WELL DRILLING APPARATUS

BACKGROUND OF THE INVENTION

In conventional rotary drilling, a power-driven rotary table operating through a so-called "Kelley joint" connected to the upper end of the drill pipe string is employed for rotating the drill string and high-powered drawworks systems, including derricks with multiple-strand, cable-connected crown and travelling blocks, are employed for running the drill string into and out of the well and for otherwise performing drilling and pipe handling operations. Conventionally, the rotary table and the drawworks and the power units for driving and operating the same constitute massive, relatively complicated and expensive structures, particularly those designed for deep drilling.

The present invention is directed to a relatively simple, compact structure comprising fluid pressure-operated, preferably hydraulic, elements for performing both the drilling and pipe-running functions of more conventional rotary rigs.

In accordance with the present invention, an improved form of hydraulic snubbing device is provided comprising a stationary lower snubbing member or head and an upper snubbing member or head which is both vertically reciprocable and rotatable relative to the lower head, the snubbing heads cooperating with a pipe string to perform the rotary drilling functions and the running of the pipe string into and out of the well. Each of the snubbing heads includes sets of vertically reciprocable pipe-gripping wedges or slips and angularly rockable, cam-actuated gripping shoes for applying torsional forces to the pipe string for use both in rotating the pipe string for drilling and when making and breaking the threaded pipe joints as when adding joints to the drilling string and when running the string into and out of the well.

All the principal elements of the device are designed for fluid pressure, preferably hydraulic pressure, operation.

The structure in accordance with this invention is thus very compact, low in cost, easily transportable, simple in operation, and readily adaptable for drilling to any desired depth. The structure requires only a relatively simple, low capacity derrick or mast in conjunction therewith, since the major functions of such derrick or mast will be to support relatively low weight elements such as the mud swivel and hose and at most, only a few sections of pipe, since the main load of the pipe string both in drilling and in running into and out of the well will be taken by the snubber heads, as will appear hereinafter.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates one useful embodiment in accordance with this invention.

In the drawing:

FIG. 1 is a view partly in elevation and partly in section of the snubber device showing the upper snubbing member in gripping engagement with the drilling string and the lower snubbing member in released position;

FIG. 2 is a view similar to FIG. 1 but showing both snubbing members in gripping engagement with the drilling string;

FIGS. 3 and 4 are cross-sectional views taken respectively on lines 3—3 and 4—4 of FIG. 1;

FIGS. 5, 6 and 7 are cross-sectional views taken respectively on lines 5—5, 6—6 and 7—7 of FIG. 2;

FIG. 8 is a detail view taken on line 8—8 of FIG. 1;

FIG. 9 is a cross-sectional view taken on line 9—9 of FIG. 1; and

FIG. 10 is a cross-sectional view taken on line 10—10 of FIG. 1.

Referring to the drawing, the snubber device is shown mounted on a base plate 10 which is generally U-shaped (FIG. 9) and is ordinarily appropriately mounted on a longitudinally slotted skid S enabling the structure to be moved laterally into place about the upper end of a well W. A plurality of hydraulic jacks, designated generally by the letters J, four in number in the illustrative embodiment, are mounted in upright position on base plate 10 and spaced to define the corners of a square. Each of the jacks comprises a cylinder 11 and a suitably sealed piston 12 slidably mounted for reciprocation in the cylinders between pressure fluid connections 13 and 14 which serve alternately as inlet and discharge conduits for the pressure fluid employed for reciprocating the pistons. The pistons are connected to elongate piston rods 15 which extend upwardly through stuffing boxes 16. The upper ends of the piston rods are suitably connected to a transverse crosshead plate 17 which supports an upper snubbing head, designated generally by the letter H_1, for vertical reciprocating with the crosshead plate.

A lower crosshead plate 18 extends transversely between the cylinders 11 at a suitable elevation above base plate 10 and is fixedly secured to the cylinders. Crosshead plate 18 supports a stationary lower snubbing head, designated generally by the letter H_2.

A top plate 19 is supported above crosshead plate 17 on the upper end of a ring-shaped wall 20 which is seated about a peripheral shoulder 21 on plate 17 and has its upper end secured by bolts 22 to the rim of top plate 19.

The snubbing heads H_1 and H_2 are generally similar in construction, the same or corresponding parts bearing the same numerals. Snubbing head H_1 includes additional structure for positively rotating the same and the parts therefor will be appropriately designated as the description proceeds.

Each snubbing head comprises a tubular housing 23 carrying on its lower end an off-set flange 24 which is received in the upper end of a housing extension 23a and secured thereto by bolts 24a. In the case of upper snubbing head H_1, the housing is mounted for rotation in coaxial openings 25 and 26 in top plates 19 and in crosshead plate 17, respectively. In the case of lower snubbing head H_2, the housing extends through a central opening 27*a* in lower crosshead plate 18 and is fixedly secured thereto by means of a bolted flange 28. A rotary bushing 29, having a downwardly and inwardly tapering frusto-conical bore 30, is mounted in housing 23 for relative rotation on bearings 27 and is provided about its exterior with an annular groove 31 adapted to receive the inner ends of guide pins 32 (FIG. 5) which are screwed through the wall of housing 23 to effectively guide relative rotation between the latter and bushing 29. The lower end of the latter carries a downwardly extending annular flange 33 keyed to a