April 17, 1956 R. E. SNYDER 2,742,264

IMPACT DRILL

Filed July 16, 1951 2 Sheets-Sheet 1

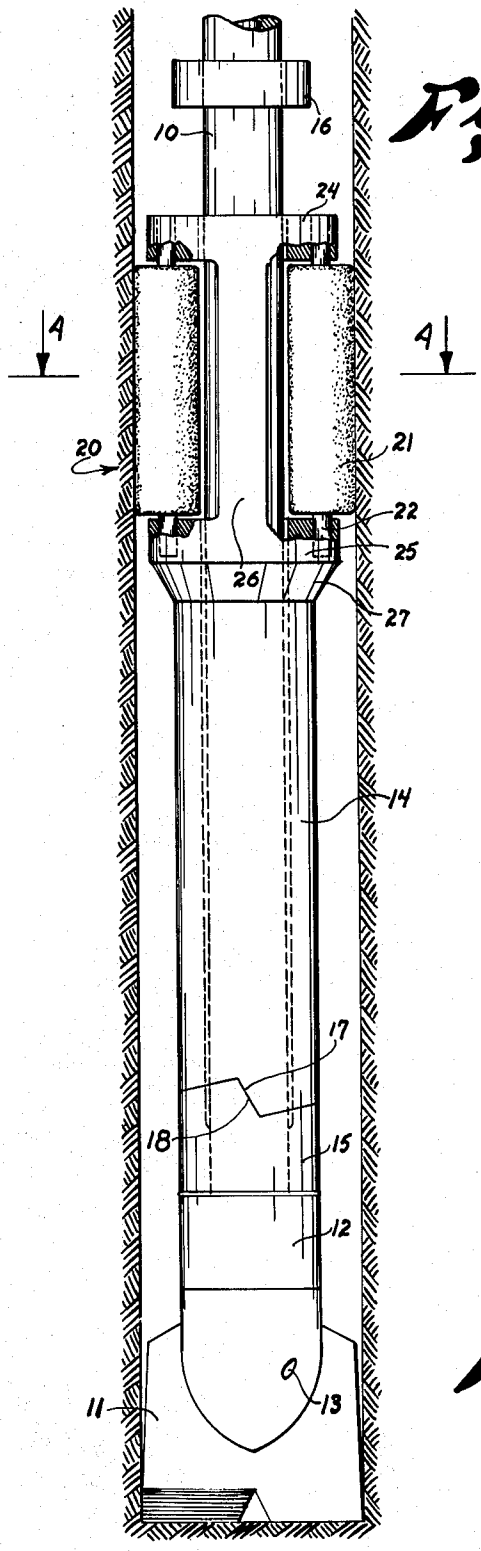

Fig. 1

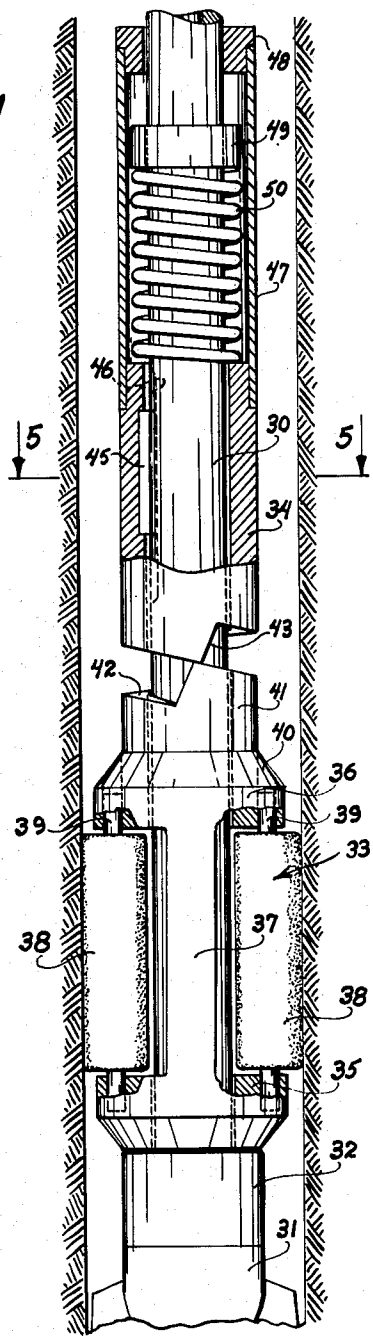

Fig. 2

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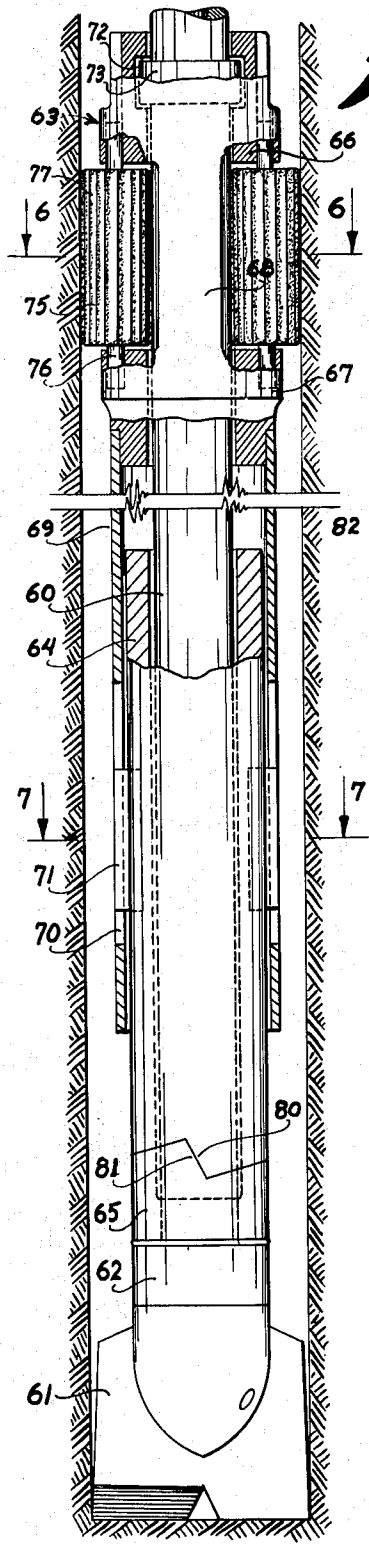

Fig. 3

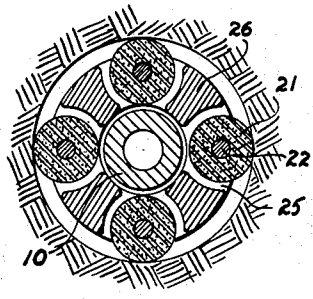

Fig. 4

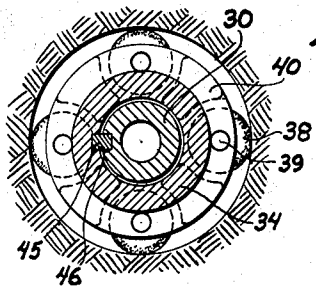

Fig. 5

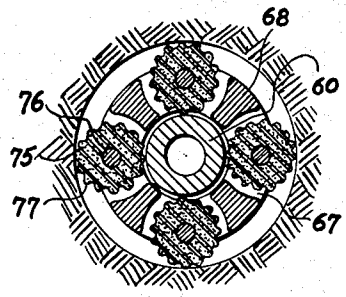

Fig. 6

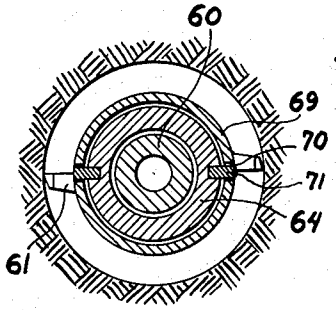

Fig. 7

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United States Patent Office 2,742,264 Patented Apr. 17, 1956

2,742,264

IMPACT DRILL

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Application July 16, 1951, Serial No. 236,936

8 Claims. (Cl. 255—3)

My invention relates generally to rotary impact drills and more particularly to impact drills of the type in which relative rotation occurs between the drill shank and a body mounted thereon. This relative rotation effects movement of a reciprocable hammer member and causes a series of impacts to be delivered to a rotating drill bit.

In my Patent No. 2,425,012, issued August 5, 1947, I have disclosed certain forms of retarder means which create relative rotation of a body member by fluid engagement of blades or vanes mounted thereon. The retardation is caused by frictional forces acting between the blades and the drilling fluid or mud, and the blades are not designed to engage the walls of the drilled hole. The present application, broadly considered, discloses a new type of retarder means which makes a direct and substantially constant rolling contact with the walls of the drilled hole. A preferred embodiment of my invention includes essentially one or more wall rollers which roll against the wall of the hole as the drill stem is rotated. The resistance to rotation of these rollers retards the rotation of an attached body member, and actuates the desired impacting means.

The retarder means have additional important functions besides that of creating the desired relative rotation. The rollers, if positioned within the vicinity of the drill bit, will center the drill stem within the hole. They are also adapted to override small projections in the hole to produce a smooth and uniform bore. Under some conditions they may be toothed as in standard reamer rollers to make biting engagement with the walls of the hole and enlarge the bore thereof. As can be understood, the wide variety of earth formations encountered in drilling wells requires the use of many types of drills and bits in order to secure the best results. Consequently, the aforementioned operational features will be advantageous under many different conditions, and the proper use of my impact drill will be apparent to those skilled in the art.

A major object of my invention is to provide an impact drill which may be operated by the use of wall roller means adapted for rolling contact with the wall of the hole.

Another object of my invention is to provide an impact drill of this type, which tends to center the drill bit within the hole and to produce a smooth and uniform bore.

It is also an object of my invention to provide an impact drill of this type which may be operated simultaneously as a wall reamer.

An additional object of my invention is to provide an impact drill wherein the impact rate is substantially independent of the volume and pressure of the circulating drilling fluid.

Still another object of my invention is to provide retarder means which are adapted for substantially uniform rolling contact with the walls of the drilled hole to produce a uniform impacting rate.

It is a further object of my invention to provide simple and durable retarder means adapted to withstand rough usage and avoid jamming or "hanging up" in the hole.

These and other objects and advantages of my invention will become apparent from the following detailed description of various embodiments thereof, and from an inspection of the accompanying drawings, in which:

Fig. 1 is a side elevation, partially in section, of one form of my improved impact drill, with the cam operating means in their lowermost position, immediately after one of the cams has overridden the other.

Fig. 2 is a side elevation of a modified form of my device with the cams about to override each other;

Fig. 3 is a view similar to Fig. 1 of another modification of impact drill;

Fig. 4 is a cross-section taken along the line 4—4 of Fig. 1;

Fig. 5 is a cross-section taken along the line 5—5 of Fig. 2;

Fig. 6 is a cross-section taken along the line 6—6 of Fig. 3; and

Fig. 7 is a cross-section taken along the line 7—7 of Fig. 3.

Referring now to the drawings, and particularly to Fig. 1 thereof, a simple form of my improved impact drill is shown, in which the numeral 10 indicates generally a rotatable drill shank. A conventional drill stem (not shown) is coupled to the drill shank 10 and transmits driving power to rotate a lower drill bit 11. Preferably, the bit 11 is coupled to a collar 12 formed on the lower end of the shank 10 and may be easily replaced.

The shank 10 is of hollow tubular construction and carries the drilling fluid or mud to ports 13 in the bit 11 where the fluid is discharged to pick up the rock chips and other detritus within the drilled hole. The drilling fluid then circulates upwardly in the hole through the space around the shank 10. To this extent the operation of the drill is similar to that of a conventional rotary drill, and the associated drilling equipment including the fluid pumps, driving means, and such, need not be described herein.

Above the shank collar 12 is an impact structure which includes a reciprocable body member or hammer 14 and an anvil 15. The hammer 14 is formed as a relatively heavy tubular member and is mounted for rotation and reciprocation on the shank 10. The anvil 15 is formed as an annular ring welded or otherwise fastened to the upper face of the collar 12 for rotation with the shank 10. The engaging faces of the body member 14 and anvil 15 provide cam operating means to cause reciprocation of the body member relative to the shank 10. An upper cam 17 is shaped on the body member 14 and a complemental lower cam 18 is formed on the anvil 15. Upon rotation relative to each other, cams 17 and 18 cooperate to periodically lift the body 14 which in turn falls to impact on the anvil 15. A collar 16 is secured to the shank 10 above the body member 14 at such a position as to limit relative axial movement of the latter while allowing free cooperative movement between cams 17 and 18.

Near the top of the body member 14 are retarder or wall roller means 20 surrounding the shank 10. The roller means 20 are in frictional contact with the wall of the drilled hole and retard the body member 14 to create relative rotation with respect to the shank 10. The roller means 20 may be formed as a plurality of cylindrical rollers 21 rotatably supported by extended axles 22. The rollers 21 are spaced about the periphery of the shank 10 to rotate on the individual axles 22 as they revolve about the axis of the shank. In this form of the drill, the rollers 21 are made of a durable resilient material, such as rubber, and have a smooth surface adapted to slidably engage the wall of the hole and the drilling mud therein.

To position the rollers 21 a housing is formed with an upper support or flange 24 and lower flange 25 spaced apart and secured to the body member 14. Suitable webs or ribs 26 connect the flange 24 with the flange 25, and a tapered shoulder 27 joins the lower flange to the body member 14. The roller axles 22 are disposed parallel to the axis of the shank 10 with the ends rotatably seated in the flanges 24 and 25. As is best seen in Fig. 4, the rollers 21 are spaced about the periphery of the shank 10 and have sufficient clearance with the exterior surface of the shank so that they do not bind or jam thereon. The outer edges of the rollers 21 are concentric with the shank 10 and lie on a circle of diameter approximately equal to that of the bit 10 so as to contact the wall of the drilled hole and center the shank therein.

Considering the operation of the drill, it will be seen that as the shank 10 commences to rotate, the body 14 is seated upon the anvil 15 through the faces of cams 17 and 18. Because of the frictional engagement of cams 17 and 18, the body 14 rotates with the shank 10, and in turn rotates the roller supporting flanges 24 and 25. The rollers 21 roll about the wall of the drilled hole much in the manner of a roller bearing in which the wall acts as an outer race. The presence of the fluid mud, and the mud coating on the walls, as well as the internal friction of the rollers, offers a substantial resistance to rotation of the assembly. The body 14 tends to be retarded relative to the shank 10 and commences to rotate at a slower rate. As the rollers 21 turn, they override any small irregularities in the wall of the drilled hole, and thus create a smooth and uniform bore. To increase the reaming effect of the rollers 21 they may be formed with toothed surfaces for biting engagement with the wall.

Although the body 14 is retarded with respect to the shank 10, it is not normally stopped because the retarding forces depend principally upon the rolling friction created. Thus, there is little tendency for the roller 21 to bind or jam within the hole. Prior devices having wall-engaging means were, in general, provided with non-rotatable and sharply projected contact members which tended to "hang up" within the drilled hole. As can be appreciated, the uniform rolling contact of the retarder means used herein greatly reduces the danger of jamming the drill within the well bore.

When the body member 14 commences rotating at a slower rate than the shank 10, the upper cam 17 is caused to periodically override the lower cam 18. One or more complemental lobes or crests are formed on the cam surfaces, and so arranged as to lift upper cam 17 upon rotation relative to lower cam 18. Because the cam 18 is fixed for rotation with the shank 10 in this form of the device, it may be considered as the driving cam, while the cam 17 may be considered as the driven cam. When the driven cam 17 as rotated counterclockwise with respect to the driving cam 18, as viewed in Fig. 1, the former is forced upwardly by the cam action to lift the body member 14. The cam lobes then override and the body member 14 falls to impact against the anvil 15.

As was previously mentioned, the body member 14 is made relatively heavy to form a hammer, and the force of the impacts thus created are transmitted through the anvil 15 and collar 12 to the bit 11. As can be understood, the rate of impacting and the character of the impacts may be varied to suit different drilling conditions. For example, many of the different types of cam means shown in my copending application Serial No. 734,989, filed March 15, 1947 may be used in the present device.

The impact rate is substantially independent of the circulation rate of the drilling fluid because the retardation is dependent upon rolling friction rather than fluid friction. Under certain drilling conditions, this characteristic of the drill will be very advantageous, and represents a departure from the operation of the drill in my aforementioned patent.

In the form of structure just described the rollers 21 are required to reciprocate with the body member 14, in addition to rolling around the wall of the hole. As the body member 14 falls against the anvil 15, the rollers 21 must be dragged downwardly and this may tend to lessen the impact. By reference to Fig. 2, an alternate form of drill is shown in which the retarder means are not required to reciprocate with the hammer body. An impact spring means is also used to increase the force of the impacts.

A suitable drill shank 30 is rotatably driven within a drilled hole by the customary equipment (not shown). On the lower end of the shank 30 is a drill bit 31 and collar 32 generally similar to the bit 11 and collar 12 of the previously described form. Above the collar 32 is a retarder or wall roller means 33 and a body member or hammer 34. The roller means 33 is rotatable on the shank 10 and normally bears against the upper face of the collar 32. The hammer 34 is reciprocably mounted on the shank 30, and impacts downwardly against the roller means 33 to transmit energy to the bit 31 through the collar 32.

The roller means 33 includes a housing formed of a lower annular ring 35 and upper ring 36 connected by webs or ribs 37. The housing thus formed is both rotatably and axially movable on the shank 10 and supports a plurality of rollers 30 spaced about the periphery of the shank 30. Each roller 38 is supported on an axle 39 rotatably journaled by the rings 35 and 36 and spaced outwardly from the shank 30, to provide clearance between the surfaces of the rollers and the exterior of the shank. The outer edges of the rollers 38 just contact the wall of the drilled hole and create retarding friction as has previously been described. In this form of the drill, the rollers 38 are again preferably made of a durable resilient material, such as rubber, and have a smooth surface adapted to slidably engage the wall of the hole and the drilling fluid therein.

At the top of the ring 36 is a tapered shoulder 40 which joins an anvil 41 of reduced diameter. The upper face of the anvil 41 is formed as a lower or driven cam 42 which engages with a complemental upper or driving cam 43 formed on the hammer body 34. Since the hammer 34 is fixed for rotation with the shank 30, the driving cam 43 normally causes rotation of the driven cam 42 through frictional engagement until such time as the retarder means 33 decreases the rotational speed of the driven cam. As was previously mentioned, the entire retarder means 33 is rotatably and axially movable on the shank 30. However, as shown in Fig. 2, the weight of the structure will normally cause the lower housing ring 35 to seat downwardly against the collar 32.

The hammer 34 is fixed for rotation with the shank 30 by means of inwardly projecting longitudinal key 45 which is slidably engaged in the groove 46 formed in the shank to permit reciprocation of the hammer. The upper portion of the hammer 34 is connected to a thin-walled shell 47 which is terminated by a cap 48. Within the shell 47 is a collar 49 secured to the shank 30 and the shell is thus movable relative to the collar upon reciprocation of the hammer 34. The collar 49 serves to limit the axial movement of the hammer 34, but is so positioned as to allow free cooperation between the cams 42 and 43.

To change the character of the impacts delivered by the hammer 34, an impact spring means 50 is confined within the shell 47. The spring means 50 is preferably formed as a strong coil spring having one end seated upon the top of the hammer 34 and the other end abutting the collar 49. Upward movement of the hammer 34 thus causes compression of the spring 50. Energy is stored in the spring 50 upon compression, and is returned to the hammer 34 upon the downward movement of the latter to increase the magnitude of the impact delivered to the anvil 41.

The operation of the drill is, in general, similar to that of the form previously described. Upon rotation

of the shank 30, the wall roller means 33 are retarded due to the frictional rolling contact with the wall of the drilled hole. The hammer body 34 is fixed for rotation with the shank 10, and as the roller means 33 is retarded, relative rotation occurs between the engaging cams 42 and 43. The upper cam 43 rotates clockwise with respect to the cam 42, as shown in Fig. 2, and periodically lifts the hammer 34. The upward movement of the hammer 34 compresses the spring 50 to store energy therein. When cam 43 overrides cam 42, the hammer 34 impacts downwardly against the anvil 41 under the combined force of the spring and gravity.

It should be particularly noted that in this form of the drill, the rollers 38 are not forced to reciprocate within the well bore. The hammer 34 may thus reciprocate with a much freer action and a higher impact rate is made practical.

In Fig. 3 another modification of my drill is shown which differs from the previously described forms in the arrangement of elements and the structure of the wall roller means. A shank 60 is adapted to be rotated within a drilled hole, and carries a lower drill bit 61 coupled to a collar 62. Mounted on the shank 60 is an impact structure having a retarder or wall roller means 63 spaced above the collar 62, and an intermediate hammer or body member 64 adapted to reciprocate and impact against an anvil 65.

The wall roller means 63 includes a housing formed of a rotatable upper ring or support 66 and a similar lower ring 67 connected by webs or ribs 68. Attached to the ring 67 is a dependent skirt or sleeve 69 which slidably engages the hammer body 64. Grooves 70 are formed in the sleeve 69 to receive keys 71 formed on the hammer 64 and lock the members for rotation together. The upper ring 66 is held against axial movement on the shank 60 by means of a bearing or annular groove 72 which fits over a collar 73 rigidly secured on the shank.

A plurality of rollers 75 are peripherally spaced about the shank 60 and extended between the rings 66 and 67. Each roller 75 is supported on an axle 76 rotatably journaled in the rings 66 and 67 and spaced outwardly from the shank 60 to provide clearance between the exterior surface of the shank and the rollers. The outer surface of the rollers 75 just contacts the wall of the drilled hole, and creates retarding friction, as has been previously described. To increase the reaming effect of the rollers 75, they are formed with toothed or longitudinally serrated surfaces 77, as may best be seen in Fig. 6. The toothed surfaces 77 are adapted to make biting engagement with the wall of the hole, and thus insure a straight and uniform bore. The depth of engagement between the surfaces 77 and hole wall may be modified to suit different drilling conditions, but will be relatively small so as not to interfere with the impacting characteristics of the drill.

The anvil 65 is formed as an annular ring welded or otherwise affixed to the upper face of the collar 62 for rotation with the shank 60. The engaging faces of the hammer body 64 and anvil 65 provide cam operating means to cause reciprocation of the hammer relative to the shank 60. An upper or driven cam 80 is shaped on the hammer 64 and a complemental lower or driving cam 81 is formed on the anvil 65. When relative rotation occurs, the cams 80 and 81 cooperate to periodically lift the hammer 64, which in turn falls to impact against the anvil 65.

At the top of the hammer 64 is an impact spring means 82 which increases the force of the blows delivered to the anvil 65. The spring means 82 is preferably in the form of a strong coil spring confined between the upper end of the hammer 64 and the roller housing ring 67. The spacing between the ring 67 and hammer 64, and the proportions of the spring 82 are such as to permit sufficient axial movement of the hammer for free cooperation between the cams 80 and 81. Upon lifting of the hammer 64, the spring 82 is compressed to store energy, which is subsequently returned when the hammer falls, to increase the force of the impact.

Upon retardation of the wall roller means 63 through the frictional rolling contact with the wall of the drilled hole, the hammer 64 is likewise retarded because of the engagement of keys 71 and grooves 70. Retardation of the hammer 64 creates relative rotation between upper cam 81 and lower cam 80 and causes the hammer to be lifted. The hammer 64 in turn falls and impacts against the anvil 65 under the combined force of gravity and the spring 82. The impacts are delivered to the bit 61 through the collar 62 to increase the drilling rate over that of a conventional rotary drill.

As can be understood, this form of my drill is similar in many respects to the previously-described forms, but has a somewhat different mode of operation. The retarder means do not reciprocate within the well bore, and consequently the hammer body has a freer action making suitable a high impact rate. The provision of the serrated roller surfaces 77 creates a more positive frictional engagement with the wall surface, and the retarding effect is increased. Additionally, the wall is reamed to a positive and uniform bore size. For these reasons, this form of the drill may be advantageous in certain types of drilling operations.

While I have described my invention with relation to particular forms of my drill, it will be apparent that modifications can be made in each of the forms, and there may be combinations of features other than those set forth. Accordingly, I do not wish to be restricted to the details of construction herein-described, except as defined in the appended claims.

I claim:

1. A rotary impact drill for earth boring which includes: a shank adapted to have a bit attached thereon and to be rotated in an earth bore; impact means reciprocably mounted on said shank for delivering impacts thereto; retarder means rotatably mounted on said shank, said means comprising a roller housing and a plurality of wall rollers rotatably mounted therein substantially parallel to the axis of said shank, said rollers being positioned for rolling frictional engagement with the wall of said bore to retard rotation of said retarder means; and cam means on said shank frictionally urging said retarder means to rotate with said shank but responsive to relative rotation between said shank and said retarder means to lift said impact means for impacting against said shank.

2. A rotary impact drill for earth boring which includes: a shank adapted to have a bit attached thereon and to be rotated in an earth bore having drilling fluid therein; a tubular impact hammer reciprocably mounted on said shank; an anvil mounted on said shank below said hammer and held against downward movement; retarder means rotatably mounted on said shank comprising a roller housing and a plurality of wall rollers rotatably mounted therein substantially parallel to the axis of said shank, said rollers being positioned for rolling frictional engagement with the wall of said bore to retard rotation of said retarder means; and cam means on said shank associated with said hammer and said anvil, said cam means frictionally urging said retarder means to rotate with said shank but being responsive to relative rotation between said shank and said retarder means to lift said hammer for impacting against said anvil.

3. A rotary impact drill for earth boring which includes: a shank adapted to have a bit attached thereon and to be rotated in an earth bore having drilling fluid therein; a tubular impact hammer reciprocably mounted on said shank; an anvil mounted on said shank below said hammer and held against downward movement; a driving cam mounted on said shank and rotatable therewith; a driven cam mounted on said shank and urged to rotate by rotation of said driving cam, one of said cams being connected to said hammer and reciprocable therewith on said shank; and retarder means rotatably

mounted on said shank and connected to said driven cam for rotation therewith, said means comprising a roller housing and a plurality of wall rollers rotatably mounted therein, said rollers having their axes of rotation generally parallel to said shank and positioned for rolling frictional engagement with the wall of said bore to decrease the rotary speed of said housing and said driven cam and establish relative rotation between said cams, thereby causing said reciprocable cam to lift said hammer and produce an impact on said anvil.

4. A rotary impact drill for earth boring which includes: a shank adapted to have a drill bit attached thereto and to be rotated in an earth bore having drilling fluid therein; a driving cam fixed on said shank for rotation therewith; a driven cam mounted on said shank and frictionally engaged with said driving cam; a tubular impact hammer rotatably mounted on said shank and connected with said driven cam, said hammer reciprocating on said shank upon relative rotation between said driving and driven cams; an annular roller housing connected to said hammer and rotatably mounted on said shank; means to limit the axial movement of said housing; and a plurality of generally cylindrical rollers rotatably mounted in said housing and spaced outwardly from said shank, the outer edges of said roller being adapted for constant rolling frictional engagement with the wall of said bore to decrease the rotary speed of said housing and said hammer, whereby to create relative rotation between said driving and driven cams.

5. A rotary impact drill for earth boring which includes: a shank adapted to have a drill bit attached thereto and to be rotated in an earth bore having drilling fluid therein; an annular roller housing rotatably mounted on said shank and held against downward movement; a driven cam joined to said roller housing for rotation therewith; a driving cam reciprocably mounted on said shank; a tubular impact hammer keyed to said shank for reciprocation thereon, said hammer being joined to said driving cam to cause said cam to rotate with said shank, said hammer having an upper extension spaced outwardly from said shank; impact spring means confined within said hammer extension and having one end abutting said hammer; a collar within said extension fixed to said shank, said collar end abutting the other end of said spring means; and a plurality of generally cylindrical rollers rotatably mounted in said housing and spaced outwardly from said shank, the outer edges of said rollers being adapted for constant rolling frictional engagement with the wall of said bore to decrease the rotary speed of said housing and said driven cam, whereby to create relative rotation between said driving and driven cams and cause reciprocation of said hammer.

6. A rotary impact drill for earth boring which includes: a shank adapted to have a drill bit attached thereto and to be rotated in an earth bore having drilling fluid therein; a driving cam fixed on said shank for rotation therewith; a driven cam mounted on said shank and frictionally engaged with said driving cam; a tubular impact hammer rotatably mounted on said shank and connected to said driven cam, said hammer reciprocating on said shank upon relative rotation between said driving and driven cams; an annular roller housing rotatably mounted on said shank, said housing having a lower extension spaced outwardly from said shank and keyed to said hammer to rotatably drive said hammer and permit relative reciprocation thereof; a collar fixed to said shank, and rotatably engaging said housing to hold said housing against axial movement; impact spring means codnfined within said housing extension with one end abutting said hammer and the other end abutting said housing; and a plurality of cylindrical rollers rotatably mounted in said housing and spaced outwardly from said shank, the surfaces of said rollers being longitudinally serrated and positioned for frictional engagement with the wall of said bore to decrease the rotary speed of said housing and said hammer, whereby to create relative rotation between said driving and driven cams and cause reciprocation of said hammer.

7. A rotary impact drill for earth boring which includes: a shank adapted to have a drill bit attached thereto; an annular roller housing rotatably mounted on said shank and held against downward movement, and provided with a driven cam on its upper end rotatable therewith; a tubular hammer reciprocably mounted on said shank and rotatable therewith and provided with a driving cam on its lower end rotatable therewith, said hammer having an upper extension spaced outwardly from said shank; spring means within said hammer extension and confined between said hammer and a collar on said shank urging said hammer downwardly; and a plurality of rollers generally parallel to said shank rotatably mounted in said housing outwardly of said shank and adapted for individual rolling frictional engagement with the wall of said bore to decrease the rotary speed of said housing, whereby to cause relative rotation between said cams and reciprocation of said hammer.

8. A rotary impact drill for earth boring which includes: a shank adapted to have a drill bit attached to its lower end; a tubular hammer reciprocably mounted on said shank for delivering impacts thereto; cam means mounted on said shank including a driving member rotatable with said shank and a driven member frictionally urged to rotate with said driving member, one of said members beinlg connected to said hammer and reciprocable therewith on said shank; and retarder means mounted on said shank and rotatable with said driven cam member to thereby be urged to rotate with said shank by the frictional engagement between said cam members, said retarder means comprising means mounting a plurality of wall rollers on individual axes substantially parallel to and spaced about said shank so that said rollers will have substantially uniform rolling contact with the wall of said housing and said bore of such magnitude as to retard rotation of said retarder means and driven cam upon rotation of said shank to thereby cause relative rotation between said cam members and periodic reciprocation of said reciprocable cam and said hammer.

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