Feb. 24, 1931. G. A. MONTGOMERY 1,794,196

CONTROL MECHANISM FOR ROTARY DRILL PIPES

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Fig. 2.

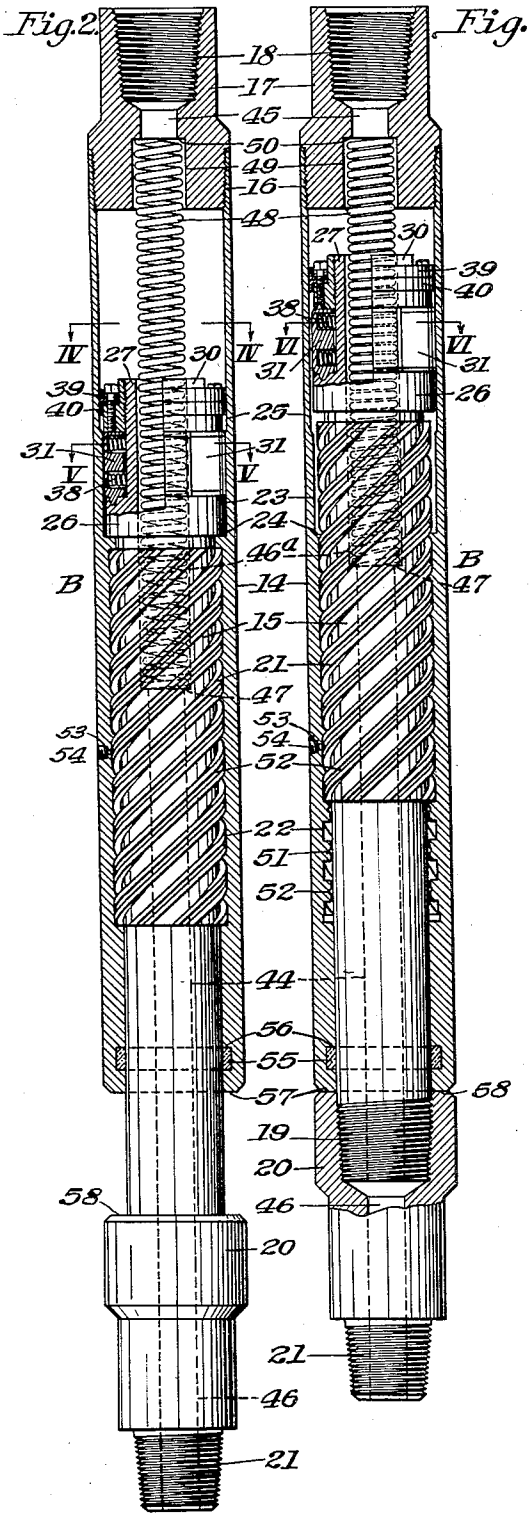


Fig. 3.

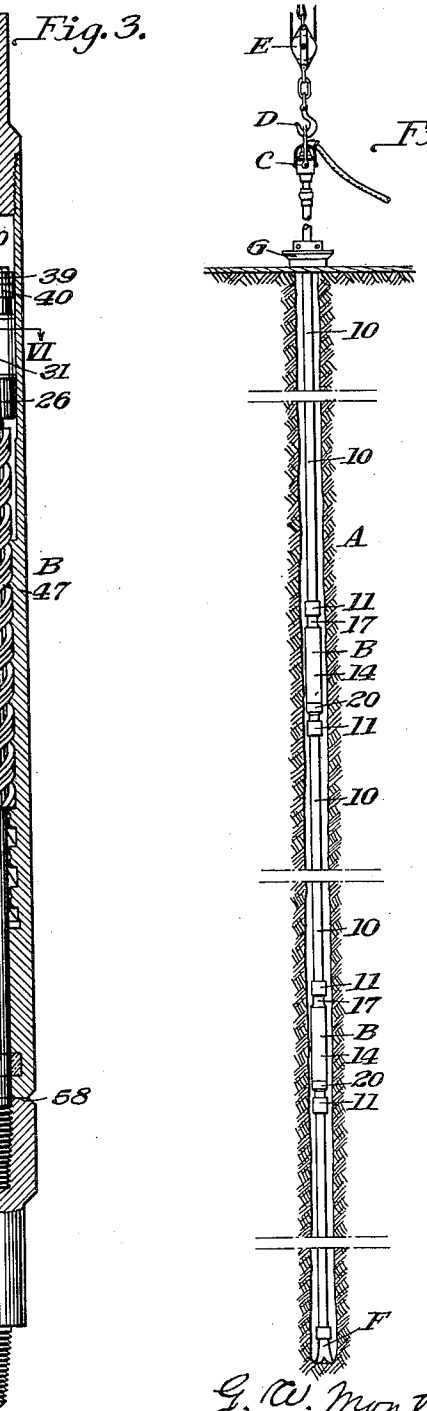


Fig. 1.

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Fig.4.

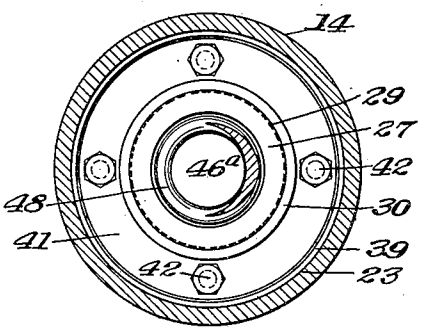


Fig.5.

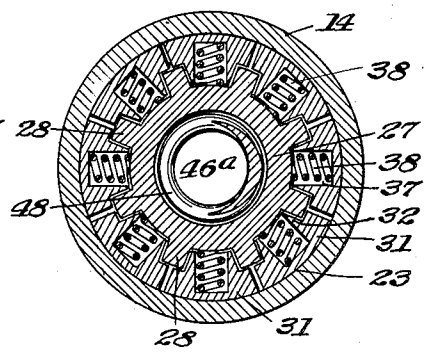


Fig.6.

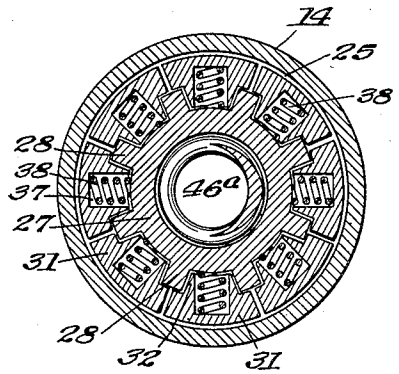
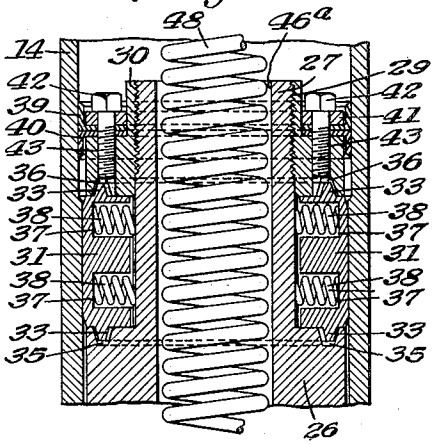


Fig.7.



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CONTROL MECHANISM FOR ROTARY DRILL PIPES

Application filed January 13, 1928. Serial No. 246,618.

My invention relates to the art of rotary well drilling, and more particularly to means for automatically controlling the operation of the rotary drilling tool whereby the rate of feed of the tool and the torsion to which the drill pipe is subjected may be taken care of in a simple and inexpensive manner.

Important objects of the present invention are:—to provide simple and efficient mechanism including means for controlling or regulating the pressure or weight on the drill tool and the load or torque on the drill pipe or stem; to provide mechanism of the character specified designed to be incorporated in and constitute a part of the drill pipe; to provide means that will automatically lift the drilling tool when excessive resistance to the normal rotary drilling action is encountered; to provide means that may be positioned at any desired elevation in the drill pipe, said means either including a single control mechanism or a plurality of control mechanisms arranged at different levels in the drill pipe; and to provide mechanism of the character stated that may be used in connection with any style of power driven rotaries.

A further and important object of the invention is to provide a mechanism of the class described having parts adapted to move relatively under undue torsion or load on the drill pipe connected primarily by helical splines of such pitch that the weight of the drill pipe above said control mechanism is not imposed on the drill tool and the feed of the tool is under control of the weight of the stem located between the controller mechanism and the bit or tool.

Still further objects are, to provide the control mechanism with means for imparting sufficient pressure or weight to the drilling tool to effect drilling in cases where the weight of the drill pipe below the control mechanism is not sufficient to impart the necessary drilling pressure; to provide the control mechanism with cooperating spring cushioning means and piston means, the latter being operable by the circulating fluid employed in the operation of drilling.

Various additional objects and advantages of my invention will become apparent from a consideration of the following description taken in connection with the accompanying drawings, illustrating an operative embodiment.

In the drawings:

Fig. 1 is a diagrammatic view, showing my invention applied to rotary well drilling equipment and positioned in a well;

Fig. 2 is a central longitudinal sectional view of the control mechanism, showing the parts in extended position;

Fig. 3 is a view similar to Fig. 2, showing the parts in retracted position;

Fig. 4 is a cross sectional view taken on the line IV—IV of Fig. 2;

Fig. 5 is a cross sectional view taken on the line V—V of Fig. 2;

Fig. 6 is a cross sectional view taken on the line VI—VI of Fig. 3; and

Fig. 7 is an enlarged central longitudinal sectional view taken through the brake shoes and their mountings.

Referring to the drawings, I have illustrated diagrammatically in Fig. 1 certain parts of a rotary well drilling equipment, with my invention embodied therein. As shown, A designates the drill pipe or drill stem made up, as usual, of a number of sections 10, said sections being united together by coupling members 11.

My invention is designed to be incorporated into and constitute a part of the drill pipe and, as shown, the control mechanism, designated generally by the character B, may be placed at any desired position in the drill pipe. My invention contemplates the employment of one or several control mechanisms, and in Fig. 1, I have shown two control mechanisms. C designates the hydraulic swivel by which the drill pipe is suspended, said swivel being in turn supported by a hook D carried from a crown block E of the usual or any preferred construction. F designates the drill tool or bit secured to the lowermost section of the drill pipe, and G a portion of a rotary table mechanism of any preferred form employed for driving the drill pipe. It will, of course, be understood that a drilling mixture, i. e., mud and water, is supplied through the hydraulic swivel and

is passed downwardly through the drill pipe and the control mechanism forming a part thereof, in the usual and well known manner.

With specific reference to the control mechanism B, said mechanism, as illustrated and as preferred, comprises a tubular barrel 14 of suitable length, in which a movable or retractile tubular member 15, of very sturdy construction, is disposed and operates. Barrel 14, at its upper end, is screw-threaded at 16 to a suitable form of coupling 17 having female threads 18, whereby the same may be connected to an adjacent threaded coupling or joint 11 of one of the pipe sections 10. At the lower end, the retractile tubular member 15, at 19, is screw-threaded to a coupling or sub-joint 20, which has male screw threads 21 adapted for connection with a complemental threaded portion of an adjacent coupling 11. Thus, by means of the couplings 17 and 20, the device is detachably and operatively secured to and between any of the adjacent pipe sections 10, according to the position to be occupied in the drill pipe.

The upper portion of member 15 has exterior helical threads or splines 21, preferably of substantially square cross section. These splines are designed to engage in corresponding helical grooves 22 provided in the bore of the barrel 14. The pitch of the splines 21, as shown, is approximately forty-five degrees; the pitch of the splines may be varied, but it should be such as to permit relative movement of the barrel 14 and tube 15 by gravity when not restrained. Above the grooves 22, the bore of barrel 14 is slightly enlarged, as at 23, which provides a shoulder at 24; and above the enlargement 23 of the bore is a further enlargement of the bore, as at 25.

Formed integral or otherwise rigid with the member 15, in slightly spaced relation to the splines 21, is a collar 26. Beyond this collar 26, member 15 has a reduced extension 27; and formed on the extension 27, relatively close to the collar 26, are spaced exterior radial ribs 28. Screw-threaded at 29 to the stem 27 is a ring nut 30. Said nut secures in place a plurality of brake shoes 31 adapted for slight radial movement and, at their peripheries, to have braking contact with the bore wall of barrel 14 at the enlargement 23. Said brake shoes 31 have inner ribs or projections 32 located intermediate the ribs at 28, whereby they are positioned against displacement by turning. Each brake shoe 31 at each end has an arcuate flange or projection 33; the said flanges 33 at one end of the brake shoes are disposed in an annular groove 35 provided in the collar 26, and the projections 33 at the other ends of the brake shoes are disposed in an annular groove 36 provided in the nut 30.. It will be noted that the grooves 35 and 36 are enlarged relatively to the projections 33 which they contain, so that the brake shoes may have limited radial movement.

Each brake shoe has one or more recesses 37 open only at their inner surfaces, said recesses being occupied by expansive springs 38 of any desired tension, and which springs engage the extension 27 between ribs 28 and thus maintain the brake shoes in braking engagement with the bore wall at the aforesaid enlargement 23 to a degree proportional to their tension. Incidental to retraction of the tubular member 15, the brake shoes 31 are moved out of the enlargement 23 into the enlargement 25, where they do not contact with the bore wall or exert any braking action, because radial outward movement thereof to a sufficient extent to make contact is limited by the recesses 35 and 36, as shown in Fig. 3.

In combination with the nut 30, a piston head is provided within the enlargement 25, by the employment of packing members 39 and 40; these packing elements are secured against the upper face of said nut 30. To this end, a ring 41 engages the uppermost packing element, and screws 42 are passed therethrough into screw-threaded openings 43 in said nut 30. One or more of said screws may be of such length as to extend beyond the under surface of the nut 30 and into a position intermediate ribs 28, whereby the nut 30 is locked against accidental rotation. It will be noted that the free terminals of the packing elements 39 and 40 extend in opposite directions and are in intimate wiping contact with the bore wall at the aforesaid enlargement 25.

The retractile member 15 has a bore opening 44 designed to communicate with openings 45 and 46 provided through the couplings 17 and 20, respectively, and thus form a continuous passageway through the entire device for the drill mixture or circulating fluid. The bore opening 44 is enlarged, as at 46*a*, and provides a shoulder at 47 within the retractile tube 15. A relatively strong expansive coil spring 48 of any desired tension occupies the enlargement 46*a*, and rests on the shoulder 47. Said spring 48, at its upper end, extends into an enlargement 49 of the passageway 45, thus providing a shoulder at 50 within the coupling 17, against which the upper end of the spring 48 abuts.

The splines 21 and also splines 51 of the grooves 22 of the barrel member 14 are provided with lubricant grooves 52, to which lubricant may be supplied by any suitable device, through an opening 53 in the wall of barrel 14; said opening 53 is normally closed by a screw plug 54, or otherwise. It will be noted that the construction just described provides for an efficient lubrication of the parts, and that the escape of the lubricant in a downward direction is prevented by a pack-

ing ring 55 disposed in a groove 56, the latter forming an enlargement of the bore of barrel 14, and which packing intimately wipes the adjacent portion of tube 15. The escape of such lubricant in the opposite direction is prevented by the packing members at 39 and 40. Said packing members also tend to prevent the rise or escape of mud-laden fluid backwardly through the controller and drill stem.

The extent of retractile movement of the tube 15 relatively to the barrel 14 is limited by the engagement of the lower end 57 of barrel 14 with the upper end 58 of coupling 20, and which distance is shown in Fig. 2.

In operation, my improved control mechanism effectively controls the rate of feed of the drill tool and takes care of the torsional strains to which the drill pipe or stem is subjected. It controls and limits the application of power to the greatest possible safe torsional force by which to rotate the drill pipe A and attached tool F, such safe torsional force being predetermined as somewhat less than the elastic limit of the weakest joint in the drill pipe. The weight of that portion of the drill pipe below the controller is utilized to control and regulate the feed of the bit F.

The position of the parts of the controller as when normally operating is shown in Fig. 2, where it will be noted that the shoulders 57 and 58 are spaced apart and the tube 15 and parts connected thereto are in lowermost position with the collar 26 resting on the shoulder 24 and the brake shoes 31 exerting frictional or braking engagement against the bore wall at the enlargement 23, under the urgency of springs 38, thus resisting relative turning movement of the barrel and tube. The spring 48 urges the tube 15 to the said operating position and, in addition, the tube is further urged to said operating position through the force of the drill fluid supplied through the pipe A and the control device and which acts against the nut 30, ring 41, and packing 39 and 40 as a piston head.

Due to the angularity of the splines 21, the tool F is subject only to the weight of those sections of the drill pipe A connected to the coupling 20, and thus is not subject to the weight of that portion of the drill pipe A which is connected to the coupling 17. The weight of that portion of the drill pipe A as supported from the coupling 20, therefore, alone urges and governs the feed of the drill stem and bit F, and hence there is no danger of the weight of the remainder of the drill pipe being injuriously imposed upon the drill bit or hampering its operation.

Of course, during normal operation, the drill pipe A and all of the parts of the control mechanism rotate or turn as a unit through the action of the rotary. In the event of the bit or tool F becoming stuck, or having its turning movement or rotation arrested, the control mechanism will function to lift the tool by retracting the member 15. This action is due to the fact that the stoppage of rotation of member 15 will not affect the turning of barrel 14, but will overcome the braking action between the shoes 31 and the barrel 14, so that said further turning of the barrel 14 would exert screw action or lifting effect on the member 15 to the extent permitted by the shoulders 57 and 58, and thus elevate the member 15 from the position of Fig. 2 to the position of Fig. 3. In this last position, the tube will be retracted to the maximum extent and the brake shoes will be located in the bore enlargement 25 and can exert no braking effect. Too severe or forcible retraction of the member 15, particularly such as could bind or cause the barrel 14 and coupling 20 to stick at the shoulders 57 and 58 is prevented by the cushioning effect afforded by spring 48 and also the cushioning effect afforded by the piston structure at the upper end of the stem with the inflowing drill fluid.

It will be noted that the rate of feed of bit F is governed by the weight of that portion of the drill pipe A below coupling 20. If the bit F were connected directly to the screw-threaded portion 21 of coupling 20, or if an insufficient amount of the drilling pipe A were disposed between such coupling 20 and the drill F, there would not be sufficient weight on the bit to cause the feed thereof. The present invention is of particular importance in such an instance, that is, in enabling the control mechanism to be located relatively close to the bit, since the feed of the bit is insured by the expansion of the spring 48 alone or augmented by the action of the incoming drill fluid against the piston head formed at the upper end of member 15.

As particularly shown in Fig. 1, more than one of the controllers B may be used in the length of the drill stem. In such event, the pitch of the helical spline or threads 21 should be finer or at a more obtuse angle to the axis of the screw, in proportion to the height and in an upward direction, in proportion to the weight of the parts of the drill pipe A above and below the same, in order not to affect the rate of feed of the bit F and to insure the controllers operating simultaneously in the event the tool or bit F becomes stuck.

I do not limit myself to the particular details and use shown and described. The device is capable of other uses, for instance, that of a rotary jar. Assume that the portion of the drill pipe A below the coupling 20 becomes stuck, and cannot be raised, as above described. Then, in that case, the portion of the pipe A above the controller would be lowered so that the shoulders 57 and 58 would meet. Then the portion of

drill pipe A fastened to the barrel 14 would be hoisted rapidly, causing collar 26 and shoulder 24 to strike. This would produce hammerlike blows affecting the stuck drill stem, which would ordinarily release the same and relieve the stuck condition.

If the said stuck drill tool could not be released by jarring, as described, one or all of the torsion control devices could be unscrewed in a left-hand direction, until one or all of them assume the extended position seen in Fig. 2. Then, all of the stretch in the drill pipe would be taken up and pipe tongs or the like engaged with the pipe and operated in right-hand direction, while the tension is held on the drill pipe.

In this connection, the action between the barrel and tube would be similar to that of a screw jack. Also, if further power were needed to release a stuck bit, the pipe could be fixed to a rotary table by slips and the condition relieved through the actuation thereof.

I claim:

1. In combination with a rotary drill pipe and its tool, of a control mechanism incorporated in the pipe and operable for controlling the rate of feed of the tool and the load or torque on the drill pipe, said control mechanism, including a relatively movable barrel and a hollow retractile member and a device normally maintaining the barrel and retractile member against relative rotation and relative longitudinal movement, and a spline connection between the barrel and said member disposed entirely within the barrel, said device including brake shoes arranged for cooperation with the interior of the barrel.

2. In combination with a rotary drill pipe and its tool, a relatively movable barrel and a hollow retractile element respectively connected to different portions of the drill pipe, and a plural helical spline connection between said barrel and element to effect automatic retraction of the element through the action of the barrel when the tool becomes stuck, said spline connection formed with lubricant passages and entirely disposed within the barrel.

3. A controller of the class described having a barrel adapted for rotation, a retractile member, a connection therebetween whereby rotation of the barrel may retract said member, and means between said member and barrel normally holding the barrel and member against relative rotation and relative sliding movement resisting retraction of said member, and adapted to yield when said member is subjected to torsion beyond a predetermined degree, said means including spring pressed brake shoes arranged for cooperation with the barrel and a spring having an end entered in the retractile member.

4. A controller of the class described having a barrel adapted for rotation, a hollow retractile member, a plural helical spline connection therebetween whereby rotation of the barrel may retract said member, said spline connection disposed entirely within the barrel and brake means in addition to the splines carried by said member and normally engaging said barrel to resist retraction of said member, said brake means being adapted to yield when said member is subjected to torsion beyond a predetermined degree.

5. A controller of the class described having a barrel adapted for rotation, a retractile member, a connection therebetween whereby rotation of the barrel may retract said member, and brake means between said member and barrel normally resisting retraction of said member, and adapted to yield when said member is subjected to torsion beyond a predetermined degree, said barrel having an enlarged portion into which said brake means is moved out of braking engagement with the barrel through retraction of said member.

6. A controller of the class described having a barrel adapted for rotation, a hollow retractile member, a plural spline connection therebetween whereby rotation of the barrel may retract said member, said spline connection disposed entirely within the barrel and additional brake means between said member and barrel normally resisting retraction of said member and adapted to yield when said member is subjected to torsion beyond a predetermined degree, and a spring means to increase the resistance to retraction of said retractile member.

7. A controller of the class described having a barrel adapted for rotation, a retractile member, a connection therebetween whereby rotation of the barrel may retract said member, brake means between said member and barrel normally resisting retraction of said member and adapted to yield when said member is subjected to torsion beyond a predetermined degree, said member having a piston head intimately fitting the bore wall of the barrel for co-action with inflowing drilling fluid to urge projection of the member and a spring means to increase the resistance to retraction of said retractile member.

8. A controller of the class described having a barrel adapted for rotation, a retractile member in telescopic relation therewith, a connection therebetween whereby rotation of the barrel may retract said member, said barrel having a shoulder, said member having means to engage said shoulder, ribs on said member, brake members to engage said barrel to resist retraction of said member, said brake members being adapted to yield when said retractile member is subjected to torsion beyond a predetermined degree, said brake members being disposed between said ribs.

9. A controller of the class described hav-

ing a barrel adapted for rotation, a retractile member in telescopic relation therewith, a connection therebetween whereby rotation of the barrel may retract said member, said barrel having a shoulder, said member having means to engage said shoulder, ribs on said member, brake members to engage said barrel to resist retraction of said member said brake members being adapted to yield when said retractile member is subjected to torsion beyond a predetermined degree, said brake members being disposed between said ribs, a nut on said retractile member, said brake members being positioned between said means and said nut, and an element on the nut extending between two of said ribs to prevent rotation of the nut.

10. A controller of the class described having a barrel adapted for rotation, a retractile member in telescopic relation therewith, a connection therebetween whereby rotation of the barrel may retract said member, said barrel having a shoulder, said member having means to engage said shoulder, ribs on said member, brake members to engage said barrel to resist retraction of said member, said brake members being adapted to yield when said retractile member is subjected to torsion beyond a predetermined degree, said brake members being disposed between said ribs, a nut on said retractile member, said brake members being positioned between said first mentioned means and said nut, packing secured in place by said nut to form a piston head, said barrel having an enlarged portion with the bore wall of which said packing engages, spring means urging braking action of said shoes, and means preventing braking contact of said shoes with the bore wall at said enlargement when said shoes are located therein through the retraction of the first mentioned member.

11. A controller of the class described having a barrel adapted for rotation, a retractile member in telescopic relation therewith, a connection therebetween whereby rotation of the barrel may retract said member, said barrel having a shoulder, said member having means to engage said shoulder, ribs on said member, brake members to engage said barrel to resist retraction of said member, said brake members being adapted to yield when said retractile member is subjected to torsion beyond a predetermined degree, said brake members being disposed between said ribs, a nut on said retractile member, said brake members being positioned between said means and said nut, packing secured in place by said nut to form a piston head, said barrel having an enlarged portion with the bore wall of which said packing engages, spring means urging braking action of said shoes, means preventing braking contact of said shoes with the bore wall at said enlargement when said shoes are located therein through the retraction of the first mentioned member, means on said retractile member engageable with said barrel to limit the retraction of such member, a coupling member at one end of the barrel, and an expansive spring engaging said coupling member and said retractile member.

In testimony whereof I affix my signature.

GUSTAVUS A. MONTGOMERY.