The present invention relates to earth boring equipment and more particularly to a so-called slips mechanism, that is to say, a mechanism for gripping a drill pipe to support the weight of a drill pipe string.

In conventional drilling rigs it is usual to provide a mechanism known as "the slips" which incorporates a plurality of wedge members which engage upon a drill pipe and can be used to support the weight of the drill pipe string at various times, for example, while a "stand" of pipes is being removed from the string, or attached to it, during pulling out or running in. In U.S. Patent application Serial No. 33,158 filed June 1, 1960, there are described equipments for mechanically handling strings of drill pipe when withdrawing the string from a bore hole and automatically dismantling from the string the individual drill pipes as they emerge from the hole.

The equipments are reversible and may be used to assemble pipes into a string as the string is run back into the bore hole. In these equipments mechanisms of the nature of slips are also used on the lifts by which the drill pipe string is raised and lowered and these may be regarded as replacing the pipe grip carried on the pulling cable provided in the conventional rig. In the equipments shown in detail in the above applications the pipe engaging mechanisms are required to pass one another and to this end they are made divisible into two separate halves, but modifications are suggested in which the lifts operate over separate strokes, one above the other, so that the pipe engaging mechanisms do not have to pass one another. It is, in such circumstances, possible to provide slips mechanisms of a generally annular and indivisible form through which the pipe is threaded.

This means that the slips mechanism can be differently designed and the present invention is directed primarily to slips mechanism for use in such equipments. The slips mechanism according to this invention are, therefore, of a kind which are permanently threaded on the drill pipe string, and moreover are of a kind which can be readily arranged to operate automatically in rhythm with the operation of an automatic equipment.

According to a feature of the invention the wedge members may be mounted on the backing members on links permitting movement of the wedge members in directions substantially longitudinally of the above mentioned pipe passage for the introduction of a wedging action between the backing members and a pipe, jointly with engagement of abutments on a rotative ring with others on the individual backing members, to maintain the wedge members inwardly, the wedging action further tightening their grip upon the pipe string, and cams may be provided on the retaining ring adapted to operate on the wedge operating links adapted to set up said wedged action on engagement of the slips mechanism upon a pipe.

One form of slips mechanism in accordance with the invention, for gripping a drill pipe to support the weight of a drill string is illustrated by way of example in the accompanying drawings, of which:

FIGURE 1 is a perspective view of the mechanism, partly broken away to show interior details;

FIGURE 2 is a plan view of the mechanism; and

FIGURE 3 is a sectional view on the line III—III of FIGURE 2.

The body of the mechanism comprises a base plate 5 having three upstanding arms 6 equally spaced around its periphery, these arms having holes 7 in their upper ends for fastening by means of which the slips mechanism may be attached to the lift platform of an automatic drill rig. The base plate 5 is of circular form and has three equally spaced guideways 8 of dovetail form extending in generally radial directions and receiving slidably therein the three segmental bearing elements 9 of a component termed the slip bowl 10.

The slip bowl 10 is of generally circular form, but divided into the three backing elements on mating planes which subtend angles of 120° at the central axis of the mechanism. The slip bowl has a tapered inner surface 11 of frusto-conical form which is complementally engaged by wedges 12. One such wedge 12 is associated with each segmental element 9 of the slip bowl 10 and the three wedges, each being a segment with radial faces inclined at 120°, together may totally surround a pipe passing centrally through the mechanism and engage said pipe by means of friction surfaces 14 of conventional form and material.

The elements of the slip bowl 10 are outwardly contained by a confining ring 15 which turns on the base plate 5 and which is captive retained by three bearing segments 16 fixed to the respective arms 6, the bearing segments engaging a groove 17 formed in the periphery of the confining ring 15. The confining ring 15 can be turned about the central axis by a fluid pressure operated jack whose cylinder 18 is pivotally secured at 19 to an arm 21 which is integral with the base plate 5 and whose piston rod 22 is pivotally secured at 23 to a lug 24 which is formed on the upper part of the confining ring 15. The interior surface of the confining ring 15 is stepped to form three equally spaced inwardly projecting abutments 25 with intervening recesses, while each element 9 of the slip bowl is formed with an externally projecting abutment 26. When the slip bowl is rotated anticlockwise relative to the confining ring 15, so that the external projections 26 supportingly engage the internal projections 25 in one operative position of the confining ring 15, the elements 9 of the slip bowl are held together in the operative position to enable the wedges 12 to engage the drill pipe, but when the confining ring 15 is rotated anti-clockwise through its turning range with respect to FIGURE 2 by the jack 18, 22, to its other operative position, the internal projections 25 lie in intervening relationship with respect to the external projections 26 of the slip bowl whereby the elements 9 are free to slide radially in their guideways 8 away from the central axis. The elements 9 are spring-loaded outwardly by means of an enclosing spring 27 of strip form which is located by a retaining pin 28 on each element 9.

The elements 9 are arranged for inward and outward movement coordinated with rotation of the confining ring 15 by mechanism now to be described. This mechanism consists of three motion-transmitting links 29 each of which is joined at its inner end on a pivot pin 31 to the underside of an element 9. The axis of the pivot pin 31 lies in the bisecting plane between the inclined radial faces of the element 9. The outer portion of each link 29 has a longitudinal slot 32 while a pivot pin 33 which extends through the slot is attached to the confining ring 15. In the position of the links 29 as shown in FIGURE 2 the pins 33 engage the outer ends of the slots 32 to form a rotational limit stop at one end of the turning range of the confining ring 15, on extension of the jack 18, 22. When the jack is contracted the confining ring 15 will turn in an anti-clockwise sense causing the pins 33 to ride up to the stops formed by the inner ends of the slots 32 in the links 29, and simul-
taneously turning each of the latter about its corresponding pivotal joint 31 on an element 9. At the same time, each of its radial projection 25 turns out of engagement with the projection 26, each link 29 lies in a generally radial direction with the pin 33 at the inner end of the slot 32 thereby acting through the link 29 to hold the element 9 at a minimum distance from the central axis against the resilient expansive force of the spring 27.

Upon continued rotation of the ring 15, each link 29 passes over top dead centre, i.e., beyond the radial direction of the guideways 8, allowing the elements 9 to slide radially outwardly under the influence of the spring 27. The inner end of each slot 32 continues to bear against the pin 33, and the radial movement of each element 9 is therefore governed by the turning movement of the link 29 caused by rotation of the confining ring 15. At the outward end of the jack travel, i.e., when fully contracted, the confining ring 15 will have turned to allow the elements 9 to expand fully, thus leaving adequate clearance for each tool joint which is of larger diameter than the drill pipe to pass axially through the elements 9. The motions are reversed upon extension of the jack 16, 22 with the confining ring 15 acting through the links 29 to slide the elements 9 radially inward.

The links 29 hold the elements 9 closed just before the inward projections 25 of the confining ring turn to engage the outward projections 26 on the elements.

Each wedge 12 is connected to and caused to move axially relative to its associated segmental element 9 by a lever 34 whose fulcrum pin 35 is carried at offset ends in lugs 36 which extend upwardly from the element 9. The inner end of the lever has a pivot pin 38 whose ends are secured in a pair of lugs 41 which are upstanding from the wedge 12. The outer arm 42 of the lever co-operates with a cam track 43 which is formed with an incline and disposed in a position on the upper surface of the confining ring 15 to apply a downward force to the wedge 12 as the confining ring 15 is rotated towards its ultimate position in the clockwise direction in which the projecting abutments 25 provide supporting engagement for the elements 9.

The fulcrum pin 35 and pivot pin 38 are mounted in the lever 34, and preferably the lugs 36 and 41 also, by rubber bushes 39 which are preloaded torsionally to provide a resiliently acting lifting force on each wedge 12. The bushes 39 moreover accommodate a small degree of clearance imparted to the levelling levers 34 by the cams 43 to ensure positive engagement of the wedges with the drill pipe. The bushes 39 are also deformable to permit linear sliding movement of the wedges as well as accurate movement of the levers 34 connected thereto. The wedges are formed in known manner such that when engaged with the drill pipe, the grip on the pipe will increase as the downward frictional pull exerted by the pipe on the wedges increases.

When the wedges 12 no longer support the weight of the drill string they are able by virtue of the wedge angle to relax their grip sufficiently to enable the confining ring to be turned out of engagement. Therewith the wedges rise under the spring load of the rubber bushes 39 to disengage the pipe entirely, though not sufficiently to allow the tool joint to pass through. The radial movement of the elements 9 of the slip bowl with their associated wedges 12 serves the latter purpose.

I claim as my invention:

1. A slip mechanism for earth boring equipment comprising a body adapted for attachment to lift mechanism forming part of the drill rig and having a central pipe passage therein, a number of backing members disposed radially around the central axis of the pipe passage, guide means interconnecting each backing member with the body to constrain said backing members to substantially radial inward and outward movement with respect to said body, a wedge member disposed radially inwardly of each backing member by mounting means which includes co-operating wedge surfaces formed on the backing member and wedge member, a projecting abutment extending radially outwardly of each backing member, a confining ring disposed around said backing members and mounted in the body for turning movement throughout an operative range about said central axis, the internal surface of the confining ring having steps which separate inwardly projecting abutments by intervening recesses, said inwardly projecting abutments corresponding in number and position in the confining ring and in extent to provide for the supporting engagement of the backing members in one operative position of the confining ring in its range of movement and to lie between the projecting abutments of the backing members in another operative position of the confining ring, and motion-transmitting linkage means pivotally interposed between the confining ring and the projecting abutments of the backing members means being operative over a part at least of the turning range of said confining ring to co-ordinate substantially radial inward and outward guided movement of said backing members with respectively opposite turning movements of the confining ring, and the projecting abutment means of reconstructing said backing members in another operative position of the confining ring and to engage said projecting abutments of the backing members.

2. A slips mechanism according to claim 1, wherein said motion-transmitting linkage means comprises for each backing member a link connected at one end portion thereof to a first pivot which is fixed to the backing member, and connected at its other end portion to a second pivot which is fixed to the confining ring, said second pivot being disposed in the confining ring in a position to lie on opposite sides of the movement axis of said guide means in the respective operative positions of the confining ring and immediately to pass across the movement axis of said guide means at which moment said second pivot is operative through the link to hold the backing member at a minimum distance from the central axis.

3. A slips mechanism according to claim 2, wherein the link is connected to the second pivot by a slot in the link, the outer end of the slot constituting with the second pivot a rotational limit stop for the confining ring, and the inner end of the slot constituting a stop Operative upon engagement by the second pivot to hold the backing member towards the central axis at the point where the projecting abutment on the confining ring lies in a position to pass between engagement and disengagement with the projecting abutment on the body to constrain said backing members to substantially radial inward and outward movement with respect to said body, a generally radially extending lever pivotally mounted on each backing member, a wedge member connected to the inner end of each lever, said wedge member and backing member having co-operating wedge surfaces converging towards the central axis whereby to effect mutual closing and opening movements of said wedge members in accordance with respectively opposite pivotal movements of said levers, a confining ring mounted in said body outwardly of said backing members for turning movement throughout an operative range about the central axis, co-operative abutments extending respectively outwardly and inwardly from said backing members and said confining ring to provide supporting engagement by the confining ring for the backing members in one operative position of the confining ring and to lie free from engagement one between the others on each side in-
other operative position on the confining ring, motiontransmitting linkage means pivotally interposed between
the confining ring and each backing member, said linkage means being operative over a part at least of the turning range of said confining ring to co-ordinate substantially radial inward and outward guided movement of said back-
ing members with respectively opposite turning move-
ments of the confining ring and the projecting abutments thereon into and out of supporting engagement with the projecting abutments of the backing members, spring means operative upon said wedge members to urge them upwardly into mutually opening relationship, and cams mounted on the confining ring for turning movement therewith into and out of operative engagement with said levers, said cams being formed and disposed on said con-
fining ring for wedge-closing engagement with said levers
in opposition to said spring means when the confining ring and projecting abutments thereon are substantially dis-
posed in the operative position at which they provide supporting engagement for said backing members.

5. A slips mechanism as in claim 4, wherein the spring means active upon the wedge members comprises a resil-
iently deformable bushing intermediate the central pivot of each wedge-closing and opening lever and the backing member whereon it is mounted, said bushing being biased to raise its wedge member, said bushing being also de-
formable in the direction of the axis of the central pipe passage, to allow axial wedging movement of the wedge member relative to the backing member.

6. A slips mechanism for earth boring equipment com-
prising a non-rotative body formed for attachment to lift mechanism forming part of the drill rig, and having a central pipe passage, a plurality of backing members dis-
posed radially around the central axis of the pipe passage, guide means interconnecting each backing member with said body to constrain said backing members to substan-
tially radial inward and outward movement with respect to said body, a wedge member disposed radially inwardly of each backing member, and formed at its inner surface to grip the pipe string, each wedge member and its coop-
erating backing member having complemental inclined surfaces arranged to wedge the wedge members into grip-
ing engagement with the pipe string when the pipe string is suspended by such wedge members, a projecting abut-
ment directed radially outwardly of each backing mem-
ber, a confining ring rotatively supported upon said body and having complemental abutments separated by inter-
vening recesses of a size and located to receive the abut-
ments of the backing members in a first operative position of the confining ring in its range of turning movement, and to engage the abutments of the backing members in a second operative position of the confining ring, and means reacting between said confining ring and each of the backing members, separately from said cooper-
ating abutments, and operable over a part at least of the turning range of said confining ring to effect conjoint substantially radial inward and outward guided move-
ment of the several backing members with respectively op-
posite turning movements of the confining ring, and the projecting abutments thereon into and out of supporting engagement by the complemental abutments of the back-
ing members.

7. A slips mechanism as in claim 6, including levers pivotally mounted upon each backing member and ex-
tending radially inwardly and outwardly therefrom, the inner end of each lever being pivotally connected to the corresponding wedge member, and cams upon the rotative confining ring positioned to engage the outer ends of said levers and to urge the wedge member inwardly with relation to its backing member, conjointly with engagement of the abutments in the second operative position of the

References Cited in the file of this patent

UNITED STATES PATENTS

684,594  Austin  ________________  Oct. 15, 1901
689,658  Spear  ________________  Dec. 24, 1901
1,111,535  Greve  ________________  Sept. 22, 1914
2,120,850  Robichaux et al.  ___________  Oct. 8, 1918
1,731,128  Edwards  ________________  Oct. 8, 1929
1,986,284  Penick et al.  ________________  Jan. 1, 1935
2,256,155  Smith  ________________  Sept. 16, 1941
2,700,201  Bannister  ________________  Jan. 25, 1955
2,755,758  Johansen  ________________  July 24, 1956