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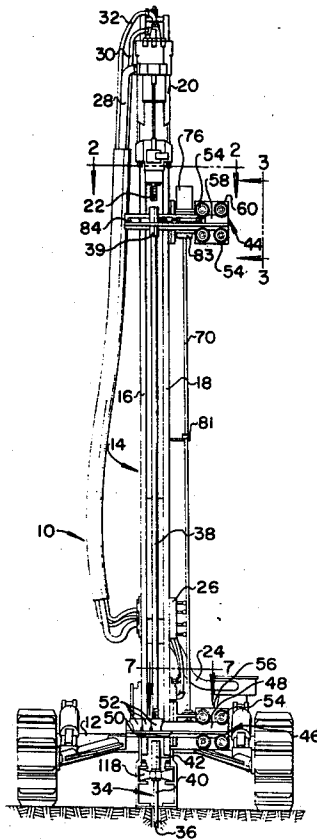
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[54] **DRILL ROD UNCOUPLING AND STORAGE APPARATUS**
 8 Claims, 7 Drawing Figs.

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 [51] Int. Cl. **E21b 19/14**
 [50] Field of Search **175/52, 85;**
 166/77.5; 81/57.16, 57.21, 57.34, (Inquired);
 214/2.5; 24/81CC, 263RC, (Inquired); 211/60S,
 (Inquired); 254/29—31, (Inquired);
 269/234(Inquired); 173/164

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ABSTRACT: An uncoupling and storage apparatus for multiple sections of extension drill rods having spaced rack members for storing drill rod sections laterally in line with the drill string and interconnected to transfer extension drill rods seriatim to and from the drill string. Spaced substantially arcuate openings in one of the rack members provide jaw surfaces for cooperatively forming with a sliding member a clamp mechanism for nonrotatively clamping a drill rod section for uncoupling from the drill string. The sliding member of the clamp mechanism has predetermined spaced recesses providing complementary jaw surfaces for clamping only the drill rod section which is successively in position to be uncoupled from the drill string.



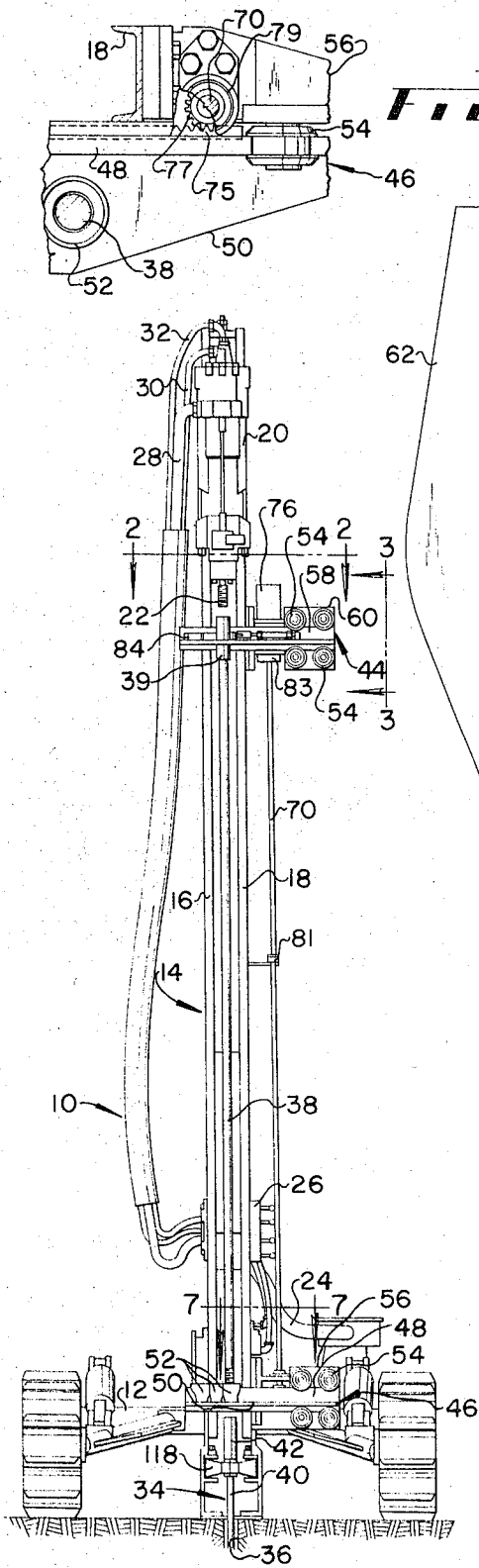


FIG. 1

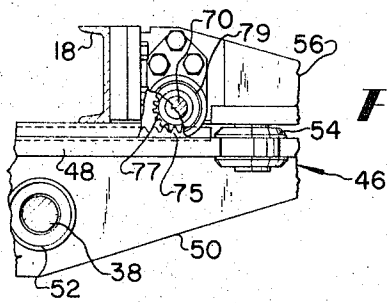


FIG. 7

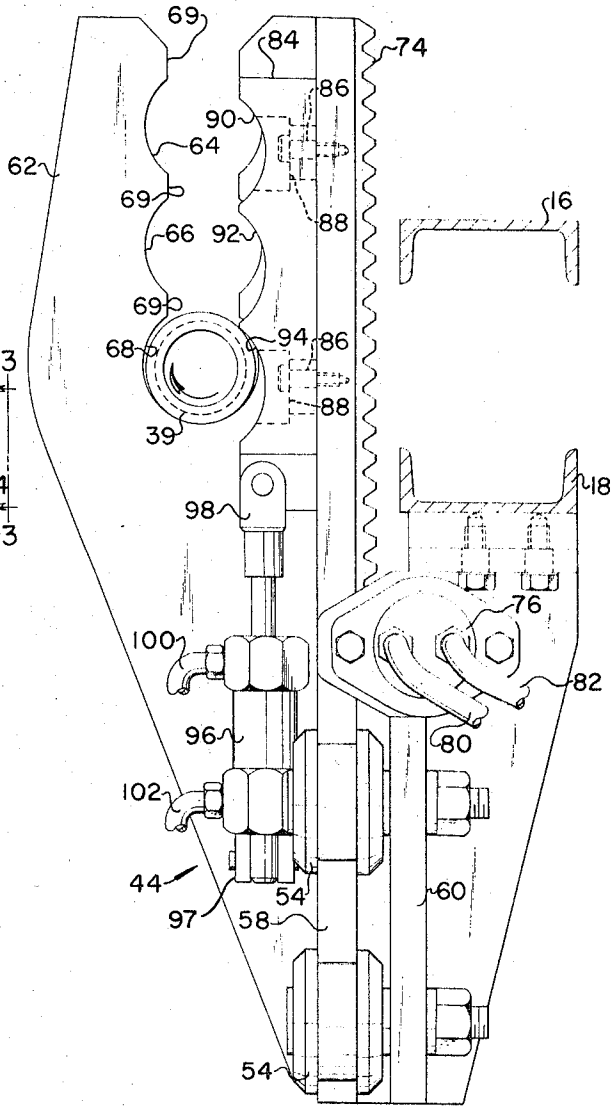


FIG. 2

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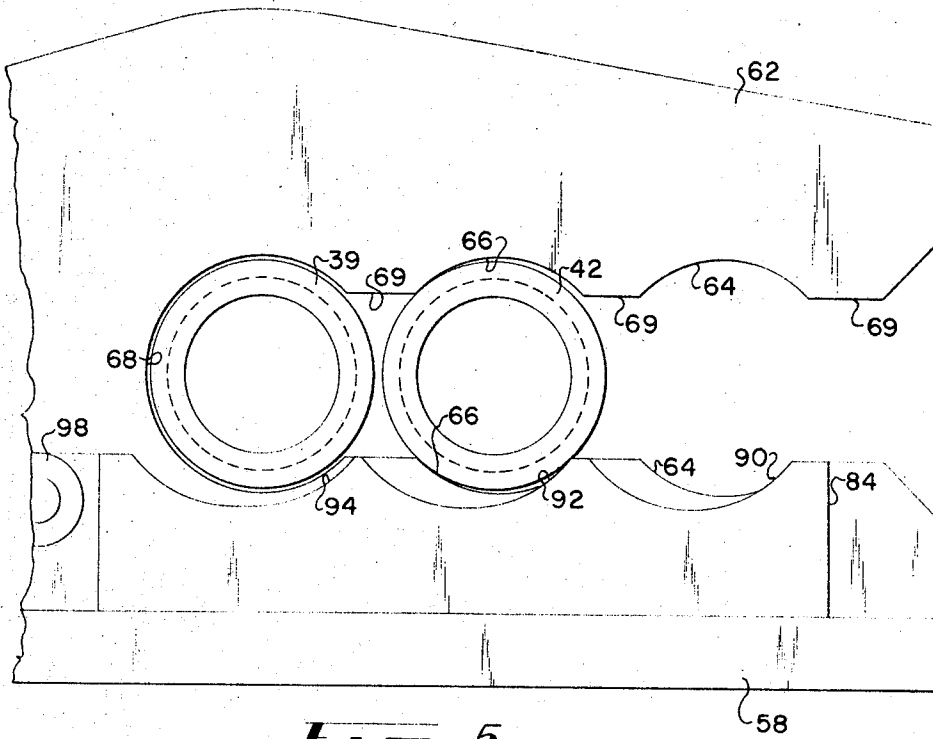


FIG. 5

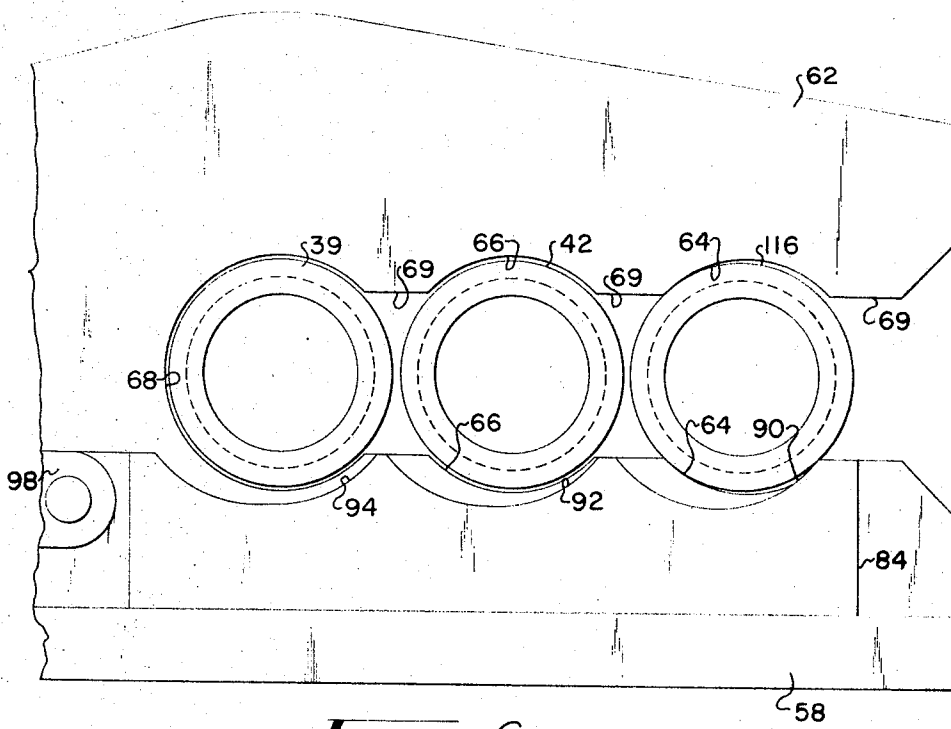


FIG. 6

DRILL ROD UNCOUPLING AND STORAGE APPARATUS

BACKGROUND OF THE INVENTION

In drilling rigs of the type used for drilling holes in the earth of substantial depth, it is accordingly necessary to provide a drill string of substantial length which for practical purposes comprises a number of extension drill rod or pipe members threadedly coupled end to end. The necessity for providing multiple extensions drill rods to make up a drill string has in turn brought about requirements for rig mounted mechanized drill rod storage and handling apparatus. A number of such devices are disclosed in the prior art including types which retain multiple drill rods laterally in line with the drill string and types which comprise a revolving magazine having spaced receiving means for retaining individual rod sections. A common shortcoming of known apparatus however is mechanical complexity which in most cases in spite of adequate operational characteristics results in high maintenance costs and contributes to reduced rig availability for actual drilling operations due to problems in reliability.

A related problem long associated with the operation of extension drill strings has been one of uncoupling one drill rod from another when removing the drill string from the drill hole for such operations as changing drill bits or upon completing the desired hole depth. Various uncoupling means sometimes known as breakout wrenches have been developed in the prior art for clamping or locking one drill rod section relative to another for unscrewing the threaded joint therebetween. Drill rod threaded joints are often very tight due to the continuous impact and torsional loading during drilling operations and, accordingly, substantially complicated breakout devices are often required to uncouple extension drill rod members. Drill rod uncoupling means are usually associated with the aforementioned storage and handling apparatus and devices known in the art are often provided for each individual drill rod retaining and storage position resulting in a substantial complication and multiplication of mechanism on the drilling rig.

SUMMARY OF THE INVENTION

The present invention provides for an improved storage and uncoupling apparatus for multiple extension drill rod sections which includes spaced retaining members of quite simplified construction for storing extension drill rods laterally in line with a drill feed. The invention also provides simplified means for moving multiple drill rods in line over the drill hole for insertion and removal from a drill string by providing spaced storage rack members synchronized to move in unison.

A particularly advantageous aspect of the invention is the provision of a simplified drill rod uncoupling device which includes a single movable member cooperable with one of the drill rod retaining members to form a clamping mechanism for nonrotatably clamping an extension drill rod section to permit unscrewing the threaded joint between a clamped drill rod section and another or between a clamped drill rod section and a drill motor.

An advantage of the present invention also resides in the construction of the cooperative movable clamping member and the drill rod retaining member to provide for nonrotatably clamping only the drill rod section which is successively in position to be removed from the drill string.

A further advantage of the present invention resides in the provision of an improved drill rod uncoupling device which is self-energizing for nonrotatably clamping an extension drill rod increasingly tighter as greater rotatory effort is applied in unscrewing threaded joints or the like. These and other advantages of the present invention will be more thoroughly understood upon reading the detailed description of a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation of a typical crawler mounted rock drilling rig and illustrates a preferred arrangement of drill rod uncoupling and storage apparatus mounted thereon.

FIG. 2 is a view from the line 2-2 of FIG. 1 illustrating details of construction of the drill rod uncoupling clamp mechanism in the process of uncoupling an extension drill rod section.

FIG. 3 is a view substantially from the line 3-3 of FIG. 1 illustrating details of the upper storage rack member.

FIG. 4 is a plan view of the retaining member and the clamp member of the drill rod uncoupling apparatus with pertinent dimensions indicated to illustrate the predetermined spacing of the complementary jaw surfaces.

FIG. 5 is a fragmentary view similar to FIG. 2 and showing a second drill rod section being clamped for uncoupling from a drill string.

FIG. 6 is a fragmentary view similar to FIGS. 2 and 5 and showing a third drill rod section being successively clamped for uncoupling from a drill string.

FIG. 7 is a view partly sectioned, taken substantially along the line 7-7 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a typical crawler mounted portable rock drilling rig, generally designated by the numeral 10, is illustrated in a vertical drilling position. The drill rig 10 comprises a crawler-type undercarriage 12 adapted to adjustably mount an elongated mast or guide shell 14. The mast 14 is constructed, basically, of two inwardly turned channel members 16 and 18 which provide for slidably mounting a pressure fluid operated drill motor 20. The drill motor 20 is of a well known percussion type and includes a short section of drill steel in the form of a threaded shank portion 22 retained and extending from the lower end thereof. The shank portion 22 is adapted to transmit percussion blow energy and rotational motion provided by the drill motor 20 to a string of extension drill steel in a manner well understood by those of ordinary skill in the art. The drill motor 20 receives pressure fluid from a source, not shown, via a main supply line 24, a bank of control valves 26 and a plurality of flexible conduits 28, 30 and 32 for providing, respectively, percussion and rotational energy, and hole cleansing medium. The drill motor 20 may be slidably fed back and forth along the mast 14 by a feed mechanism, not shown, of one of a number of types well known in the art of drilling apparatus to provide for feeding an extension drill string 34 in and out of the drill hole 36.

In the condition illustrated in FIG. 1 an extension drill rod 38 having a coupling 39 is in the process of being uncoupled from the drill string 34 including a section of drill rod 40 and coupling 42, and from the shank 22. Uncoupling and handling of the extension drill rod 38 and additional extension drill rod members of the drill string 34 is accomplished by apparatus comprising upper and lower storage rack members 44 and 46, respectively. The lower rack member 46 comprises a substantially T-shaped element having a vertical rail section 48 and a portion 50 perpendicular thereto for supporting a plurality of cuplike receptacles 52 for receiving the threaded ends of extension drill rods such as the drill rod 38 in FIG. 1. The lower storage rack 46 is movably supported by four grooved rollers 54 which in turn are rotatively mounted on a bracket 56 attached to the mast 14.

Referring to FIGS. 1, 2 and 3 the upper storage rack member 44 is also of somewhat T-shaped construction including a rail portion 58 movably supported also by grooved rollers 54 mounted on a bracket 60 also fastened to the mast 14. The rack member 44 includes a drill steel retaining member 62, FIG. 2, having a plurality of substantially arcuate openings 64, 66 and 68 interconnected by an elongated slot 69. The slot 69 is predetermined to be of sufficient width for receiving drill rods and the openings 64, 66, and 68 are of predetermined diameter to be slightly larger than the coupling diameter. The upper and lower rack members 44 and 46 are interconnected by an elongated drive shaft 70 (FIGS. 1 and 3) having spur gear members mounted near each end thereof. FIG. 3 illustrates the gear 72 engaged with a gear rack 74 mounted on the upper storage rack member 44. Referring to FIG. 7, the lower

storage rack member 46 includes a gear rack 75 attached to the rail portion 48 and engaged by a spur gear 77 mounted on the lower end of the drive shaft 70. A bearing 79 supported by the bracket 56 rotatively journals the drive shaft 70 adjacent the lower end thereof, and an intermediate bearing 81 and a bearing 83 on the bracket 60, FIG. 1, also serve to hold the drive shaft in proper alignment.

The drive shaft 70 is rotatively driven by a reversible fluid operated motor 76 mounted on the bracket 60 and drivably cone connected to the shaft 70 by means of a coupling 78. Fluid conductors 80 and 82 provide motive fluid to the motor 76 via a suitable control, not shown. The spaced storage rack members 44 and 46 are thereby interconnected to move laterally in unison into and out of position in line with the drill string 34 for removing and adding, successively, extension drill rod sections. The simplicity of construction of the rack members 44 and 46 and the simple but effective motor and drive shaft arrangement for synchronizing the movement of the rack members 44 and 46 to position the drill rod storage apparatus makes possible the use of such apparatus even on relatively lightweight drilling rigs such as the rig 10 shown in FIG. 1.

Referring to FIG. 2, the rail portion 58 of the upper rack member 44 slidably retains a movable clamp member 84 by means of shoulder type screws 86 located in the counterbored slots 88. The clamp member 84 is retained adjacent the retaining member 62 and includes a plurality of arcuate recesses comprising jaw surfaces 90, 92 and 94 which are complementary to the jaw surfaces formed by the arcuate openings 64, 66, and 68 on the retaining member 62. Actuation of the clamping member 84 to nonrotatably engage the drill rod coupling 39 as shown in FIG. 2 is provided by a double acting linear fluid motor 96 mounted on the upper rack member 44 by means of the bracket 97 and connected to the clamp member 84 by means of the clevis 98. Pressure fluid is supplied to the linear motor 96 by means of the conductors 100 and 102 via a suitable control, not shown.

The present invention provides for a lateral in line drill rod storage apparatus which comprises a retaining member and a movable clamp member operable to nonrotatably clamp only the drill rod section which is successively in position to be uncoupled from a drill string. This feature is provided by the retaining member 62 and the movable clamp member 84 which have a series of respective coacting jaw surfaces thereon spaced a predetermined distance in such a manner that only one extension drill rod is nonrotatably engaged thereby assuring that the force applied by the linear motor 96 is used to clamp only the drill rod section normally required to be uncoupled. Referring to FIG. 4, the clamp member 84 is shown positioned so that the center 106 defining the radius center for the radius R_1 of the complementary jaw surface 90 comprises also the center of the radius R_2 for the arcuate opening 64 in the retaining member 62. However, the center 108 for the radius R_1 defining the jaw surface 92 is spaced the distance X from the center 110 of the radius R_2 of the second arcuate opening 66 on the retaining member 62, and the center 112 for the radius R_d defining the third complementary jaw surface 94 is spaced the distance Y from the center 114 for the radius R_2 of the third arcuate opening 68 on the retaining member 62.

As may be seen in FIG. 4 the spacing of the centers 112 and 114 as defined by dimension Y is greater than the spacing of the center 108 and 110 as defined by the dimension X. A means of determining the spacing of the respective jaw surface radius centers for each respective pair of coacting jaw surfaces would comprise constructing a common center 106 for the outermost, or furthest to the right in FIG. 4, radii defining the surfaces 64 and 90 on the retaining member and clamp member, respectively. The center spacing of the centers 108 and 112 could then be laid out along a straight or curved line equidistantly from one another starting from the reference point 106. Then the centers 110 and 114 could be laid out along the same straight or curved line also equidistantly from

one another from the reference point 106 but on a center distance greater than the dimension chosen for the centers 108 and 112. The result is that pairs of coacting jaw surfaces are progressively further apart when the reference points are coincident. The effect that this predetermined spacing of the jaw surfaces has on achieving the clamping of only the extension drill rod section successively in position to be uncoupled from the drill string may be appreciated by viewing FIGS. 2, 5, and 6 in succession.

In FIG. 2 the coupling 39 of the drill rod section 38, first to be removed from the drill string 34, is shown nonrotatably engaged by the coacting jaw surfaces 68 and 94 in response to actuation of the clamping member 84 by the linear motor 96. Obviously, since no other drill rod member is in the retaining member 62 the clamp member 84 will slide toward the linear motor 96 until such engagement occurs. However, in FIG. 5 a second drill rod member 40 having a coupling 42 has been engaged by the coacting jaw surfaces 66 and 92 and being in position to be removed from the drill string, it is desirable that all clamping effort be concentrated to nonrotatably clamp the coupling 42 for unscrewing the threaded joint with the shank 22. It will be noted that the jaw surfaces 94 and 68 are not in engagement with the coupling 39 due to the previously mentioned predetermined spacing of the surfaces 94 and 92. In like manner, when a third drill rod member having a coupling portion 116, FIG. 6, is to be removed from the drill string the jaw surfaces 64 and 90 hold only the coupling 116 in nonrotative engagement for performing the uncoupling operation due to the spacing of the surfaces 92 and 90.

A particularly advantageous feature of the present invention is the self-energizing character of the clamping member 84 when the threaded joint of a coupling is being unscrewed. In FIG. 2 the arrow indicates the direction in which the drill motor rotation means tends to rotate the coupling 39 of the drill rod section 38 during the uncoupling operation. Such tendency to rotate will tend also to cause the clamping member 84, engaged with the coupling 39 by the jaw surface 94, to move further toward the linear motor 96. This action will clamp the coupling 39 even tighter between the jaw surfaces 68 on the retaining member 62 and the complementary jaw surface 94 on the clamp member 84. Rotation of the drill rod section 38 is thereby prevented even when the threaded joints are particularly tight.

In a typical operating sequence, referring to FIG. 1, during normal drilling operation the storage rack members 44 and 46 would be retracted laterally clear of the drill string 34 and the drill motor 20. Upon completion of a drill hole or for changing a drill bit, successive removal of drill rod sections would be accomplished by retracting the drill motor 20 up the mast 14 until the coupling 42 was above the pivoted jaw type drill rod centralizer 118 or a similar device suitable for supporting the drill string 34 to prevent the latter from slipping back into the drill hole 36. Suitable manual or power operated means, not shown, would be used to uncouple the joint of the rod section 38 with the coupling 42 after which the drill motor 20 and rod section would be raised until the lower end of the rod section 38 was above the lower rack member 46 and coincidentally the slot 69 on the upper retaining member 62 would be in line to laterally move around the rod section 38 immediately below the coupling 39. Upon actuation of the fluid motor 76 the drill rod handling apparatus would be moved in line over the drill string and the rod section 38 would be lowered into the receptacle 52 directly below the opening formed by the jaw surfaces 68 and whereby also the jaw surfaces 68 on the retaining member 62 would substantially circumsurround the coupling 39. The linear motor 96 would then be actuated to move the clamp member 84 into nonrotative engagement with the coupling 39 by clamping the same between the jaw surfaces 68 and 94, FIG. 2. After rotation of the shank 22 to unscrew the threaded joint with mechanism coupling 39, the drill rod handling apparatus, having uncoupled and stored a rod section, would be moved laterally out of line with the drill string and the linear motor 96 would be reversely actuated to employed

the clamp member 84 to the position of FIG. 4. the drill motor 20 would be fed down the mast 14 to connect the shank 22 to the next in line to be removed section of drill rod, whereupon successive sections of drill rod could be uncoupled and stored by repeating substantially the above-described operating sequence.

In the process of adding extension drill rod members to the drill string 34 for deepening the drill hole, the clamping mechanism would not normally be required as the direction of rotation of the drill shank 22 is reversed to screw the threaded connections together. However, the invention contemplates that the clamping mechanism suitably mounted could be employed advantageously at the lower end of the mast 14 to non-rotatably clamp a coupling and rod section to disconnect the shank from a drill rod section preparatory to adding another drill rod section to the drill string.

As can be readily appreciated by one skilled in the art the present invention could be modified to accommodate numerous types of extension drill rods or drill pipe and the number of extension drill rod sections that could be clamped and stored are limited only by practical considerations in the design of the drill rig and in the mechanism for actuating the clamping member. Furthermore, the geometry of the coating jaw surfaces need not be substantially arcuate, as the preferred embodiment discloses, in order to practice the invention. Although the embodiment illustrated utilizes the clamping mechanism to uncouple rod sections from a drill motor shank the invention could be employed to uncouple one rod section from another as well.

I claim:

1. In a drill rig, in combination:

a. an elongated support;

a drill motor mounted on said support for longitudinal movement therealong; and

a plurality of extension drill rod members for making up an extension drill string, said drill string being connectable at one end thereof to said drill motor to be driven longitudinally with respect to said support; and the improvement comprising: drill rod handling and storage means comprising spaced storage rack members independently mounted on said support and movable laterally relative thereto; said rack members including retaining means for retaining, respectively therebetween, opposite ends of a plurality of drill rods, whereby said drill rods are stored laterally seriatim with respect to the axis of said drill string, and rotary drive means for moving said spaced rack members, in unison, into and out of line with said drill string for adding or removing drill rod sections with respect thereto.

2. In a drill rig:

a. means for rotating a drill string made up of a plurality of coupled rods;

b. apparatus operable for holding said rods successively against rotation as each of said rods is uncoupled from said drill string, said holding apparatus comprising:

1. a member having openings comprising a series of jaw surfaces for receiving said rods laterally with respect to the rotational axis of said drill string and for receiving said rods seriatim as they are successively uncoupled from said drill string; and

2. clamping means comprising a member slidably disposed adjacent said drill rod receiving member and having recess means comprising a series of jaw surfaces complementary to and coactable respectively with said series of jaw surfaces on said receiving member, and in response to the operation of said clamping member any one of said drill rods received in any one of said openings will be nonrotatively clamped with respect to said receiving member when said one drill rod is suc-

cessively in position to be uncoupled from said drill string.

3. The invention according to claim 2 wherein: said jaw surfaces on said receiving member substantially surround said drill rods when said drill rods are retained thereby, and said complementary jaw surfaces on said clamping member are operable, in response to the operation of said clamping member to clamp said one drill rod section and the operation of said rotation means to tend to rotate said one drill rod section, to nonrotatably clamp said one drill rod section increasingly tighter.

4. The invention according to claim 2 wherein: each jaw surface on said clamping member is spaced progressively further apart from its respective coating jaw surface on said receiving member when the jaw surfaces of an endmost pair of complementary jaw surfaces in said series are positioned coincident with each other.

5. The invention according to claim 4 wherein: said complementary jaw surfaces on said clamping member and said receiving member are substantially arcuate having a predetermined radius of curvature and the center of each said radius for each jaw surface on said clamping member is located progressively further apart from the radius center of each respective coating jaw surface on said receiving member when the radius centers of an endmost pair of jaw surfaces in said series are positioned coincident with each other.

6. In a drill rig, in combination:

a. an elongated support;

a drill motor mounted on said support for longitudinal movement therealong; and

a plurality of extension drill rod members for making up a rotatable extension drill string; said drill string being connectable at one end thereof to said drill motor to be driven longitudinally with respect to said support; and the improvement comprising: drill rod handling and storage means comprising spaced so storage rack members independently mounted on said support and movable laterally with respect to said support; said rack members including retaining means for retaining, respectively therebetween, opposite ends of a plurality of drill rods, and drive means interconnecting said spaced rack members comprising an elongated shaft rotatively mounted on said support and operable to be driven by rotary motor means, said drive shaft including gear means adjacent said respective storage rack members and engaged with complementary gear rack means on said storage rack members whereby in response to actuation of said rotary motor said storage rack members are movably positioned, in unison, laterally with respect to the rotational axis of said drill string for adding or removing extension drill rod members.

7. In a drill rig:

a. means for rotating a drill string made up of a plurality of coupled rods;

b. apparatus for uncoupling and storing said plurality of rods, said apparatus comprising:

1. a member having a plurality of openings for receiving a plurality of said rods laterally with respect to the rotational axis of said drill string and for receiving said rods seriatim as they are uncoupled from said drill string; and

2. means movable with respect to said receiving member and cooperable therewith to clamp any one of said plurality of rods received in said receiving member and to hold only said one rod against rotation when said one rod is in position to be uncoupled from said drill string.

8. The invention set forth in claim 7 wherein: said clamping means comprises a member slidably disposed adjacent said drill rod receiving member and having recess means complementary to said openings in said receiving member.