(No Model.) 2 Sheets—Sheet 1.

# R. M. DOWNIE.

## DRILLING MACHINE.

No. 527,237. Patented Oct. 9, 1894.

FIG. 1.

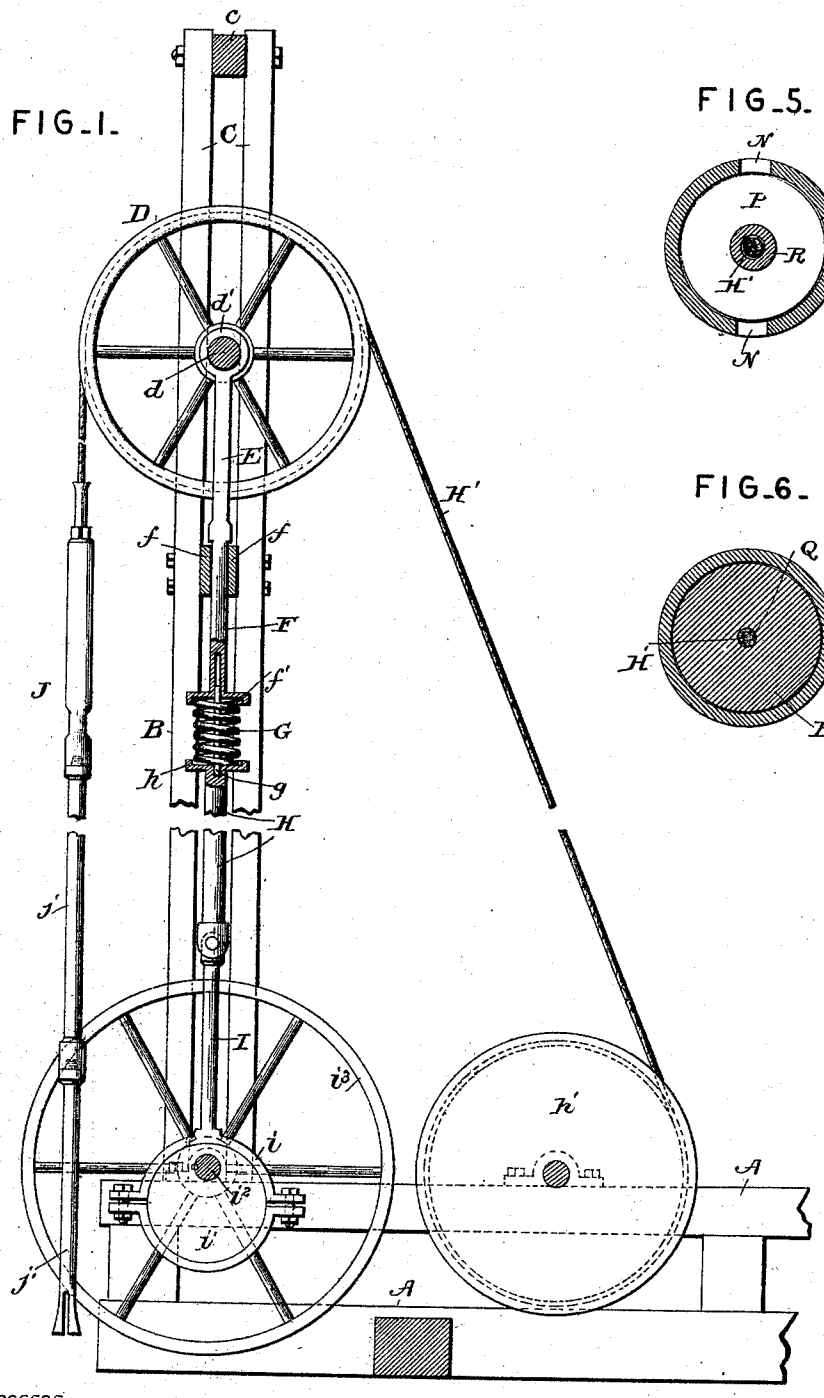


FIG. 5.




FIG. 6.




Inventor

Witnesses

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(No Model.) 2 Sheets—Sheet 2.

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## DRILLING MACHINE.

No. 527,237. Patented Oct. 9, 1894.

FIG. 2.

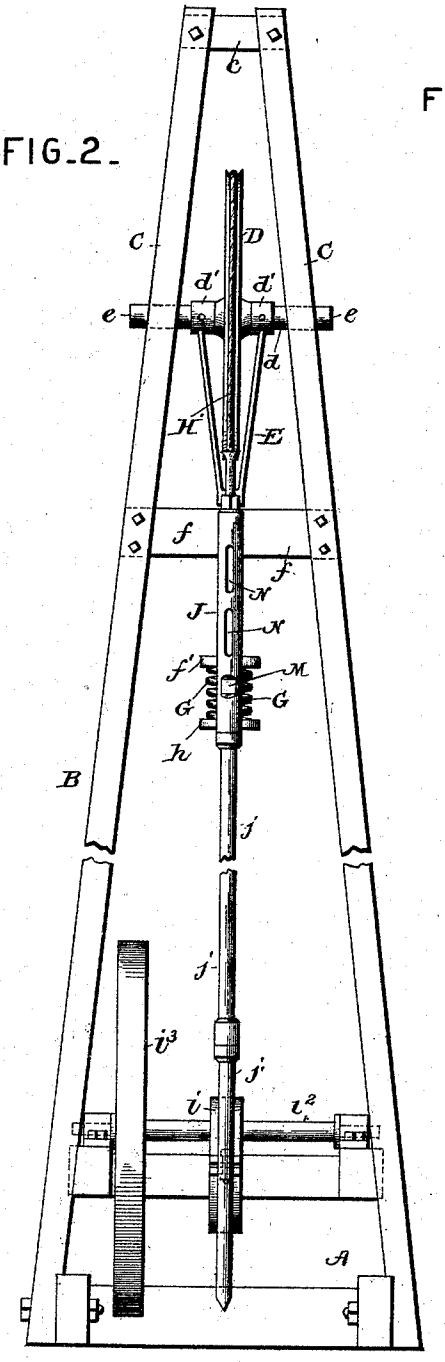



FIG. 3.

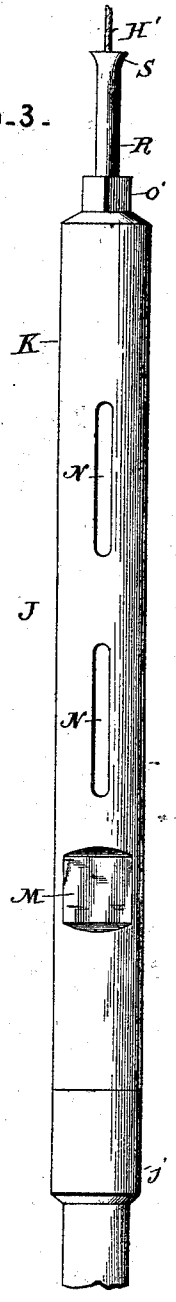
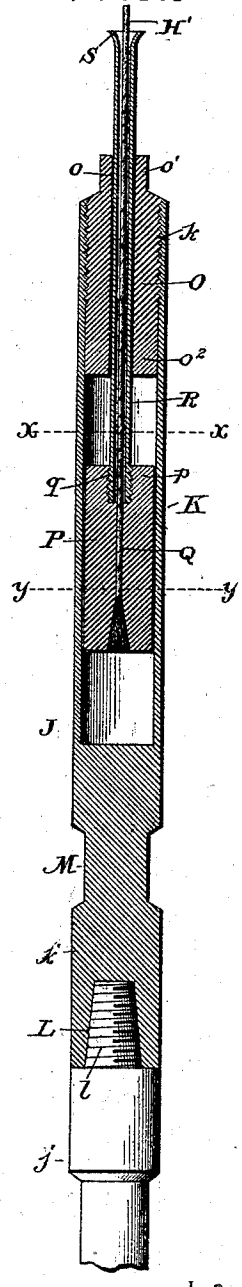



FIG. 4.




Witnesses

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# UNITED STATES PATENT OFFICE.

ROBERT M. DOWNIE, OF BEAVER FALLS, PENNSYLVANIA, ASSIGNOR TO THE KEYSTONE DRILLER COMPANY, OF SAME PLACE.

## DRILLING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 527,237, dated October 9, 1894.

Application filed December 18, 1893. Serial No. 493,921. (No model.)

*To all whom it may concern:*

Be it known that I, ROBERT M. DOWNIE, a citizen of the United States, residing at Beaver Falls, in the county of Beaver and State of Pennsylvania, have invented a new and useful Drilling-Machine, of which the following is a specification.

This invention relates to drilling machines for Artesian and oil wells; and it has for its object to effect certain improvements in the operating mechanism and the tools of a drilling machine, whereby the efficiency and durability of such machine shall be greatly increased.

It is well known, to those skilled in the art of drilling, that heretofore it has been difficult to successfully employ a wire cable or rope for drilling purposes, for the reason that such rope or cable is too rigid and has not a sufficient spring in itself to allow the string of tools to successfully work, while at the same time a severe strain is not only placed upon all parts of the machine but upon the wire rope itself. At the same time, the advantages of a wire rope or cable have been recognized, on account of its durability and strength, and the present invention is therefore primarily designed to provide a drilling machine so constructed and used in connection with certain tools, whereby the employment of a wire cable for drilling may be rendered practicable. Furthermore, it is well known that in order to drill a hole either round or straight, it is necessary that the drilling tools or bit be turned constantly so that the drilling shall be properly accomplished, and it is also known that when the drilling tools have been "buried," the drilling rope or cable is under such a strain, that it will naturally tend to untwist or turn in one direction, that is, when the entire weight of the string or set of tools is suspended therefrom at the point of time when the drill is being lifted off of the bottom of the well. Now by the employment of a wire rope or cable, this turn or twist may be utilized for automatically turning the bit in the hole so as to keep up the proper turning or shifting thereof in the hole, and by reason of using a wire cable it will be at once apparent to drillers that when the string or set of drilling tools have their entire weight suspended from the wire cable after being buried, the cable will be so rigid that when it turns or twists in response to the unraveling tendency of the weight thereon, the torsional energy thereof will be sufficiently strong to turn the bit, which will follow the twisting of the cable as perfectly as if a rigid iron shaft were employed. To this end, therefore, the present invention utilizes the turn or twist of the wire cable to effect the turning of the bit, and provides a construction whereby this turning or twisting of the cable may be depended upon for the work required of it.

With these and other objects in view which will readily appear as the nature of the invention is better understood, the same consists in the novel construction, combination and arrangement of parts hereinafter more fully described, illustrated and claimed.

In the drawings:—Figure 1 is a vertical longitudinal sectional view of the front portion of a drilling machine constructed in accordance with this invention, sufficient of the machine showing to illustrate the features claimed. Fig. 2 is a front end view of the construction shown in Fig. 1. Fig. 3 is a detail side elevation of the drill jar, or more properly speaking, set of drill jars, employed in connection with the drilling machine. Fig. 4 is a central longitudinal sectional view of the construction shown in Fig. 3. Fig. 5 is a transverse sectional view on the line $x$—$x$ of Fig. 4. Fig. 6 is a similar view on the line $y$—$y$ of Fig. 4.

Referring to the accompanying drawings, A represents an ordinary frame of a drilling machine, which is usually mounted on wheels so as to provide means for readily moving the machine from place to place, and from the front end of the frame A, arises the frame derrick B, which is sufficiently high as to enable the proper length of stroke being given to the set of drilling tools.

The frame derrick B, arising from the front end of the machine frame A, preferably comprises the opposite pairs of standards C, suitably connected by the transverse braces $c$, to provide a derrick sufficiently strong for the work, and the opposite pairs of standards C, form guides for the vertically moving spring-supported derrick pulley D. The derrick pul-

ley D, is constructed of a suitable size and strength to accommodate the stroke of the drilling tools and to sustain the weight thereof, and such pulley is mounted on the journal pin or axle *d*, which journal pin or axle is mounted to turn in the opposite bearings *d'*, at the upper end of the bearing yoke E. The journal pin or axle *d*, is provided with the projected spindles *e*, extended beyond the bearings at the upper end of the bearing yoke E, and which are guided to work between the opposite pairs of standards C, which hold the pulley steady in its vertical or upright reciprocation, but it will of course be understood that a supplemental guide frame or other means for guiding the movement of the derrick pulley may be supplementally attached to the upper end of the derrick if found desirable.

The bearing yoke E, which supports the large derrick pulley D in position, is provided with a lower hollow stem or shank F, guided to move through the guide blocks *f*, arranged transversely between the opposite pairs of derrick standards, and the lower end of said hollow stem or shank preferably carries a flanged retaining cap *f'*, which receives and holds in position the upper end of the coiled pulley supporting spring G.

The coiled pulley supporting spring G, is mounted on the rod *g*, having one end thereof fitting in the hollow stem or shank F, and its other end in the upper end of the vertically reciprocating pitman H, which pitman is also provided at its upper end with a flanged cap *h*, which forms a seat for the lower end of the spring G, to hold the same properly in position. The lower end of the pitman H, is pivoted to the upper end of an eccentric arm I, projected from an eccentric strap *i*, working over the shaft eccentric *i'*, mounted on the transverse drive shaft $i^2$. The drive shaft $i^2$, is mounted in suitable bearings at the front end of the machine frame and carries near one end thereof the drive wheel $i^3$, which is intended to receive a belt for imparting motion to the drive shaft, and thereby giving the proper reciprocations to the derrick pulley D.

The vertically moving spring supported pulley D, is adapted to receive thereover the wire drilling rope or cable H', one end of which is wound on the ordinary rope reel *h'*, journaled on the machine frame A, and the other end of which is connected to a string or set of drilling tools, which in the present invention is intended to consist of a set of drill jars J, specifically constructed for use in connection with a wire cable, a stem *j*, connected to the lower end of the jars, and the bit *j'*, connected to the lower end of the stem, it being found that by employing a wire drilling rope or cable the sinker-bar may be dispensed with, and the entire set of tools shortened owing to the added weight given by the wire rope or cable. It will be obvious that when the drive shaft is set in motion, the reciprocation of the derrick pulley will impart the necessary stroke to the drilling tools to effect the drilling of a well, and it is to be noted that by reason of the direct coupling of the large top derrick pulley with the drive shaft therebelow, by means of an eccentric or crank connection, having a shorter stroke than the diameter of said pulley, the stroke of the eccentric or crank multiplies the stroke of the drilling tools sufficiently, so as to render these means of operating the drill very efficient. It will be noticed that by the operation of this device the periphery of the large rope pulley travels about its axis only one half the distance which it would have to travel if the pulley were stationary in the derrick. This is a very important improvement in connection with the drill cable, because heretofore the principal wear on the drill cable was in continuously passing forward and back over this pulley and stopping and starting it by its friction therewith. It should also be noted that in operation this pulley must travel forward and back from sixty to seventy return trips per minute, and the speed of its periphery when so traveling must be the speed of a body falling freely, or some sixteen feet per second, the length of stroke being from twenty-four to forty-eight inches. Now if the pulley were journaled stationary in the derrick, and, if to get such speed upon the falling drilling tools, the power were delivered to the cable by means of rotating the rope drum *h'*, it will be seen at once that the periphery of the rope pulley must attain a speed forward and back equal to the speed of a falling body, and such speed would have to be suddenly attained, and again suddenly stopped, sixty or seventy times per minute, solely by the friction of the cable. This would cause great wear and soon destroy the cable. By the mechanism described, the speed of the periphery attains only one half the speed of a falling body, the cable travels on the pulley only half the distance around the periphery, and the power being delivered to the pulley, instead of to the drum-end of the line as heretofore, the momentum of the periphery of the pulley will not interfere with the rapid reverse in the direction of the cable's travel. This application of power to a drill cable is, I believe wholly novel, and is of great advantage in that it enables a much greater speed to be attained than by any other device heretofore used. It is to be further noted, that by reason of interposing a spring between the pitman H, and the bearing yoke of the pulley, such pulley will yield sufficiently to give the necessary "spring" to the wire cable or rope, and thereby relieve it from the strain which would otherwise bend or "kink" the same and render it impracticable for drilling purposes, and it will therefore be seen that a spring supported pulley of the character described is essentially necessary for the practicable employment of a wire rope or cable for drilling.

The set of jars J, referred to, are suspended

directly from one end of the wire cable H', and such set of jars or more plainly speaking, the drill jar, has an outer cylindrical jar casing K. The cylindrical jar casing K, is provided with an upper interiorly threaded end *k*, and a lower solid end *k'*, projected below the lower end of the interior bore of the casing so as to give additional weight to the set of drilling tools, and which is provided in its lower extremity with a threaded socket L, which removably receives the screw or pin *l*, at the upper end of the stem *j*. The cylindrical jar casing K, is further provided at a suitable point with the squared sides M, which admit of a suitable wrench for handling the jars, and at a point below the upper interiorly threaded end of the casing the same is provided with the side vent slots N, of a sufficient length and width which provides for a free ingress or egress of water during the process of drilling, and while the moving member of the jars is in motion toward the end of the stroke.

The upper interiorly threaded end *k*, of the cylindrical jar casing K, is adapted to detachably receive the exteriorly threaded guide and jar plug O. The exteriorly threaded guide plug O, fits snugly within the upper threaded end of the casing and is provided with a central guide opening *o*, a squared wrench head *o'*, at its upper outer end, and a highly tempered inner jar end $o^2$, which is adapted to receive the blow or jar from the upper end of the jar head P, the latter having a movement inside of the casing below the guide plug at the upper end thereof. The moving jar head P, is also provided at its upper end with a highly tempered jar end *p*, which is that part of the head adapted to come in contact with the lower tempered jar end of the guide plug, and by reason of tempering the contacting jar portions the metal is prevented from spreading and the wear on these parts reduced to a minimum.

The moving jar head P, is provided with a central opening Q, in which one end of the wire rope or cable H', is securely fastened by soldering or other suitable means, and at the upper end of said opening Q, the head P, is provided with a threaded socket *q*, which detachably receives the lower threaded end of the rope or cable guide tube R, which is arranged to slide freely in the central guide opening *o*, of the upper guide plug O. The rope or cable guide tube R, serves to hold the portion of the drilling rope or cable, which works inside of the jar casing, perfectly straight and guides it in its longitudinal movement, and said guide tube is provided with an upper flared end S, which admits of a free lateral play or swing of the rope or cable without presenting any sharpened edges thereto. A modification of this method of attaching the drilling cable to the moving jar head P, which I may employ is to fasten the cable into the upper end of the guide tube R, at the point S, in Fig. 4, and in this latter construction the guide tube R, may or may not be made solid in its lower portion and screwed or riveted into the moving jar head P. In this latter case the guide tube will be considered as an extension upward of the solid jar head P, such modification being in all respects the exact equivalent of the construction shown in the drawings, Fig 4.

Now by reason of employing the specific constructions of drill jar just described, in connection with the wire rope or cable H', it will be seen that the use of "sinker bars" is unnecessary, and the entire length of the set of drilling tools may be shortened, because the heavy wire rope forms a part of the moving weight of the tools, and by extending into the jar casing of the jars and being connected to the moving jar head, the rope forms a substantial part of the upper half of the drill jars, and gives additional weight to such jars, so as to render the same especially useful in the connection claimed.

The operation of ordinary drill jars is well known to those skilled in the art, such jars being simply employed to "start up" a drill from the bottom of the well, so as to prevent the drill bit from becoming fast in the mud or crevices of the rock; but the jars herein described serve three or more very important and distinct purposes in addition to the above. These purposes are first, they, in operation, turn the drilling tools automatically a portion of a turn at each stroke of the drill; second, they provide for taking up the excess of cable length which may be in the well at the end of the downward stroke, preventing the "kinking" of the wire cable at the top of the tools. This is effected partly by the jar head P, dropping down in its pocket formed within the casing, partly by the spring G, and partly by a means hereinafter described; third, the momentum of the jar head P, upon its vertical axis, in turning, serves a very important purpose in making efficient and utilizing the torsional power of the rope to turn the drill automatically at each stroke. To make these points clear it will be necessary to describe the action of the jars at different points during the stroke, from which it will be readily seen that if the jar head P, was not free to turn upon its axis in either direction, or if said jar head P, had any frictional contact with any other part of the drilling tool, as for instance a stuffing box around the guide tube R, friction clutches, dogs or ratchets, it would not serve the purpose intended in this invention. To describe then, the action of the jars:—Before the strain is applied to the drilling cable to lift the string of tools, it is seen that the jar head P, is neither in contact with the upper jar head O, nor any other part of the drilling tools. At this point of time, the cable will have, what is called, its normal twist, but as soon as the strain is put upon the cable by the machinery, the jar head P, will be drawn

into frictional contact with the jar head O. At this instant, and owing to the fact that a strain tends to lengthen a rope by partially untwisting it, and owing again to the fact that the cable cannot run its twist out at the upper end, the tendency of the cable to untwist will be imparted to its lower end, and so soon as the drill bit *j'*, has been lifted out of contact, with the bottom of the well, the set of drilling tools will begin to obey the turning tendency of the cable. This will continue as long as the strain is on the cable or during the up stroke. At the end of the up stroke, the drilling tools will have gained a momentum on their axis which will continue to keep them revolving in that direction until they strike the rock at the end of their down stroke.

Now by the employment of the spring G, upon the shaft which elevates the rope pulley, it will be noticed that the drilling tools will receive during their up stroke a toss or impulse which will elevate them to a considerable distance beyond that represented by the throw of the eccentric or crank *i'*, and hence the downward stroke of the eccentric will have begun before the set of drilling tools will begin their descent. The jar head P, will be the first to feel the release of the cable for the downward stroke and will drop downward in its casing, releasing its frictional hold or impact on the jar head O. This will take place at and during the down stroke. At the instant of release, the cable will recover its normal amount of twist, the jar head P, revolving back freely and unimpeded with the cable. It will also be noticed that the jar head P, being of considerable weight, will receive from the cable a sharp backward impulse or revolution upon its axis, which impulse will carry it back to and some distance beyond its former starting point from the normal twist of the cable, which it would not do if it were a mere swivel. This excess of twist beyond the normal will be saved and secured by the then applied friction of the two heads to assist in a still greater torsional power when the next strain comes on the drilling cable. In fact, in practice it is found that after a time the wire cable becomes so soft and flexible, and its torsional power so weak that it will not turn the drills under all circumstances, unless this torsion is accumulated from stroke to stroke until the torsion is great enough to effect the turning. In order to secure this service it is obvious that if any ratchet, spring, or frictional device were introduced to retard the quick and prompt back action of the jar head P, upon its axis, and prevent its revolving back freely, at the slackening of the cable, it would prevent the cable from twisting back fully to its normal unstretched condition.

The device claimed not only allows the jar head P, to revolve with the utmost freedom, but the surrounding casing protects it from all friction with the débris in the well, and the walls of the hole being drilled.

I am aware that it is not new to connect a string of drilling tools to a rope by means of a loosely swiveled connection, usually called a "rope socket," but it is new to dispense with all rope sockets, swiveled or otherwise, and connect the cable directly to swiveled and self turning jars; also, it is novel to construct a set of jars the friction of whose free member against the opposing face of the rigid one, serves to automatically revolve the drilling tools by the torsion of the rope. It is also novel, as I believe, to combine the swiveled connection and the jars in such manner as to avoid the use of a heavy "sinker bar" above the jars.

The sinker bar is a dead weight and of no efficient value whatever, except to give weight to the free member of the jars in knocking the tools loose, and in addition to the foregoing it is also novel to make the weight and momemtum of the free jar head P, revolving back upon its axis, a means of accumulating, from stroke to stroke, the torsion of the rope to compel the drill bit to turn, even if greatly impeded by the mud which accumulates in the well while drilling.

Jars constructed as described, serve, as stated, the additional function of taking care of and protecting the surplus of line, preventing the throwing of kinks in the line at the top of the guide tube R, and thus preventing breakage at that point, where breakage is sure to occur if a complete loop should be thrown into the cable at that point. This is accomplished in the following way: As is well known, a revolving line or shaft is not nearly so liable to bend or kink as one motionless on its axis. Now by virtue of the fact that the jar head P, is free from all frictional or ratchet contact with anything else, so soon as relieved of the strain of the cable, it will revolve freely from the recovering torsion of the cable, preventing kinking; also the jar head P, being at the same time free to drop down in its pocket formed by the casing, prevents the surplus rope from looping on itself at the top of the tube R. In short, at the moment the bit stops its descent either from striking the bottom of the well or any obstruction in the well, the jar casing of the jars is suddenly stopped, while the wire drilling rope or cable continues to move downward sufficiently so as to lower the jar head P, out of contact with the guide or jar plug O, at the upper end of the jar casing and for this reason the jars described effectually prevent the rope or cable from bending or kinking in the event of the tools becoming wedged or stuck in the well before reaching the bottom. This is due to the fact that the drilling rope or cable is rigidly fastened to the jar head P, and should the drilling tool become suddenly wedged, it will be seen that the downward movement of the

drilling rope or cable, if in advance of the tools, is not interrupted, since the jar head P, will continue to slide downward after the jar casing has stopped, and thereby prevent such an injury to the rope as noted, and if it were not for this movement the rope would tend to coil or kink up at a point directly above the jars such as shown in dotted line in Fig. 3, of the drawings, and would soon break.

Changes in the form, proportion and the minor details of construction may be resorted to without departing from the principle or sacrificing any of the advantages of this invention.

Having thus described the invention, what is claimed, and desired to be secured by Letters Patent, is—

1. In a drilling machine, the combination of a spring supported derrick pulley, a drill jar having an independent longitudinally movable and freely revoluble part adapted to support the entire weight of the string of tools, and a wire drilling cable arranged over said pulley and connected to said longitudinally movable and freely revoluble part of the drill jar, said part of the drill jar being adapted to freely rotate in response to the torsional energy of the cable when relieved of the weight of the tools, substantially as set forth.

2. The combination with a well drilling rope or cable; of a cylindrical swivel drill jar adapted to have one of its members suspended from the lower end of said rope and its other member connected to the drilling tool, said swivel drill jar being adapted to turn bodily with the drilling rope as the same untwists in response to the suspended weight thereon, substantially as set forth.

3. In combination with a well drilling rope or cable, of a cylindrical swivel drill jar having a casing and an independently revoluble jar head moving longitudinally therein and attached to the lower end of said drilling rope or cable, substantially as set forth.

4. In combination with a drilling cable; of a set of jars comprising a casing having a fixed upper jar plug and a movable jarhead arranged to independently rotate within the casing below said plug and attached to the lower end of the drilling cable said movable jar head being adapted to have a jarring and frictional contact with the upper fixed plug, substantially as set forth.

5. A drill jar comprising a cylindrical casing having an upper guide or jar plug provided with a lower tempered jar end, and an inner longitudinally moving and independently revoluble jar head adapted to be connected to the lower end of the drilling rope or cable and provided with an upper tempered jar end, said inner jar head being adapted to freely rotate within the casing when relieved from contact with the upper jar plug, substantially as set forth.

6. In combination with a wire drilling cable; of a set of jars comprising a cylindrical casing having side vent slots and a lower solid end, a perforated guide plug detachably fitted into the upper end of the casing, an inner longitudinally movable and independently revoluble jar head arranged to work below the said guide plug and connected to the lower end of the drilling cable, and a cable guide tube fitted at its lower end into said jar head and adapted to slide in the central opening of the guide plug, substantially as set forth.

7. In combination with the wire drilling cable; of a set of jars comprising a casing having an upper jar plug and inclosing a pocket below said plug, and a longitudinally moving and independently revoluble jar head arranged within the casing pocket below said plug and attached to said drilling cable, said head being adapted to move below the jar plug in the pocket to take up the surplus length of the drilling cable, substantially as set forth.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

ROBERT M. DOWNIE.

Witnesses:
M. A. DOWNIE,
JAMES F. MERRIMAN.