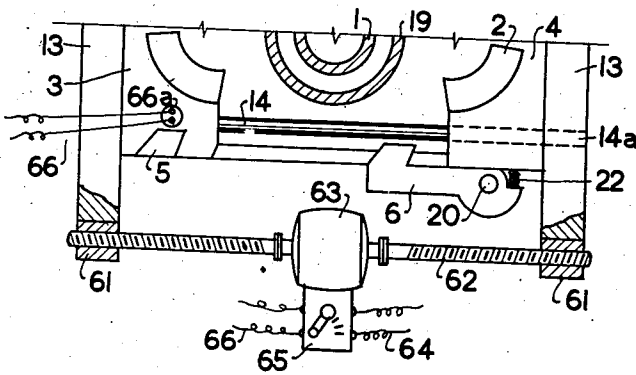
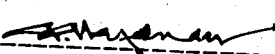


Fig. 6

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UNITED STATES PATENT OFFICE

2,351,887

POWER-ACTUATED SPIDER AND SLIPS

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4 Claims. (Cl. 255-23)

The present invention relates to apparatus for drilling wells by the rotary method, and pertains more specifically to a power-operated spider and slips arrangement for supporting tubular strings in a well while connecting and disconnecting said strings.

In drilling wells by the rotary method, drill pipe is used as a means of transmitting power to rotate the drill bit. Drill pipe is manufactured in joints or lengths varying from 25 to 40 feet. As the well is drilled deeper, joints or stands of drill pipe are progressively added to those already in the hole, and the drilling is continued. Frequently, the drilling bit becomes worn to a point where it must be replaced, in which event the whole drill string must be withdrawn and then lowered again into the well with the new bit attached thereto. Withdrawing and installing drill strings necessitates several operations, one of which is supporting the drill pipe left in the hole while further joints or stands are removed or added. This is usually effected by means of slips used in conjunction with a spider, which may be the rotary table itself or some other confining or supporting means for said slips. The slips engage and wedge the drill pipe in such a manner as to prevent its slippage down the well. In this method of supporting the drill pipe, the slips or wedges are manually removed from the bowl of the spider during pulling or lowering operations, and are manually inserted into the bowl again when it is desired to hold the drill pipe. This manual removal and replacement of the slips is a relatively difficult and fatiguing operation which necessitates the employment of additional manpower on the rig, and also increases drilling hazards because of the unavoidable lack of coordination between members of the crew operating the hoisting mechanism and those actually handling the slips.

It is, therefore, an object of this invention to provide a mechanism for engaging and disengaging the slips from the drill pipe by the employment of power, the application of which is at all times under the control of the driller or hoist operator.

It is also an object of this invention to provide a structure for supporting a tubular string depending into a well, such as a drill string, tubing string or casing string, by means of slips affixed to a completely split spider, and adapted to be reciprocated into and out of engagement with said string by power driven motion solely in a horizontal plane.

It is also an object of this invention to provide

for the above purpose a split spider and slips structure adapted to be positively locked about a tubular string with the slips in gripping engagement with said string.

It is also an object of this invention to provide synchronized control means for actuating said split spider and for releasing it from a locked position by the application thereto of power from a single source of supply.

These and other objects of this invention will be understood from the following description taken with reference to the attached drawings, wherein:

Fig. 1 is a plan view, partly in cross-section, of the present split spider and slips structure;

Fig. 2 is an elevation view of the structure of Fig. 1 with the control valves removed;

Figs. 3, 4 and 5 are diagrammatic views of different arrangements of the elements of Fig. 1;

Fig. 6 is a plan view, cut along the center line, of another embodiment of the structure of Fig. 1.

Figs. 1 and 2 show the mechanism of the present invention, which in general is arranged symmetrically or co-axially about the surface pipe 19 and the drill pipe 1, and may be positioned either below or above the rotary table, not shown in the drawings.

A set of rails or horizontal beams 17, which may be supported either directly on the surface pipe 19, or, as seen from Fig. 2, on special supports 18, provide a base or frame on which slip holders 3 and 4, which are the two members forming in combination the split spider of the present invention, are adapted to slide in a horizontal plane, bumper blocks 17a being used for cushioning effect when opening the spider, as will be described hereinbelow.

The slip holders 3 and 4 have attached thereto the slips 2, adapted to grip the pipe 1 when the slip holders are drawn together. Instead of the two slip holders and four slips shown in the drawings, any desired number thereof can obviously be used. The slips are attached to the slip holders by any desired means, such, for example, as pin and spring arrangements, which give them a certain degree of freedom in both the vertical and the horizontal direction, and permit a firm gripping engagement with the tubing or drill pipe 1.

One of the slip holders is equipped with latches 6, pivoted on pinions 20, and normally tensioned as shown in the drawings by means of springs 22.

The other slip holder is equipped with notches 5, adapted to receive and to hold the latches 6.

The slip holder 3 is provided with cylinders or wells 7, of which only one is shown in cross-section in Fig. 1, in which plungers or pistons 8 are held in a retracted position by means of springs 9, said plungers being adapted to extrude into the notches 5 by the application of fluid pressure, thereby disengaging the latches 6, as will be explained hereinafter.

Means for reciprocating the slip holders 3 and 4 with regard to each other comprise cylinders 10 which are rigidly connected with one of the slip holders by means such, for example, as a bar 13, and piston rods 12 and pistons 11, fitting within said cylinders and rigidly connected to the other slip holder, whereby the slip holders together with the slips carried thereby may be actuated to slide toward or away from each other along the rails 17 by the admission of steam, compressed air or any other suitable pressure gas or liquid to the proper side of the pistons 11 in the cylinders 10.

In order to insure a satisfactory alignment and engagement of the slip holders 3 and 4 with each other, there are provided a plurality of guide rods 14, which are fixedly attached to one of the slip holders, for example, slip holder 3 and are adapted to fit slidably within a passage provided in the other slip holder to receive them, as shown in dotted lines at 14a in Fig. 1.

A control system for actuating the above mechanism comprises the multi-port valves 40 and 30 and the necessary pipe conduits for admitting the operating pressure fluid to the cylinders 10 and 7, respectively. The valves 30 and 40 may be compounded or synchronized by linking means diagrammatically shown by the dotted line 28 in such a manner as to be operable as a single control.

The valve for actuating the cylinders 10 comprises a body 30, a core 32, and a handle, not shown in the drawings, whereby it may be switched to a desired operating position. The body 30 has four openings: a power inlet 31 in communication, through pipe 29, with a source of high pressure fluid, such as steam, compressed gas or air, oil or any other liquid under pressure; two power outlets 38 and 36 in communication, through pipes 38a, 38b and 36a, 36b, respectively, with the cylinders 10 on either side of the pistons 11, and an exhaust outlet 37. The valve core 32 consists of a rotatable block fitting accurately within the valve body to form an effective seal against the operating pressures. The core has formed therein passages 34 and 35, as shown in the drawings.

The valve for actuating the cylinders 7 comprises a body 40 and a core 42. The body 40 has three openings: a power inlet 41, a power outlet 48, in communication, through pipes 48a and 48b with the latch-releasing cylinders 7, and an exhaust outlet 47. The core 42 has a power passage 45 and an exhaust passage 44, which are shaped somewhat differently from those of the core 32 because of the difference in the number and arrangement of the valve inlets and outlets, as shown in Fig. 1.

The positions of the openings in the valve bodies 30 and 40, and the shape of the passages in their cores are selected so as to adapt the cores of said valves to be rigidly attached to each other by means such as a link 28 for purposes of operation by a single handle. In this manner, the valves 30 and 40 may be actuated together by a

single motion of the operating handle 30 as to cause the mechanism comprising the cylinder and pistons 10 and 11, the cylinders and pistons 7 and 8 and the springs 9 to operate in desired synchronism or time sequence by the application thereto of a desired pressure fluid.

In operation, assuming that it is desired to remove the drill pipe 1 from the well, this may be effected in well-known manner by conventional hoisting means with the present mechanism in the position shown in Fig. 1.

When the desired length or stand of pipe has been hoisted, the valve 30 is switched, by counter-clockwise rotation, to a position where the passage 35 is in register between the power inlet 31 and power outlet 36, leading to the right-hand side of the pistons 11. The left-hand side of the pistons 11 being still open to atmosphere through pipes 38, passage 34 and exhaust outlet 37, the cylinders 10 and pistons 11 move with regard to each other to contract the slip holders 3 and 4 together. In the valve 40, the core 42 rotates together with the core 32, but the power inlet 41 is still shut off and the cylinders 7 are still open to exhaust 47 through passage 44, so that said plungers 8 remain inoperative in their recessed position during this phase of the operations.

When the slip holders 3 and 4 have slid to the extremity of their inward stroke on rails 17, thereby causing the slips 2 to grip pipe 1, the latches 6 engage with the notches 5, thereby firmly connecting the slip holders 3 and 4 against outward movement.

Upon engagement of the latches 6 with the notches 5, the hoisting mechanism is released, the weight of the pipe string being now supported solely by the slips 2.

The length or stand of pipe that had previously been raised from the well by the hoisting mechanism is now unscrewed and separated from the pipe string remaining in the well, and the hoisting mechanism is engaged with the next uppermost stand of pipe. A pull is taken on the hoisting mechanism in the usual manner, and the compounded valve cores 42 and 32 are set, by clockwise rotation, so that, in proper sequence, pipe 48 is put in communication with the power inlet 41, through passage 45, the pipe 36 is put in communication with the exhaust 37, and pipe 38 is put in communication with power inlet 31.

Pressure fluid is therefore admitted, through pipes 48a and 48b, to the cylinders 7, driving plungers 8 outwardly against the action of the springs 9, and disengaging the notches 5 and latches 6 from each other. Simultaneously, the pressure fluid is exhausted from the right-hand side of the pistons 11 through pipes 38a, 38b and 37. Pressure fluid is then admitted to the left-hand side of the pistons 11, causing the slip holders 3 and 4 to slide away from each other to their extreme position in contact with cushion blocks 17a (Fig. 2). The valves may then be set to a neutral position, shown in Fig. 1, preliminary to repeating the cycle of operations described above.

It is understood that the particular arrangement of parts necessary to actuate the present spider and slips mechanism, such as cylinders 10, valves 40 and 30, etc., has been described and illustrated above only by way of example, and that any other arrangement or structural modification thereof capable of achieving the objects of this invention may equally well be used. Some of these modifications are illustrated in Figs. 3, 4 and 5, wherein diagrammatically shown ele-

ments similar to those of Figs. 1 and 2, but differing therefrom in arrangement, are indicated by the same numerals, while elements in all points identical to those of Figs. 1 and 2 are omitted for clarity.

The arrangement of Fig. 3 is similar to that of Figs. 1 and 2, except that the cylinders 10a are positioned along a single axial line instead of being placed in parallel, and are fixedly attached to the derrick or other suitable anchoring point, as shown at 50, whereby only the pistons 11a, attached to the slip holders by pins 51, form the moving elements of the mechanism.

The arrangement of Fig. 4 likewise comprises stationary cylinders 10b adapted to actuate the slip holders to and from each other by means of the pistons 11b and a toggle linkage comprising pivots 52, 53 and 54.

The arrangement of Fig. 5 permits the employment of a single cylinder 10c connected to the slip holder 4 by means of a rigid tong arm 55, while the piston 11c is connected to the other slip holder 3 by a tong arm 56. Both tong arms are pivoted around a common pin 57, slidably mounted in a fixed slot 58. It will be seen that in the embodiment of Fig. 5, as in that of Figs. 1 and 2, both the cylinder and the piston move with regard to each other, while in the embodiments of Figs. 3 and 4, only the piston moves with regard to the cylinder.

Although the present system has been described above as actuated by the application of a pressure fluid involving the use of cylinders 10 and pistons 11, it is obvious that the reciprocation of the slip holders may be effected by means involving the use of any other prime-movers, for example, by manual operation, steam turbines, internal combustion engines or electric motors, as illustrated in Fig. 6.

In the embodiment of Fig. 6, which shows only half of the present spider and slips system, the members 13 have attached thereto, instead of the cylinder 10 and piston 11, nut members 61, adapted to engage a rotating screw 62, actuated by an electric motor 63. The screw 62 is provided with right-hand threads on one side of the motor 63, and with left-hand threads on the other side thereof, whereby the rotation of the motor 63 in one direction causes the slip holders 3 and 4 to move toward each other, while its rotation in the other direction causes them to move away from each other. The motor 63 receives electric power from any suitable supply line by means of connections 64, and its direction of rotation may be reversed by means of the control mechanism indicated at 65. The latch-disengaging pistons 8 of Fig. 1 may in this case be replaced by electromagnetic relay coils operated from the same source of supply through connections shown at 66 and 66a, and automatically energized by the operation of the control 65 upon stopping or reversing the motor 63, in a manner well understood by electrical engineers.

I claim as my invention:

1. In a structure adapted to support from the surface a tubular string depending into a well, a

split spider comprising two members adapted to reciprocate with regard to each other in a horizontal plane, slips carried by said members, latching means carried by said members, said slips being adapted to engage and support said tubular string and said latching means being adapted to lock said members with each other upon the completion of a stroke bringing said members together, release means for disengaging said latching means, and prime mover means for reciprocating said members.

2. In a structure adapted to support from the surface a tubular string depending into a well, a split spider comprising two members adapted to reciprocate with regard to each other in a horizontal plane, slips carried by said members, latching means carried by said members, said slips being adapted to engage and support said tubular string and said latching means being adapted to lock said members with each other upon the completion of a stroke bringing said members together, release means for disengaging said latching means, prime mover means for reciprocating said members, and synchronized control means for supplying power from a single source to said release means and said prime mover means.

3. In a structure adapted to support a tubular string depending into a well, a supporting frame surrounding said string at the surface, a split spider comprising two members adapted to reciprocate with regard to each other in a horizontal plane on said frame at opposite sides of said string, guide means for said members fixedly connected with one of said members and slidably connected with the other member, slips carried by said members, latching means carried by said members, said slips being adapted to engage and support said tubular string and said latching means being adapted to lock said members with each other upon the completion of a stroke bringing said members together, release means for disengaging said latching means, prime mover means for reciprocating said members, and synchronized control means for supplying power from a single source to said release means and said prime mover means.

4. In a structure adapted to support from the surface a tubular string depending into a well, a split spider comprising two members adapted to reciprocate with regard to each other in a horizontal plane, slips carried by said members, latching means carried by said members, said slips being adapted to engage and support said tubular string and said latching means being adapted to lock said members with each other upon the completion of a stroke bringing said members together, plunger means for releasing said latching means, prime mover means comprising cylinder means attached to one of said members and piston means attached to the other member for reciprocating said members with regard to each other, and control valve means for actuating said release and said prime mover means by admitting thereto a pressure fluid.

HORACE V. STEADMAN.