United States Patent

[11] **3,579,752**

[72] Inventor **Cicero C. Brown**
5429 Sturbridge Drive, Houston, Tex. 77027

[21] Appl. No. **26,841**
[22] Filed **Apr. 9, 1970**
[45] Patented **May 25, 1971**

[54] **AUTOMATIC ROTARY SLIPS**
7 Claims, 8 Drawing Figs.

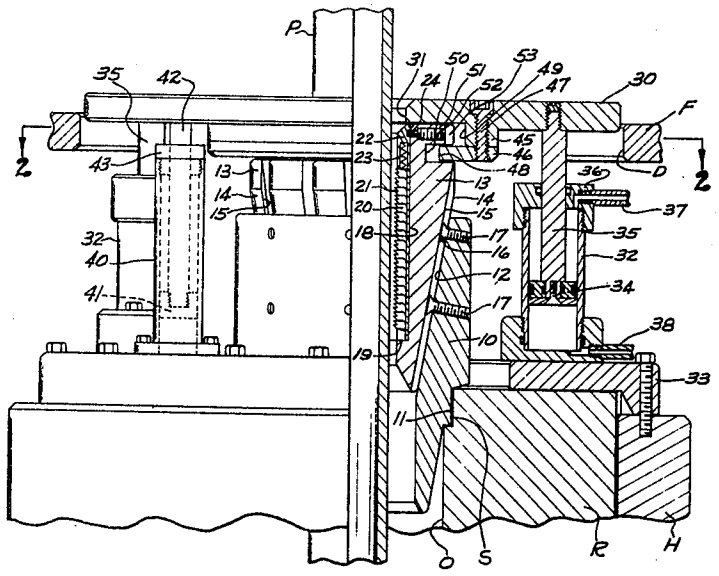
[52] **U.S. Cl.** **24/263**
[51] **Int. Cl.** **F16l 7/00**
[50] **Field of Search** ..... 24/263 (D), 263 (DK), 263 (DM), 263 (DS), 263 (DA), 263 (DN), 263 (DT), 263 (DS), 263 (DQ)

[56] **References Cited**
UNITED STATES PATENTS

1,817,467	8/1931	Thompson	24/263.5AUX
2,231,923	2/1941	Koen	24/263.5TUX
2,288,851	7/1942	Sharp	24/263.5T
2,698,734	1/1955	Tremolada et al.	24/263.5SAA
2,736,941	3/1956	Mullinix	24/263.5SAA
3,076,245	2/1963	Acker	24/263.5A

Primary Examiner—Donald A. Griffin
Attorney—R. Werlin

ABSTRACT: Automatic slips mountable in a rotary table for gripping and releasing drill pipe or casing being run through the table and for rotating the pipe when desired. The mechanism includes a slip spider which is raised and lowered by fluid pressure operated pistons and is held in a balanced position by telescopic supports mounted on the rotary table housing in a symmetrical arrangement about the pistons.



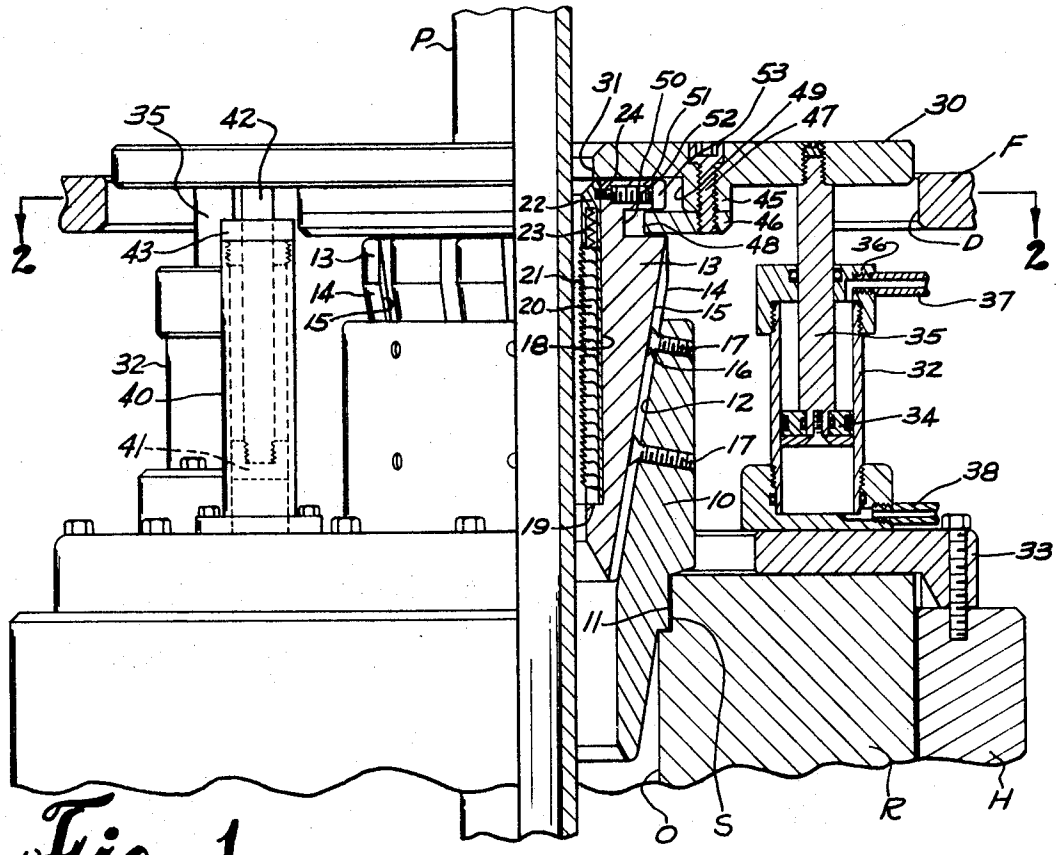


Fig. 1

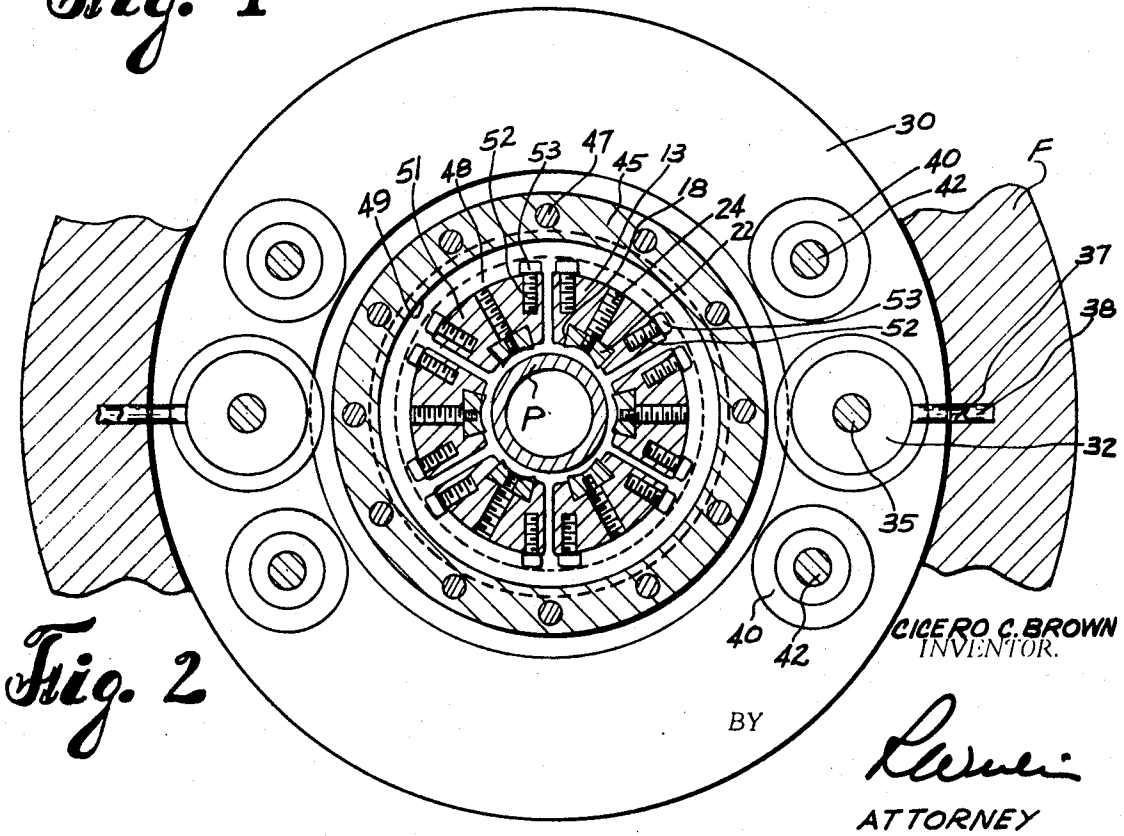


Fig. 2

CICERO C. BROWN
INVENTOR.

BY

ATTORNEY

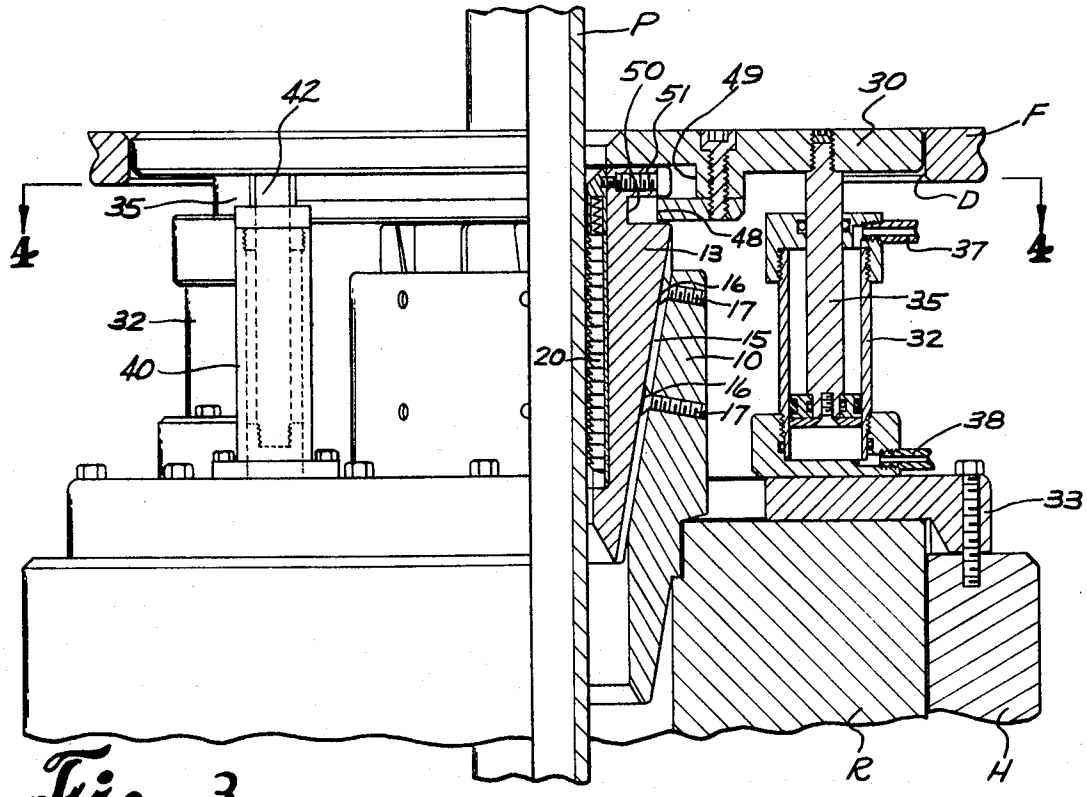


Fig. 3

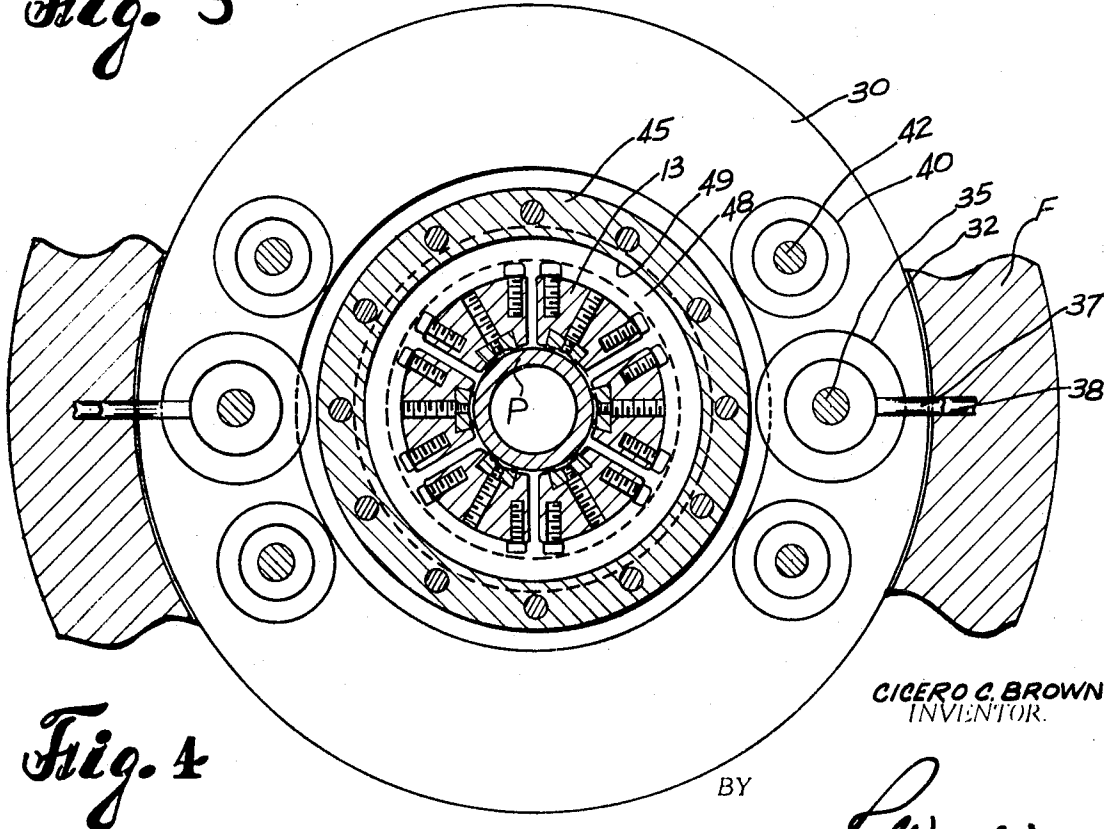


Fig. 4

CICERO C. BROWN
INVENTOR.

BY

ATTORNEY

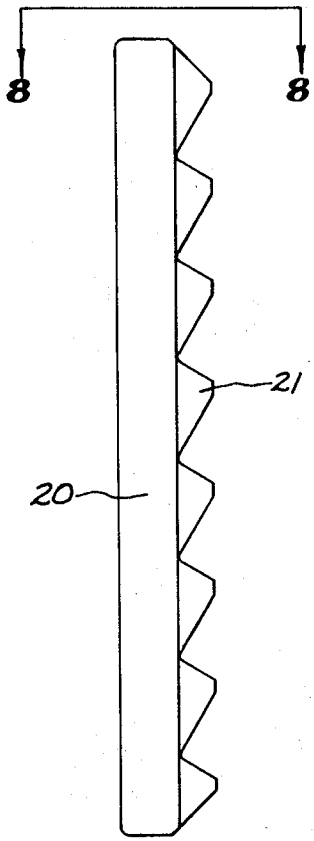


Fig. 5

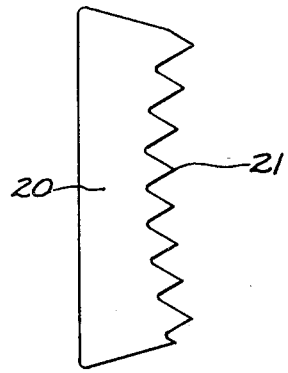


Fig. 8

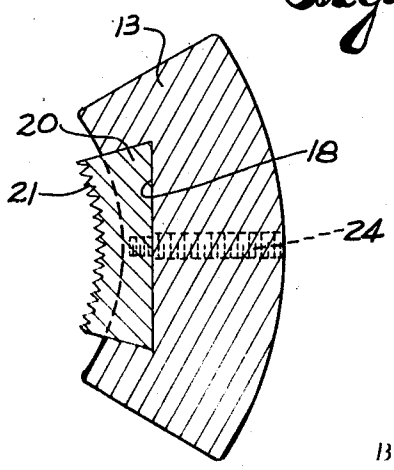


Fig. 7

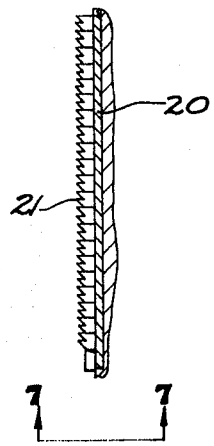


Fig. 6

CICERO C. BROWN
INVENTOR

BY

ATTORNEY

AUTOMATIC ROTARY SLIPS

Conventional so-called automatic rotary slips are commonly designed for use with a rotary table primarily to grip drill pipe as it is being run into and out of the well. The slips are designed primarily to hold the portion of the pipe string extending downwardly from just above the rotary table, while joints of pipe are added to or removed from the string. While such conventional slips are occasionally employed to rotate the pipe string, they are designed primarily to function as backup wrenches to hold the lower portion of the pipe string stationary while pipe sections are screwed into or broken out of the pipe string, depending on whether the pipe string is being run into or out of the well.

Earlier automatic slips or slip lifters also generally employ a lifter arm supported outboard of the rotary table providing an unbalanced arrangement, together with rather complicated pivoted linkages between the slips and the slip spider all of which create sources of breakage and operating difficulties under the heavy loads frequently involved and particularly when it is sought to rotate the pipe.

In accordance with the present invention automatic rotary slips are provided which obviate the undesirable features of earlier designs, such as those noted above, and which are especially adapted for effectively rotating a drill pipe or casing string in a well.

In a preferred embodiment, the present invention contemplates the combination of a slip bowl which is adapted to be nonrotatively seated in the master bushing of a rotary table; a set of slips slidably keyed to the inner surface of the slip bowl to permit rotation therewith while allowing the slips to be radially retracted and advanced while moving downwardly and upwardly in the slip bowl; a lifting ring or a spider mounted on a symmetrical arrangement of fluid pressure actuated lifting pistons and stabilizing pistons supported from the rotary table housing to assure level support for the spider at all positions while raising and lowering the slips. A simple sliding tongue-and-notch connection is provided between the slip spider and the slips to accommodate the radial movement of the slips when being moved into and out of pipe-gripping positions by the spider. This arrangement requires minimum vertical movement of the slips between gripping and release positions. The slips are provided with pipe-gripping teeth of specialized form adapted particularly for applying rotational torque to the pipe.

Various other 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 a preferred embodiment in accordance with this invention.

In the drawing:

FIG. 1 is an elevational view, partly in section, showing the slips in retracted nongripping relation to a pipe extending through the rotary table;

FIG. 2 is a cross-sectional view taken on line 2–2 of FIG. 1;

FIG. 3 is a view similar to FIG. 1 showing the slips in pipe-gripping position;

FIG. 4 is a cross-sectional view taken on line 4–4 of FIG. 3; and,

FIGS. 5, 6, 7, and 8 illustrate details of the teeth elements of the slips.

Referring to the drawing, there is shown the upper end of a conventional rotary table R enclosed by a stationary housing H, which forms the support for the automatic slip mechanism of this invention. The rotary table is provided with a central opening 0, the upper end of which is formed to provide the usual square or polygonal seat S commonly employed to receive the master of kelley bushing.

The automatic slip mechanism includes a slip bowl **10** insertable into opening O and provided externally about its lower portion with a square or polygonal section **11** shaped to fit into seat S so that bowl **10** will rotate with table R. The interior of bowl **10** is defined by a downwardly and inwardly tapering, generally conical surface **12** adapted to slidably receive a plurality of angularly spaced pipe-gripping slips **13** having conically tapered outer faces **14** complementing bowl surface **12**. Outer faces **14** are provided with longitudinally extending dovetail spline grooves **15** shaped to receive the conically tapered heads **16** of screws **17** which are screwed into inner surface **12** of the slip bowl and form male splines cooperating with grooves **15** to constrain radial movement of the slips in response to their longitudinal movement into and out of the slip bowl. These spline connections also prevent relative rotation between the slips and slip bowl and secure the slips to the slip bowl throughout their movement.

The inner face of each of the slips **13** is provided with a longitudinally extending dovetail slot **18** (FIG. 2) terminating at its lower end in a shoulder **19** and adapted to receive a plurality of correspondingly shaped dies **20** in a stacked arrangement, each die carrying specialized pipe-gripping teeth **21** in its outer face.

As best seen in FIGS. **5** to **8**, inclusive, teeth **21** are formed on the inner faces of dies **20** to provide vertical flutes having a regular V-shape in horizontal cross section (FIGS. **7** and **8**). Each of the V-shaped flutes is then machined to form a plurality of upwardly facing buttress teeth in vertical profile (FIGS. **5** and **6**). The V-shape assures the application of strong torsional force to the pipe when it is desired to rotate the pipe and also to hold the pipe when the tool is used as a backup. The upwardly facing buttress shape assures a strong grip against downward slippage of the pipe whether the tool is being used as a backup when making up or breaking out pipe sections. A spring **23** is mounted in compression between keeper plug **22** and the upper end of die **20**. Plug **22** is locked in place by means of a setscrew **24** which extends radially through the body of slip **13** adjacent its upper end and into plug **22**.

A slip spider or lifter ring **30** having a central opening **31** is horizontally disposed above the slips for vertical reciprocatory movement relative to slip bowl **10**, through an opening D in the floor F of a derrick (not shown). Raising and lowering of lift ring **30** is effected by fluid pressure operated means comprising a pair of cylinders **32–32** vertically disposed on an annular baseplate **33** mounted to housing H above rotary table R. Cylinders **32–32** are positioned on diametrically opposite sides of slip bowl **10**. Each cylinder encloses a sealed piston **34** which is secured to a piston rod **35**, the upper end of which projects through a cylinder head **36** and is rigidly secured to lifting ring **30**. Pressure fluid conduits **37** and **38** communicate with the interior of cylinder **32** on opposite sides of piston **34** to serve alternately as inlet and exhaust ports for pressure fluid, depending upon the direction in which the piston is to be moved.

Mounted on base place **33** on opposite sides of each cylinder **32** is a pair of dashpots or stabilizing cylinders **40–40**. Each of the stabilizing cylinders **40** is fitted with a piston **41** secured to a piston rod **42** which projects through an upper cylinder head or gland **43** and has its free end rigidly secured to lift ring **30**. The angular spacing between the stabilizing cylinders and the lift cylinders is made uniform to provide a symmetrical, fully balanced support for the lift ring.

The lower face of lift ring **30** is formed with a downwardly projecting annular boss **45** radially spaced from and surrounding the upper ends of slips **13**. An annular flange plate **46** is secured to the lower end of boss **45** by means of bolts **47** to provide an inwardly projecting annular lip **48** separated by a space **49** below the lower face of ring **30**. The exterior of each slip is provided adjacent its upper end with a transverse notch or groove **50** adapted to receive lip **48**, the portion **51** of the upper end of the slip above notch **50** being dimensioned to be freely received in space **49**. Lip **48** and notch **50** form a tongue-and-groove connection permitting the required radial movement of the slips in response to their longitudinal movement into and out of the slip bowl. To reduce the friction in the connection between the slips and the lift ring, particularly during rotation of the slips, portion **51** of each slip is fitted with a pair of bolts **52** which are screwed radially into the outer end face of portion **51** on opposite sides of setscrew **24**

(FIGS. 2 and 4) and carry rollers 53 on their outer ends which project into space 49 so as to ride on the upper face of lip 48.

The operation will be described in connection with a string of pipe P being run through the lifter mechanism into and out of a well. To move slips 13 from their retracted, nongripping position shown in FIG. 1, to pipe-gripping position (FIG. 3), pressure fluid, which may be either gas or liquid will be introduced through conduits 37 into both cylinders 32 above the pistons 34 forcing the latter downwardly, thereby pulling lift ring 30 downwardly. This downward movement of the lift ring will be transmitted through the tongue-and-groove connection comprising lip 48 and notch 50 to the slips which will thereby be caused to slide downwardly and inwardly along surface 14 of the slip bowl into gripping engagement with pipe P. With the pipe gripped firmly, sections may be added thereto or removed therefrom in the usual manner, the slips acting as a backup wrench as required screwing or unscrewing pipe sections whenever necessary or desirable to rotate the pipe by rotating rotary table R. In this case, the tongue-and-groove connection between the slips and the lift ring and rollers 53 provide a relatively low friction bearing between each of the slips and the stationary lift ring.

To retract the slips, pressure fluid is introduced through conduits 38 into cylinders 32 below the pistons to thereby raise the lift ring which will in turn raise the slips, causing them to radially retract from engagement with pipe P.

By the symmetrical positioning of the stabilizing cylinders, level horizontal movement of the lift ring is assured and binding of the parts due to uneven loading will be avoided.

The relatively flat tongue-and-groove connection provided between the lift ring and the slips, as described, reduces the maximum vertical movement of the slips and lifter elements to a minimum so that the entire slip assembly may be mounted below the derrick floor, with the lift ring protruding only slightly above the floor at its maximum elevation. This makes for substantially improved safety conditions for the drilling crew operating the device.

It will be understood that various modifications may be made in the details of the illustrative embodiment within the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

I claim:

1. Automatic rotary slips, comprising:
   a. a slip bowl seatable in a rotary table for rotation thereby;
   b. a stationary base disposed about said rotary table;
   c. a horizontally disposed lifting ring vertically spaced from the top of the slip bowl;
   d. fluid pressure operated means mounted on the base for vertically reciprocating said lifting ring;
   e. stabilizing means mounted on the base and connected to said lifting ring to maintain the latter in level horizontal position during its vertical reciprocation;
   f. a plurality of pipe-gripping slips disposed in the slip bowl for radial movement in response to their vertical movement; and
   g. horizontally disposed tongue-and-groove means connecting said lifting ring to the slips to effect said vertical movement thereof.

2. Automatic rotary slips according to claim 1 wherein said fluid pressure operated means comprises:
   a. a pair of vertically disposed cylinders positioned on diametrically opposite sides of said slip bowl;
   b. pistons longitudinally slidable in said cylinders and rigidly connected to said lifting ring; and
   c. pressure fluid conduits communicating with the interior of said cylinders on opposite sides of said pistons.

3. Automatic rotary slips according to claim 1 wherein said stabilizing means comprises:
   a. a pair of dashpot means disposed in symmetrically spaced relation on opposite sides of each of said fluid pressure operated means.

4. Automatic rotary slips according to claim 1 including cooperating spline means carried by said slips and slip bowl for securing said slips to said slip bowl during said radial and vertical movement.

5. Automatic rotary slips according to claim 1 wherein said tongue-and-groove means comprises:
   a. annular flange means mounted in horizontally disposed spaced relation below said lifting ring to surround the upper end portions of said slips; and
   b. horizontal grooves in the exteriors of the upper end portions of said slips to slidably receive the lip of said flange means to accommodate said radial movement of said slips responsive to the vertical movement thereof.

6. Automatic rotary slips according to claim 5 including:
   a. antifriction bearing means arranged between said upper end portions of said slips and said flange means.

7. Automatic rotary slips according to claim 1 wherein each of said pipe-gripping slips includes:
   a. a body having a longitudinally extending dovetail slot in the inner face thereof;
   b. a plurality of correspondingly shaped tooth dies mounted in said slot, the teeth on said dies being V-shaped in transverse cross section and having upwardly facing buttress shape in profile.