July 19, 1938. O. B. GOLDMAN 2,124,414

WELL DRILLING BIT

Filed April 18, 1936

Fig. 1.

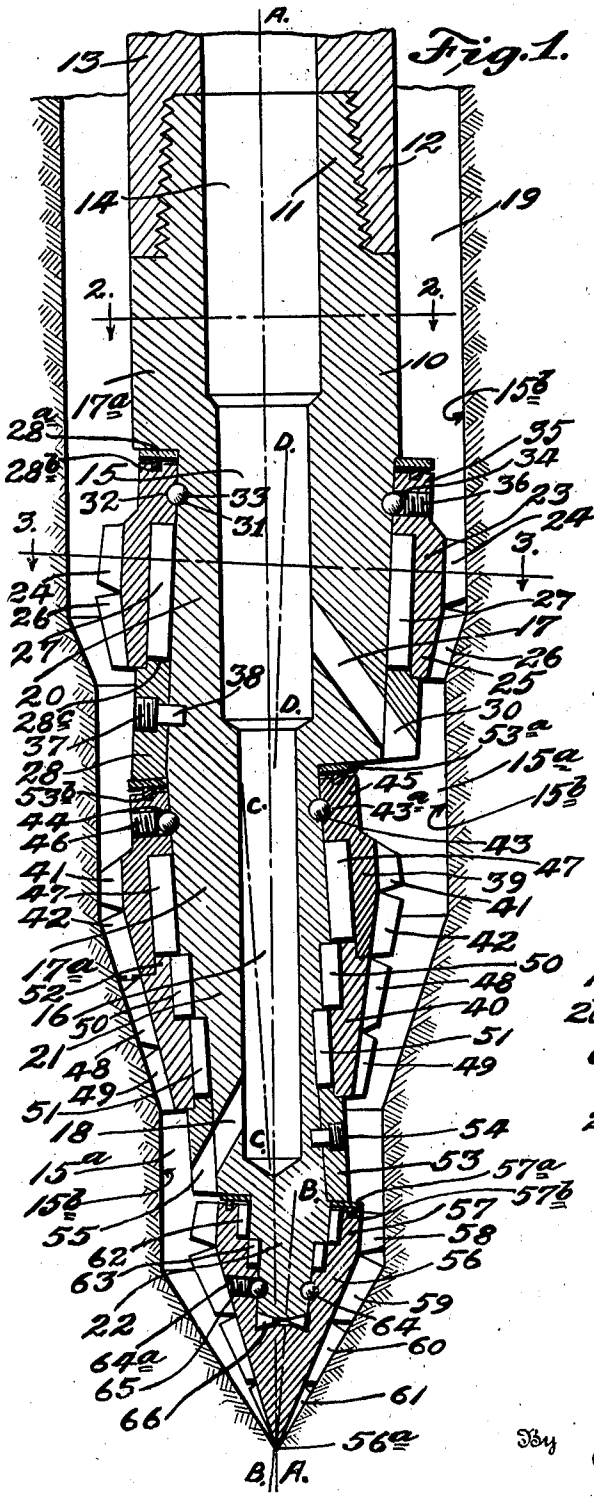


Fig. 2.

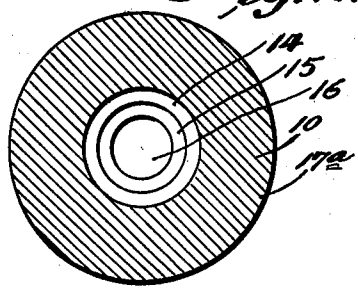


Fig. 3.

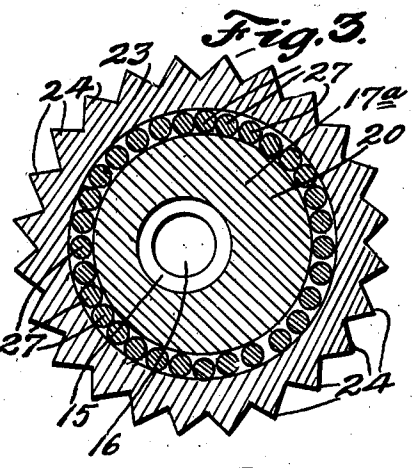
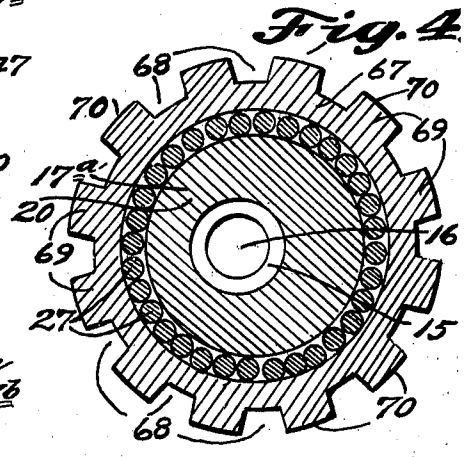


Fig. 4.



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2,124,414

WELL DRILLING BIT

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9 Claims. (Cl. 255—71)

This invention relates to well drilling bits and more particularly to bits of the roller type for rotary drilling operations.

The amount of hole which may be cut or made with any bit depends upon the total length of cutting edge or edges which the bit has and the force intensity, or force per unit length of the cutting edge or edges with which the cutting edge or edges are made to bear against the formation or stratum being drilled. Upon these factors depends, primarily, the amount of hole which may be made by the bit before it becomes dull and makes it necessary to resort to the expensive operation of removing the drill stem from the hole and replacing the dull bit with a sharp one, to say nothing of the loss of time from the drilling operation and certain obvious hazards and detrimental happenings that may occur. The speed with which the bit makes the hole is also a factor of economical importance and, manifestly, a bit with more length of cutting edge in engagement with the formation and the same or greater force intensity will make the hole correspondingly faster.

The weight, or weight on bottom, is that part of the weight of the drill stem and associated parts which, during drilling operation, is supported on the bottom of the hole and, evidently, in the present day type of bits where the cutting edges lay radially or transversely to the hole being drilled, this same weight on bottom is equal to the force with which the bit is pressed against the formation while being drilled. This weight is strictly limited, not by any inherent characteristics of the bit, but by the structure of the lower part of the drill stem which, in operation, is in compression and limited to somewhat less than that weight which will cause the drill stem to bend or buckle and cause the drilling of a crooked hole with all its concurrent ills and disadvantages.

In the present day type of bits, the weight is already used to the limit, or beyond; so that, instead of increasing the length of the cutting edge or edges in engagement with the formation at any one time, for the purpose of being able to make more hole, it is often found necessary and advantageous to notch the cutting edge in such manner that the length of the cutting edge in engagement with the formation at any one time is reduced in order to increase the force intensity and thus get faster drilling. So, too, the degree of dullness to which a bit may be worn, depends upon this force intensity which is used in drilling, so that, for example, with twice the force intensity the bit may be worn to double dullness; with the result that as much hole may be made with reduced cutting edges where, otherwise, the force intensity is too limited.

In the usual type or character of bit, the length of the cutting edge or edges cannot be increased without correspondingly reducing the force intensity and thereby correspondingly reducing the rate of drilling and the degree of dullness to which the bit may be worn and thus, obviously, also reducing the amount of hole which may be made with the bit.

In the usual type of roller bit, a succession of cutting edges are formed on a conical or cylindrical roller body whose axis, in operation, is disposed transversely to the hole and, for this reason, the length of the cutting edges which, by the rotation of the body or roller, come successively into engagement with the formation, as well as the diameter or size of the roller, which governs the number of cutting edges that may be formed thereon, are necessarily limited by the diameter of the hole being drilled.

It is an object of the present invention to produce an improved construction and arrangement in a bit of the roller type in which the diameter of the rollers, and thus the number of cutting edges which may be formed thereon, may be increased to a maximum.

Another important object of the invention is to produce a construction and arrangement in a bit wherein the length of the cutting edges may be increased and made as long as desired without inherent limits.

A further object of the invention is to produce a construction and arrangement wherein the force intensity with which the cutting edges bear against the formation or stratum being drilled will be preserved or increased without sacrificing the length of the cutting edges.

Another important object of this invention is to produce a construction and arrangement in a bit wherein the total force with which the cutting edges bear against the formation being drilled will be greater than the weight on bottom and wherein this total force may be made as great as desired without any inherent limits.

It is a still further object of the present invention to produce a construction and arrangement in a bit wherein the formation being drilled will not be compressed and compacted directly ahead of the bit but, instead, will be forced laterally or transversely to the hole so that the material of the formation, in so far as it is pushed beyond the diameter of the hole, need

not be cut, disintegrated, or removed from the hole at all, with the result that the speed and economy of drilling is increased and a hole with better standing walls is obtained.

Another important object of the present invention is to produce a construction and arrangement in a bit of the roller type involving a new principle in operation, particularly adaptable to the softer formations, whereby the hole is made substantially by lateral or transverse compression instead of by cutting, disintegrating and removing the portion of the formation upon which the drill bit operates.

Still another object of the invention is to produce a construction and arrangement in a bit of the roller type, wherein the axle or bearing portion upon which the roller rotates is larger in diameter and longer than in the usual type of roller bit, so that the bit will be more durable and longer lasting as to its bearings.

Yet another object of the invention is to produce a construction and arrangement in a bit wherein the lateral or transverse thrusts resulting from the reactions of the rollers against the formation will be balanced so that no injurious strains or twisting moments will be caused in the drill stem.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, in which an example of the invention is shown, and wherein:

Figure 1 is a longitudinal, sectional view, showing a practical application of a bit made in accordance with the invention and illustrating its action in the drilling operation at the bottom of a well hole;

Figure 2 is a transverse section on the line 2—2 of Figure 1, through the stem portion of the drill bit;

Figure 3 is a transverse section on the line 3—3 of Figure 1, illustrating one form of a practical cutter type of the hole-forming roller element of the bit; and

Figure 4 is a section similar to Figure 3 and taken substantially on the same line but showing a displacement type of hole-forming roller element for the bit.

Referring now to the drawing, the numeral 10 designates the upper tubular stem portion of the drill bit body which, as shown, has a tapered, reduced and externally screw-threaded coupling extension 11 to receive the counterpart couping portion 12 of the drill stem tubing 13, which latter, obviously, extends to above the top of the well hole and is there driven and manipulated in accordance with the usual practice.

The drill bit body is provided with an axial bore consisting of the upper portion 14, the middle portion 15, and the lower portion 16 which extends down to near the lower end of the bit body. As shown, the axial bore portion 15 communicates with the space 15*a* between the drill and the wall 15*b* of the hole being drilled by means of a diagonal port or passageway 17 provided therefor in the body 17*a* of the drill bit. In like manner, the lower end bore 16 communicates with the space 15*a* between the drill bit and the wall 15*b* of the hole being drilled through the port or passageway 18. By these provisions, the drilling fluid, or "mud" as it is termed, is circulated down through the tubular drill stem 13 and bores and ports of the drill bit body and then upwards through the well bore 19 outside of the drill stem and back to the source from which it was supplied, to be again re-circulated after it has deposited in the slush pit or basin the disintegrated materials or detritus obtained in making the hole and which the drilling fluid or mud is made to carry out of the well hole.

Below the upper stem portion 10 of the body 17*a* of the bit is an eccentric cylindrical portion 20, preferably of reduced diameter as shown, the said portion 20 being not only eccentrically disposed with respect to the longitudinal axis of the drill stem 13, but it is preferably slanted so that its longitudinal axis is out of parallelism with the axis of the drill stem 13 and the upper portion 10 of the body 17*a* of the drill bit, and, more preferably, the inclination of the axis of the portion 20 is inwardly at the bottom, towards the point 56*a* of the bit.

This eccentric cylindrical portion 20 constitutes the axle or journal bearing support for an upper hole-forming roller element to be later more fully described. Next below the eccentric cylindrical portion 20 is another eccentric cylindrical portion 21, preferably of smaller diameter than that of the portion 20, the axis of the portion 21 being preferably disposed diametrically opposite to the axis of the portion 20 with respect to the major axis A—A of the bit and inclined with respect to said major axis A—A, preferably inwardly at the bottom so as to point towards the point 56*a* of the bit. This axle or bearing portion 21, is made somewhat longer than the portion 20 or the portion 22 for a purpose to be more fully described. The lower end portion 22 of the bit body 17*a* is preferably still further reduced in diameter, eccentrically disposed, and preferably inclined similar to the portions 20 and 21, the eccentricity of the portion 22 being disposed diametrically opposite to that of the portion 21 and thus on the same side of the major axis A—A as that of the portion 20.

Rotatably mounted on the upper eccentric axle portion 20 is a hole-forming roller element 23. As shown, the upper shank portion 25 of the roller 23 is of a generally cylindrical form but just below said shank portion 35 the peripheral surface of the roller 23 is serrated or formed with sharpened teeth or cutting edges 24, disposed either longitudinally as shown or spirally according to general practice now in use. Preferably, the cutting edges 24 of the hole-forming roller 23 are so disposed that their line of contact with the wall 15*b* of the hole will be parallel to the major axis A—A, or, in other words, said cutting edges are tapered upwardly with respect to the axis D—D of the roller 23 to compensate for the inclination of the said axis D—D with respect to the said major axis A—A. The lower body portion of the roller 23 is tapered downwardly, as at 25, and provided with peripheral teeth or cutting edges 26, similar to the cutting edges 24. An annular series of cylindrical anti-friction rollers 27 is provided between the axle portion 20 and the cylindrical inner surface of the roller 23 upon which the roller 23 rotates. A retaining collar 28 is placed on the lower end portion of the axle portion 20, abutting the roller 23, said collar 28 having a port 30 therein to register with the port 17 which establishes communication between the bore 15 of the bit and the well bore 15*a*. The collar 28 serves to prevent the entrance of injurious matter to the rollers 27 from the lower end; and to prevent the entrance of such matter

from the upper end, a washer or collar 28a, together with the packing ring 28b, is provided; these collars 28 and 28a serving also to prevent the loss of lubricating material provided for the rollers 27. Preferably, the collar 28 has its upper end portion reduced in diameter, as at 28c, to fit into the lower end of the roller 23 and thereby retain the rollers 27 in place.

Due to the eccentricity of the portion 20, only the serrations or cutting edges on one side of the roller 23 engages the formation at any one time, with the result that there is a lateral or transverse thrust which is absorbed by the rollers 27 and the bearing portion 20. If, as shown, the axis of the portion 20 is also inclined with respect to the major axis A—A of the bit, then there results also a longitudinal thrust. To absorb this longitudinal thrust and also to key the roller 23 in position, registering grooves 31 and 32 are formed in the contiguous portions of the axle or bearing 20 and roller 23, thereby providing a raceway for the bearing balls 33. These bearing balls 33 are placed in the raceway and removed therefrom through an aperture 34 provided therefor in the hub or shank portion 35 of the roller 23, the said balls 33 being retained in place by means of a plug 36 inserted in a screw-threaded enlargement of the said aperture 34.

The collar 28, which also serves to hold the bearing rollers 27 in place is secured to the drill bit body 17a by means of a screw pin 37, the inner portion 38 of which is received in a socket provided therefor in the portion 20 of the body 17a.

The inverted substantially frustro-conical lower portion 25 of the roller 23, on which the cutting edges 26 are provided, functions primarily as the boring portion of the roller, while the upper portion, which is preferably upwardly tapered, as hereinbefore described, and which is provided with the cutting edges 24, serves as a reamer to keep the diameter of the hole to its proper size as the teeth or cutting edges 26 of the lower boring portion of the roller 23 become worn with use.

Rotatably mounted on the next lower axle portion 21 of the bit body 17a are the two hole-forming roller members 39 and 40 which, though separately made and accordingly applied to the axle portion 21, operate together and in effect as a single roller, substantially similar to the roller 23. The roller member 39 is provided with an annular series of serrations or cutting edges 41 on the circumference of the its upper portion which is formed similarly to the portion of roller 23 on which the cutting edges 24 are formed. The roller member 39 has a lower tapered portion on which is provided the cutting edges 42 similar to the cutting edges 26 of the roller 23. So, too, the roller member 39 is provided with a series of longitudinal thrust bearing balls 43 operating in the raceway 43a and inserted thereinto or removed therefrom through an aperture 44 provided therefor in the portion 45 and normally closed by a screw plug 46. The said roller member 39 is also provided with a series of cylindrical bearing rollers 47, similar to the bearing rollers 27 of the roller 23.

The cooperating lower roller 40 is tapered downwardly throughout and provided with two annular series of circumferential serrations 48 and 49 similar to those 26 of the roller 23 and said roller 40 is also provided with two series of cylindrical bearing rollers 50 and 51, corresponding to the hereinbefore described bearing rollers 27 and 47. As shown, the roller 40 has its upper portion 52 reduced in diameter, thereby producing an annular collar which fits into the lower end portion of the roller member 39 and provides a cooperating interfitting annular seated connection between the two roller members 39 and 40.

Abutting the lower end of the roller 40 is a retaining collar 53 which is held in place by the screw pin 54 and which is provided with the aperture 55, registering with the port 18 of the body 17a of the drill bit to permit passage of the circulating fluid. The upper end portion of the collar 53 is of reduced diameter to fit into the lower end portion of the roller 40 to retain the bearing rollers 51 and to exclude deleterious matter from the said bearing rollers. At the upper end of the roller 39 is located a washer or collar 53a and the packing ring 53b which serve to prevent the ingress of injurious matter to the bearing rollers 47 or the balls 43 and to prevent the egress of lubricating material therefrom.

At the extreme lower end of the drill body 17a and rotatably mounted on the bearing portion 22 is the conical roller 56 having an upper portion 57 formed similarly to the corresponding upper portion of rollers 23 and 39 on the circumference of which is an annular series of serrations or cutting edges 58 similar to those 24 on the roller 23 and 41 of the roller 39. The lower part of the roller 56 is tapered downwardly and provided with the three series of serrations or cutting edges 59, 60, and 61, similar to those 26 on the roller 23 and 42 on the roller 39. The bore of this roller 56 is stepped, in three diameters, and the axle portion 22 of the drill-bit body 17a is correspondingly stepped to provide two separate raceways for the two series of cylindrical bearing rollers 62 and 63 similar to those 27 and 47; and an annular series of bearing balls 64, similar to those 33 and 43, are provided in the third step to absorb the longitudinal thrust and to key the roller 56 in place. The balls 64 are placed into the raceway of the said lower step and removed therefrom through an opening 64a of the roller 56 which opening 64a is normally closed by means of the screw plug 65 to retain the balls in place. Between the lower end of the drill bit body 17a and the bottom end of the bore of the roller 56 are located the conical rollers 66 to take part of the longitudinal thrust resulting from the reaction of the roller 56 with the formation being drilled. At the upper end of the roller 56 is provided the washer or collar 57a and the packing ring 57b to prevent ingress of injurious matter to the axle bearings or the escape of lubricating material therefrom.

The major axis A—A of the drill bit body 17a coincides with the axis of the drill stem tubing 13 about which, in operation, they both rotate. The axle portion 22 of the body 17a, on which the roller 56 is journalled, is eccentric and disposed at an angle to the major axis A—A, as indicated by the line B—B, which is the axis of the said portion 22. The point or apex 56a of the roller 56 is preferably located at the point where the axis B—B crosses the major axis A—A of the drill bit body 17a so that the said point 56a does not move eccentrically and has substantially no drilling to do, while the remaining parts of the roller 56 do operate eccentrically and effect the drilling. In like manner, the axis C—C of the cooperating rollers 39 and 40 is disposed inclinedly and eccentrically to the major axis A—A so that the rollers 39 and 40 also operate eccentrically but with the difference that the eccentric

offsetting of the axis C—C is disposed diametrically opposite to the axis B—B with respect to the major axis A—A. In like manner, the axis D—D of the roller **23** is disposed eccentrically but on the same side of the major axis A—A as the axis B—B and thus diametrically opposite to the axis C—C.

The result of this disposition of the respective axes of the rollers **23**, **39**, **40**, and **56** is that the thrust of the rollers **39**, **40**, resulting from the reaction of these rollers **39**, **40** with the formation being drilled, will be oppositely to the reactions of the rollers **23** and **56**. The rollers **23** and **56** are made of such size and proportions with respect to each other that their thrust reactions will be equal, and of such relative size and proportions with respect to the cooperating rollers **39**, **40**, that the thrust reaction of each of the rollers **23** and **56** will be half of the thrust reaction of the combined rollers **39**, **40**, so that the resultant of all these reactions will add to zero and so balance. Furthermore, the rollers **23** and **56** are so located with respect to the cooperating rollers **39**, **40**, that the distance between the center of thrust of the roller **23** and the center of thrust of the combined rollers **39**, **40**, will be equal to the distance between the center of thrust of the roller **56** and of the combined rollers **39**, **40**, with the result that the resultant of the moments of these reactions will also be zero and so balance. Thus, normally, there will be no tendency for the bit to be crowded sidewise in any direction in operation, nor to cause injurious twisting strains in the drill stem tubing **13**, that is, the bit, in operation, will be balanced with respect to its forces and moments as nearly as such may be practically accomplished.

Manifestly, in order to obtain a one-sided and rolling engagement of the rollers **23**, **39**, **40**, and **56** with the formation, the said rollers must be mounted eccentrically with respect to the major axis A—A of the drill bit body **17***a*. The axes B—B, C—C, and D—D of the respective hole-forming rollers must also be inclined to the major axis A—A of the drill bit body **17***a* or only the lower ends of the serrations of the rollers would come into engagement with the formation being drilled and the length of the said serrations would serve little or no useful purpose. The inclination of these axes B—B, C—C, and D—D may be downwardly towards the major axis A—A, as shown, or upwardly towards the major axis A—A. But, in the latter case, the general form of the bit must be reversed to form a hollow cone with internal serrations or cutting edges difficult of manufacture and with a long annular cutting rim at the extreme lower end having much cutting to do so that they would soon become dull and this form would tend to compact and compress the formation inwardly towards the axis to make the cutting and disintegration of the formation more difficult and expensive, besides offering manifest difficulty in the removal of the disintegrated material by the circulation of the drilling fluid or mud.

For these primary reasons, the inclination of the axes B—B, C—C, and D—D is preferably downwardly towards the major axis A—A, as shown, and with the point **56***a* of the conical roller **56** located at the point of intersection of the axis B—B with the axis A—A; with the result that the point **56***a* has substantially no drilling to do; that the disintegrated material is freely left behind by the downward progress of the bit and readily removed by the circulating fluid or mud; and that the materials of the formation are compressed, if at all, laterally outward. It will be understood, of course, that the serrations or cutting edges of the rollers **23**, **39**, **40**, and **56** will remain sharp-edged for only a comparatively short time after being placed in operation, and thereafter will be more or less blunted so that there will always be considerable compression and compacting of the formation, this being equally true of all present classes of roller bits. However, there is an advantageous difference in the principle of operation and resultant effect of the bit of the present invention. The downward inclination of the axis of the hole-forming rollers affords a distinct advantage in tending to push the material of the formation being drilled beyond the circumference of the hole and making its disintegration and removal unnecessary; and, by the compacting of the material of the formation at the circumference of the hole, affording a hole with better standing walls.

In the softer formations, it is manifestly much easier and less expensive to make the hole substantially by the compression of the material of the formation than by cutting, disintegrating, and removing it from the hole and for this purpose I provide the displacement type of roller **67** illustrated in Figure 4, to be used instead of the serrated or sharp toothed cutter rollers **23**, **39**, **40**, and **56**, whereby to press or compress the material laterally and thereby make hole by displacement. The plain-faced or displacement type of roller may have a continuous or unbroken surface, or, for the purpose of increasing the force intensity, the continuity of the surface may be interrupted by grooves or recesses **68**, forming lugs **69** having concentrically rounded faces **70**, as shown.

The use of these displacement type rollers permits the making of hole by my new displacement method, cheaper in the softer formation than can be made by the usual method of cutting and disintegration, and permitting the use of this displacement type of roller which, having no sharp edges upon which its operation depends, cannot be "dulled" and thus affords a type of roller that will make hole more economically.

It will be observed that with the hole-forming rollers placed so that their axes are very nearly parallel to the axis of the drill stem **13**, substantially the maximum diameter of rollers, with respect to the diameter of the hole being drilled, may be employed, thereby permitting the provision on said rollers of the maximum number of serrations or cutting edges and correspondingly increasing the amount of hole that can be made therewith.

It is evident, too, that with the bit made in the generally spear-like form as shown in the drawing, the bit may be made as long as desired, the hole-forming rollers, of either the displacement or cutting edge type, correspondingly increased in length, with the result that proportionally more hole may be made. This holds true if the force intensity is maintained, and this is accomplished by the construction which I have shown, for this construction, having a spear-like form, has a wedging action in which the total wall force is equal to the weight on bottom multiplied by the ratio of the total diagonal length of the rollers to the radius of the hole being drilled, and so affords a wall force or reaction of the rollers with the formation being drilled much greater than the weight on bottom alone, besides having a force intensity which, ir-

respective of the length of the bit, is always substantially equal to the weight on bottom divided by the radius of the hole being drilled,—all as compared with the present type of bit wherein the cutting edges lay transverse to the axis of the drill stem, and which have a maximum length less than the diameter of the hole being drilled, a reaction with the formation equal only to the weight on bottom, and a force intensity only equal to the ratio of the weight on bottom divided by the diameter and thus only half of the force intensity which the construction and arrangement of the present invention affords.

Since the bit according to the present invention may be made as long as desired and since the reaction or total force with which the hole-forming rollers bear against the formation being drilled is proportional to the diagonal length of the hole-forming rollers, it is evident that this force may be made as great as desired by correspondingly increasing the diagonal length of the rollers.

In the type of bits heretofore used, also, the axles of the rollers, laying transverse to the axis of the drill stem, have necessarily been made of comparatively small diameter with correspondingly short life and difficulty in operation; whereas, in the construction and arrangement of the present invention herein disclosed, the axles of the hole-forming rollers are comparatively long and of large diameter and thus proportionally more durable and trouble free.

A particular advantage of the reduced diameters of the axle portions **20**, **21** and **22** of the drill bit body is the facility with which the hole forming rollers **23**, **39**, **40**, and **56** may be originally placed thereon and removed and replaced when occasion requires.

Obviously, the structure and application of the drill bit may be modified and changed in many respects without departing from the spirit and scope of the invention as defined in the appended claims. The invention, therefore, is not limited to the specific construction and arrangement shown in the accompanying drawing.

What I claim and desire to secure by Letters Patent, is:

1. A rotary drill bit of generally tapered and spear-like form, comprising a body member rotatable about a major axis coinciding with the axis of the drill stem to which the bit is applied, the tip of the bit coinciding with the major axis, and a multiplicity of hole-forming roller elements rotatable on said body member about axes alternately oppositely offset laterally from and inclined downwardly convergent towards the major axis of said body member, said roller elements tapering downwardly and the lowermost element terminating with an apex coincident with the major axis of the body member.

2. A rotary drill bit of generally tapered and spear-like form, comprising a body member rotatable about a major axis coinciding with the axis of the drill stem to which the bit is applied, the tip of the bit coinciding with the major axis, and a multiplicity of hole-forming roller elements rotatable on said body member eccentrically about the major axis of said body member, said roller elements tapering downwardly and the lowermost element terminating with an apex coincident with the major axis of the body member, said roller elements being offset alternately with their respective axes on opposite sides of and inclined to the major axis of the body member, said hole-forming roller elements being so proportioned that the thrusts resulting from their reaction with the formation being drilled will be balanced.

3. In a rotary drill bit, a body member attachable to a drill stem, the major axis of said body member coinciding with the axis of the drill stem, said body member having an axle portion of reduced diameter and extending downwardly with its axis disposed at one side of and inclined to the major axis of said body member, additional axle portions of successively different reduced diameters extending downwardly in stepped relation to said first mentioned axle portion, said axle portions being disposed alternately with their respective axes on opposite sides of and inclined to the major axis of said body member, and conical hole-forming roller members mounted rotatably on the respective axle portions.

4. In a rotary drill bit, a body member attachable to a drill stem, the major axis of said body member coinciding with the axis of the drill stem, said body member having an axle portion of reduced diameter extending downwardly with its axis disposed at one side of and inclined to the major axis of said body member, additional axle portions of successively different reduced diameters extending downwardly in stepped relation to said first mentioned axle portion, said axle portions being disposed alternately with their respective axes on opposite sides of and inclined to the major axis of said body member, and hole-forming roller members mounted rotatably on the respective axle portions, said hole-forming roller members being of general conical form and the lowermost roller member terminating with an apex coinciding with the major axis of said body member.

5. A rotary drill bit of generally tapered and spear-like form, comprising a body member attachable to the usual drill stem tubing, said body member having a plurality of longitudinally connected but separate axle portions, the axes of the respective axle portions being offset laterally from and inclined to the major axis of the body member and alternately in diametrical relation on opposite sides of said major axis, and hole-forming roller members mounted rotatably on the respective axle portions.

6. A rotary drill bit of generally tapered and spear-like form, comprising a body member rotatable about a major axis coinciding with the axis of the drill stem to which the bit is applied, the tip of the bit coinciding with the major axis, and a multiplicity of hole-forming roller elements all of which are rotatable on said body member about axes eccentrically and inclined to the major axis of said body member, said roller elements tapering downwardly and the lowermost element terminating with an apex coincident with the major axis of the body member.

7. The structure as recited in claim 5 and further describing the hole-forming roller members as being conical and inverted, with the apex of the lowermost roller coinciding with the major axis of the body member.

8. A rotary drill bit of general acute spear-like form, comprising, an elongate body rotatable about a major axis coinciding with the axis of a drill stem, and an acute conical hole-forming roller element for making the hole by lateral displacement, said element rotatable on the body about an axis offset laterally from the major axis thereof and inclined downwardly convergent so that the apex of said roller element coincides with the point where the inclined axis of the element crosses the major axis of the body.

9. A rotary drill bit of general acute spear-like form for making the hole by lateral displacement, comprising, an elongate tapered body rotatable about a major axis coinciding with the axis of a drill stem, an acute conical hole-forming roller element constituting the working end of the bit, said element rotatable on the body about an axis offset laterally from the major axis thereof and inclined downwardly convergent so that the apex of said roller element coincides with the point where the inclined axis of the element crosses the major axis of the body, and a plurality of superposed acute frustro-conical roller elements above said endmost roller element, the sum of all of which provides a complete conical formation for making the hole, said upper roller elements being rotatable on the body about axes offset alternately on opposite sides of and downwardly convergent towards the major axis of the body.

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