

June 22, 1926.

1,589,596

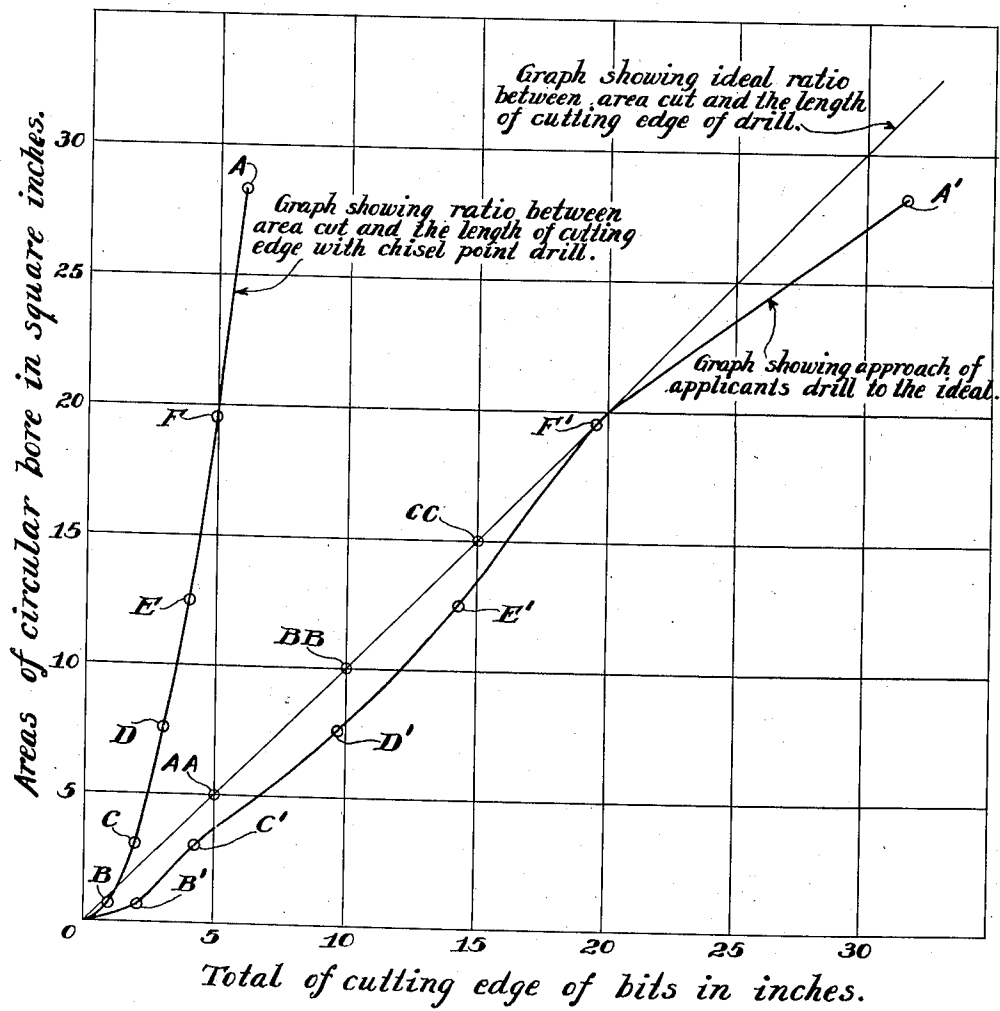
M. HOKANSON

DRILL HEAD

Filed Feb. 24, 1925

3 Sheets-Sheet 1

Fig. 1.



WITNESSES

A. B. Wallace,
C. R. Hallmark

INVENTOR

Martin Hokanson
By Winter, Brown & Ritchie
His Attys.

June 22, 1926.

M. HOKANSON

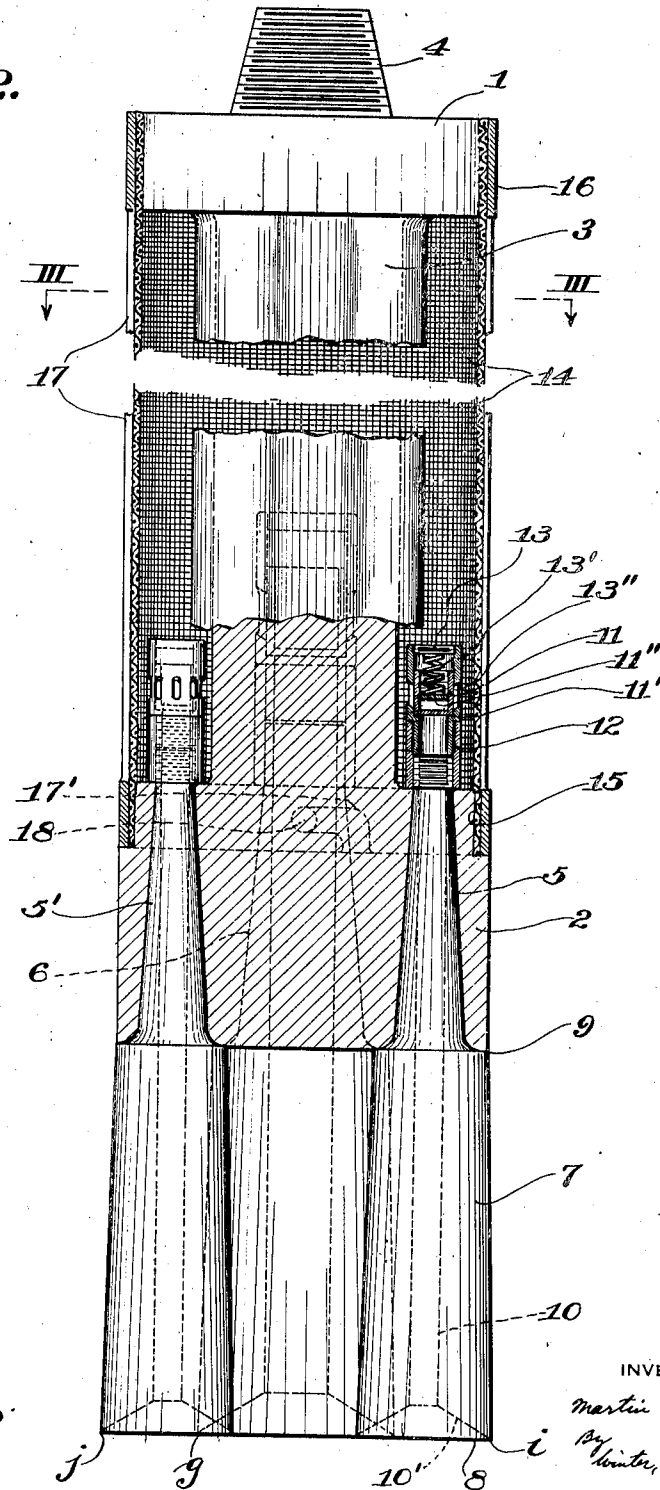
1,589,596

DRILL HEAD

Filed Feb. 24, 1925

3 Sheets-Sheet 2

Fig. 2.



WITNESSES

A. B. Wallace
C. R. Halbur

INVENTOR

Martin Hokanson
By *Wm. B. Smith*
Attys

June 22 , 1926.

1,589,596

M. HOKANSON

DRILL HEAD

Filed Feb. 24, 1925

3 Sheets-Sheet 3

Fig. 3.

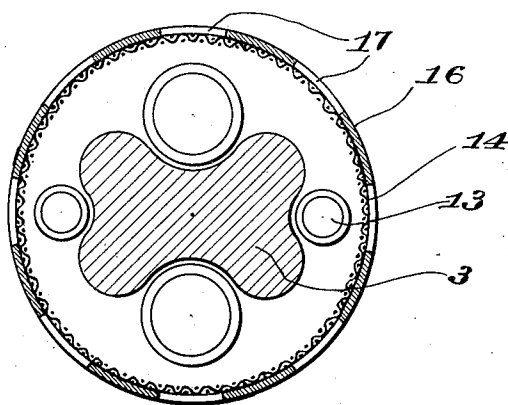


Fig. 4.

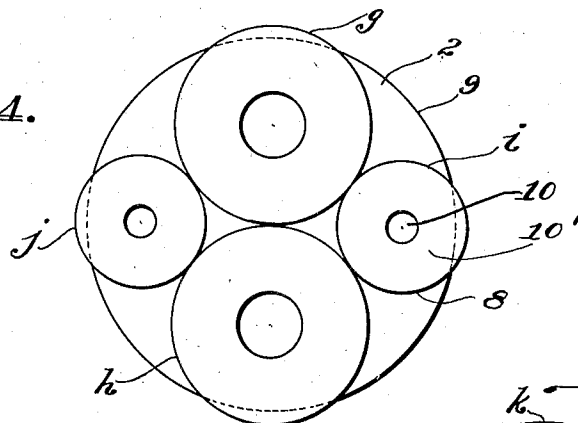


Fig. 5.

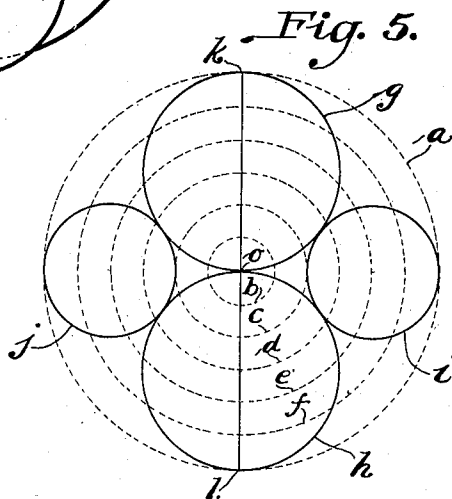
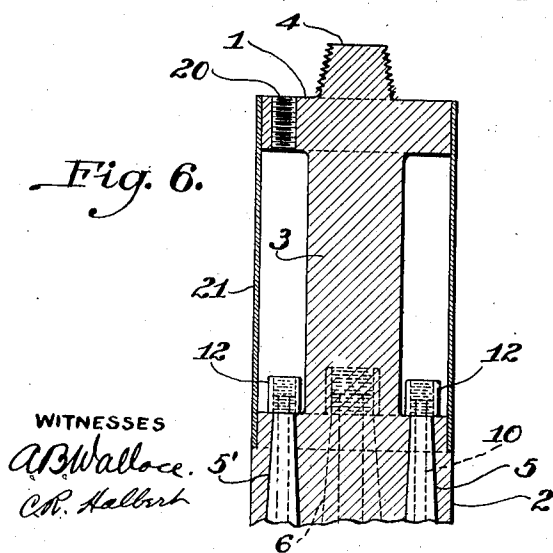


Fig. 6.



WITNESSES

A. B. Wallace.
C. R. Halbert

INVENTOR

Martin Håkanson
By winter, Brown Hitchlow
his Attye

UNITED STATES PATENT OFFICE.

MARTIN HOKANSON, OF DULUTH, MINNESOTA.

DRILL HEAD.

Application filed February 24, 1925. Serial No. 11,255.

This invention relates to drill heads, and particularly to a drill head adapted for rock or earth boring, and similar purposes.

Heretofore, particularly with drill bits of the so-called "chisel edge type", difficulties have been experienced due to the ever-increasing duty thrown upon those portions of the cutting edge lying more remote from the central longitudinal axis of the bit, this duty becoming progressively greater from the said axis to the extreme margins of the bit. This, primarily due to the fact that the ratio between the length or extent of the cutting edge provided for action in any particular zone concentrically surrounding the said axis as a center, assuming the axis of the bit to correspond generally with the axis of the bore being drilled, and the area of the surface cut by such part of the cutting edge progressively decreases the farther said part is located from the axis of the bit. This not only renders those portions of the cutting edge more remote from the axis less effective but gives rise to uneven wear throughout, necessitates frequent resharpening, often accompanied by reheating and reshaping of the metal, which tends to destroy its original temper. In these chisel edge bits, excess wear and breakage also occur at the outer extremities of the cutting edges or corners of the bits, such edges being discontinuous or terminating abruptly at the margins of the bits, in which event no provision whatever is provided for adjusting or shifting such parts so as to become effective at any other point than adjacent the wall of the bore. It is the purpose of this invention to overcome the disadvantages above noted, the general objects being to provide a drill head which is compact, strong, durable, of symmetrical construction, which will not easily get out of order, one having bits which can be readily resharpened without necessitating reheating or reshaping of the metal, in which the cutting edges are free of corners or abrupt portions, which is highly effective in operation, and which can be fabricated at a nominal cost.

It is a special object to provide a drill head in which the total length in numerical unit lengths, for example in inches, of the cutting edges of the bits employed is approximately equal to the numerical unit

areas, for example in square inches, of the bore being drilled, regardless of the size of the bore.

It is another special object to provide a drill head in which the cutting edges provided in the several concentric zones measured from the central longitudinal axis of the head towards its periphery progressively increase in length in approximately the same direct ratio as the areas of the corresponding zones cut thereby.

It is a further special object to provide a drill head in which the total length of the cutting edges thereof located within any circular zone concentric with the longitudinal axis of the drill head, and regardless of its size, will bear a substantially constant and uniform ratio to the cross-sectional area of the said circular zone.

It is still a further special object to provide a drill head in which a substantially uniform duty will be thrown upon all portions of the cutting edges, irrespective of relative dispositions, thus effecting approximately uniform wear throughout and eliminating excessive wear or localized strains at certain points of the head.

Further special objects are to provide a drill head enabling ready adjustment of the bits so as to bring any desired portions of the cutting edges thereof into new cutting zones, when needed, in which the bits may be quickly and easily replaced, one which functions to automatically remove sand and drillings from the cutting edges thus not only enhancing the speed of drilling but collecting the sand for subsequent withdrawal from the bore, one which is self-clearing, will not easily become stuck in the bore, and is free of eccentric strains.

These and other objects of the invention will more fully appear when taken in conjunction with the following description and the appended claims.

In the accompanying drawings Fig. 1 is a chart containing graphs showing the ratio between the length of the cutting edges and the area cut by such edges in the chisel point type of drill, in the preferred embodiment of applicant's invention, as well as what is considered an ideal condition; Fig. 2 a fragmentary view, partly in elevation and partly in vertical section, illustrat-

ing the preferred embodiment of the invention; Fig. 3 a transverse sectional view taken substantially on the line III—III of Fig. 2; Fig. 4 a bottom plan view of the drill head illustrated in Fig. 2 showing the relative sizes of the bits employed, as well as their relative arrangement with the cutting edges of adjacent bits lying tangent to each other; Fig. 5 a diagrammatic view illustrating not only the area of the surface cut by the bits in various zones transversely of the bore, but also the lengths of the cutting edges effective within such zones in both the chisel point type of drill and in applicant's construction; and Fig. 6 a fragmentary view similar to Fig. 1 illustrating a modified form of the invention.

It is thought that the underlying principle and the primary objects of the present invention can best be disclosed by a comparison of the ratio between the length of the cutting edge in the well known type of chisel point drill bit and the area of the surface cut thereby, with the corresponding ratio between the extent of the cutting edges and the area cut thereby in a drill head constructed in accordance with the present invention. And this comparison can probably be pictured most clearly in the form of a chart containing graphs depicting the respective ratios.

By the so-called "chisel point drill bit" mentioned previously, as well as in the description to follow, is meant a bit having its lower extremity beveled to a sharp edge, the successive parts of which lie in the same straight line with the opposite ends of the cutting edge terminating at the corners defining the side margins of the bit. In use, for boring circular holes, such a bit is bodily rotated around its longitudinal axis disposed midway between said side margins while simultaneously alternately projecting into and withdrawing the bit from the bore. When used for drilling with the longitudinal axis disposed vertically, as in well boring, or similar use, the bit is first bodily lifted then released so as to be permitted to forcibly strike the bottom of the bore on its descent, the bit being rotated in successive steps through a part of a revolution for each drop.

In the chart shown in Fig. 1 of the drawings, the abscissas represent the lengths of the cutting edges of the bits of the drill head, while the ordinates represent the area acted upon by such edges, the small numerals in alignment with the division lines indicating the number of inches in length or the area in square inches operated upon, as the case may be.

From the above, it will be understood that a plain chisel point drill adapted to drill a circular bore, say six inches in diameter, will have a straight line cutting edge six inches

in length, three inches of which is disposed at either side of the central longitudinal axis of the bit. The graph at the left hand side of Fig. 1 clearly illustrates the ratio between the area cut and the length of the cutting edge in such type of drill. The distance between the division lines on the chart represent five inches, and the graphs are plotted by locating successive points for drills of the several kinds adapted for boring a circular hole having a diameter of six inches, by considering the length of the cutting edge as well as the area cut in the several zones or subdivisions of the bore having diameters of one, two, three, four, five and six inches, respectively.

A more perfect understanding may be had by considering in connection with Fig. 1 the diagrammatic showing in Fig. 5, the latter figure depicting the cutting edges in a drill head of both the chisel edge type and one made in accordance with the present invention adapted for boring a hole six inches in diameter, as well as the portions of such edges falling within circular zones concentric with the said bore, and varying in size from one to six inches in diameter.

Referring to Fig. 5, the point O designates the center of the bore as well as the central longitudinal axis of the drill head regardless whether a plain chisel type drill or applicant's improved drill head be used. The outermost dotted circle *a* indicates the outline of the circular bore six inches in diameter made by the drill, and the area of this circle represents the area cut or traversed by the cutting bits during one complete rotation of the drill head. Each of the remaining dotted circles *b*, *c*, *d*, *e* and *f* subdivide the entire area of the six inch diameter bore into circular zones varying in diameter from one to five inches respectively. The full line circles *g*, *h*, *i* and *j* illustrate the size, positioning, and relative arrangement of the cutting edges in the preferred embodiment of the invention, in a drill head for producing a six inch bore, while the full straight line *k—l* designates the cutting edge of a plain chisel edge drill for a bore of corresponding size.

Referring now to both Figs. 1 and 5, an explanation of how the graph at the left hand side of Fig. 1 is derived will be given. An inspection of the innermost zone defined by the circle *b* shows that the length of the plane chisel edge effective in such zone equals the diameter of the circle, namely, one inch, the area of this zone being .785 square inches. The point B is therefore located at a position on the chart having an abscissa equal to 1 and an ordinate equal to .785. Likewise the length of the cutting edge of the chisel bit effective in the zone defined by the circle *c*, equals that of the diameter of this zone, namely, two inches, the area of

which is 3.142 square inches. The next point C is therefore located so that its abscissa equals 2 and its ordinate 3.142. In like fashion, the diameters of the circular zones defined by circles *d*, *e*, *f*, and *g*, and the respective areas thereof, determine the positions of the successive points D, E, F and A.

The graph at the right hand side of Fig. 1 is obtained as follows—An inspection of Fig. 5 shows that portions of both cutting edges *g* and *h* fall within the innermost zone *b*, the combined length of which when calculated is found to be approximately 2.04 inches, the area of this zone of course remaining as before, namely, .785 square inches. The point B' is given an ordinate corresponding to the point B, but an abscissa equal to 2.04. Again, considering the combined length of portions of the cutting edges *g* and *h*, falling within the circular zone defined by the circle *c*, it is found to be approximately 4.10 inches. The point C' is therefore determined by an ordinate corresponding to that of C and an abscissa of 4.10. In turn, the combined length of the portions of the cutting edges *g*, *h*, *i* and *j* falling within the circular zone bounded by the circle *d* is next determined, the point D' fixed in a similar way, and the remaining points E', F' and A' located in like manner.

The central graph of Fig. 1, passing through the points AA, BB, CC, etc. represents what is referred to as the ideal ratio between the cutting edge and the area cut, or in other words, a construction in which the ratio between the total cutting edge in any zone, regardless of its diameter, will exactly equal the cross sectional area of the surface cut by said edge. This will be evident from an inspection of Fig. 1 in which both the abscissa and the ordinate for point AA equal 5, for point BB 10, for point CC 15, etc. By comparing the graphs for the chisel point type of drill and for applicant's drill with this central graph, it at once appears how the chisel point type of bit, for sizes of drills commercially employed, in the features under discussion, constantly departs from, while applicant's construction closely approximates for practical purposes, the so-called ideal condition.

For purposes of explanation, applicant has arbitrarily selected drills for boring holes six inches in diameter, but it is obvious that the same relative proportions will prevail regardless of the diameter of the drill head considered, and that the same relation exists between the extent of the cutting edges disposed in any annular zone concentric with the axis O and its cross sectional area, as pointed out in connection with the circular zones particularly described.

The composite structure illustrated in Fig. 2 of the drawings, and representing the preferred embodiment of the invention, will

next be described. The drill head comprises a body in the form of a solid metal block having enlarged upper and lower extremities 1 and 2, respectively, both of which are preferably circular in cross section, these enlargements being joined by an integral stem 3 of reduced size, leaving a space between the enlargements and surrounding the stem which forms in connection with a screen structure a sand and water receiving and sand collecting chamber, to be described subsequently more in detail.

The enlarged portion 1 is provided with a centrally disposed threaded lug 4 for attachment to the usual drill rod used in connection with drills employed for the same general purpose.

The lower enlarged portion 2 is equipped with a plurality of tapered sockets extending through the body from its lower face to a point adjacent the juncture with the reduced stem 3, these sockets being symmetrically arranged around the central longitudinal axis of the body. Each of these sockets is adapted to receive the upper reduced shank of a tubular bit such as indicated at 5, 5' and 6 in Fig. 2, all of the bits being of identical construction differing only in size. Except as to arrangement which will be subsequently set forth, a detailed description of one of the bits will suffice for an understanding of the invention.

The main body 7 of the bit is gradually tapered from its extreme lower end 8 to a point 9 where it joins the shank 5, leaving a shoulder at this point adapted to seat against the bottom face of the portion 2. A passageway 10 extends completely through the body and shank of the bit, flaring outwardly adjacent the lower end of the body as indicated at 10' forming the sides of a cone, the meeting of which with the outer peripheral wall produces a sharp continuous circular cutting edge *i*.

The portion of the shank 5 extending above the enlargement 2 is exteriorly threaded and adapted to have connected thereto an upwardly opening check valve 11, the casing of which is fixed to the upper end of the bit by means of an internally threaded coupling 12 which also serves to forcibly bind the shoulder on the bit at the point 9 against the portion 2, whereby to positively and securely anchor the bit to the body of the head. As shown in Fig. 2, the tubular shell forming the valve casing is provided at its lower end with a reduced nipple threadedly engaging the coupling, and has its upper end closed by a threaded plug 13. The valve 11 is cup-shaped and adapted to cooperate with a shoulder seat 11', and its cylindrical portion is interiorly threaded to carry an adjustable disk 11'' between which and the plug 13 is interposed a coiled compression spring 13'. The valve

casing is equipped with a plurality of spaced ports 13" disposed slightly above the seat 11', and the outside diameter of the casing corresponds to that of the coupling 12 so as to form in effect a continuation thereof. If desired, an upwardly opening check valve, such as shown and described, may be attached to each of the bits, and for some classes of work adds greatly to the efficiency of the drill. Preferably, the relation between the cross-sections of the bars of the larger and smaller bits is the same as the relation between the areas of the circles of the larger and smaller bits defined by the extreme ends of the bits.

Extending from the enlargement 1, over which it telescopically fits, to the lower enlarged extremity 2, is a foraminated cylinder 14 in the nature of a screen, the lower end of the cylinder fitting neatly in a groove 15 on the enlargement 2 especially provided for this purpose. The cylindrical screen 14 is preferably made of a suitable non-corrodible metal, and superposed thereupon is another metallic cylinder 16 of corresponding length, the outside diameter of which corresponds to that of the enlargement 2 whereby the outer surface of the said enlargement and the cylinder 16 lie flush with each other.

The outer cylinder 16 is provided with a plurality of spaced apart slots or elongated openings 17 extending completely around the cylinder, as clearly shown in Fig. 3, and having a length equal to the distance between the upper and lower enlarged extremities 1 and 2. The width of these openings may be of considerable size, while the openings or meshes in the cylinder 14 are sufficiently small to retain particles of sand which may be discharged into the chamber formed between the cylinder and the stem 3. It is obvious that the inner foraminous cylinder may be constructed of metal mesh throughout, or merely those portions in registry with the slots 17 equipped with apertures of suitable size to retain sand but permit free flow of water outwardly there-through.

Both cylinders 14 and 16 are removably mounted upon the body of the drill head so as to be readily manipulated for the purpose of discharging the collected sand in a manner subsequently described. To this end, the lower margins of the cylinders are equipped with a pair of bayonet slots such as shown at 17' cooperating with pins 18 anchored in the body of the block, the end faces of these pins lying flush with the outer surface of cylinder 16 when in assembled condition. To facilitate handling, the cylinders 14 and 16 are suitably connected together so as to form a single unit.

All of the cutting edges g , h , i and j of the several bits shown lie in a single plane trans-

verse to the longitudinal axis of the drill head, and the peripheries of the lower ends of the bits forming the cutting edges previously described are so arranged that the cutting edges of adjacent bits lie tangent to each other.

As shown, the bits provided with the cutting edges g and h are of the same size, likewise the two smaller sized bits having the cutting edges i and j , with each of the smaller bits tangent to the adjacent larger ones. Due to the symmetrical arrangement of the receiving sockets previously described the bits are also symmetrically disposed with respect to the central longitudinal axis of the body of the drill head, the two larger bits are tangent to each other at a point coincident with the longitudinal axis, and the diameter or greatest transverse dimension of the larger sized bits, measured on a straight line passing through their point of tangency is at least equal to the distance of the most remote point of the cutting edges thereof from the said longitudinal axis.

In operation, the screens 14 and 16 being locked in place, as shown in Fig. 2, the drill head is connected to the drill rod in the usual fashion by means of the threaded lug 4, and under the customary driving action of the drill rod the drill head is alternatively lowered and raised while simultaneously rotating it.

Under the action thus noted, the continuous circular cutting edges of all of the bits are brought into play to act upon the entire cross sectional area of the bore during a complete revolution of the drill head, and due to the ratio between the lengths of the cutting edges located in any particular zone of the area cut and the area of such zone, a substantially uniform duty is thrown upon the entire drill head. This uniformity is also enhanced by the balanced or symmetrical positioning of all of the parts comprising the drill head.

During the falling or dropping of the drill head, the sand or drillings which have been loosened by the effect of the cutting edges, mixed with the water in the bore cut, will be forced upwardly through the passages 10 of the bits and the couplings 12, reverse flow being effectively prevented by the use of the check valves 11. The mixture of sand and water discharges through the check valves into the collecting chamber located between the reduced stem 3 and the cylinders 14 and 16. The apertures in the screen 14 being sufficiently small to prevent the passage of the sand, effectively serve to collect it within this receiving chamber, while permitting the water to flow outwardly through the open slots 17 exteriorly of the drill head. The escaping water readily finds its way to the bottom of the bore by way of the slight space afforded around the drill

head due to the slight outward taper of the body portion 8 of the bits. The sand is therefore automatically removed from the bottom of the bore during the operation of the drill head, not only collecting it for subsequent removal, but at all times keeping the said bottom clean and thus increasing the cutting action and the speed of operation of the drill as a whole. The slight outward taper provided at the body of the bits functions to provide a slight clearance for the drill head, found to be necessary in the practical operation of drills of this character.

The direction in which the drill head is normally rotated during the cutting operation is such that the pins 18 will be firmly seated at the innermost ends of the bayonet slots 17, thereby securely locking the screen structure to the body of the head. Whenever the quantity of sand reaching the receiving chamber bounded by the screen is sufficient to fill the chamber, the drill head is lifted or removed from the bore, the screens rotated sufficiently to bring the pins in alignment with the vertically directed portions of the bayonet slots, when they may be vertically lifted and temporarily removed from the head for the purpose of discharging the sand which has been collected. After removal of the sand, the screens are again attached to the body in an obvious fashion, when the drill head is again in condition for further cutting.

Attention is directed to the ease with which the bits may be adjusted within their sockets. In order to change the relative position of any part of the cutting edge of a bit it is merely necessary to slightly loosen the coupling 12, whereupon the bit may be bodily rotated within its socket to the desired setting, and the coupling 12 again tightened. If for any reason any particular part of the cutting edge of the bits becomes uneven or worn, by making such adjustments, the entire cutting edge may be kept more nearly uniform, thus reducing the otherwise more frequent resharpening thereof required from time to time. In fact, the readjustment of the entire set of bits in this manner from time to time, acts in a practical way as an automatic resharpening action. Such adjustments also serve to bring unworn portions of the outer surface of the bits adjacent the periphery of the drill head thus maintaining a substantially constant effective diameter of the head regardless of wear due to contact of the bits with the sides of the bore. This enables bores of uniform size to be produced regardless of the depth of the bore, and with the same drill head.

The enlarged or flared portions 10' at the lower end of the passageways 10 are secured by grinding upon conical shaped grinding tools rotating at high speed which can be

easily accomplished in the presence of an abundance of water or other cooling liquid whereby to avoid heating of the metal to such a degree as to destroy its temper. Whenever the cutting edges of the bits become dulled or marred through use, they may be quickly and easily resharpened in this manner, a feature considered to be of great practical importance, since in many types of drill bits, for instance the chisel edge type of bit, the cutting edge becomes so badly worn that reheating and reshaping of the metal is frequently necessary, thus resulting in a loss or impairment of the temper of the metal of the bit as originally put into the tool at the time of manufacture.

Attention is directed to the feature of providing the bits with exterior surfaces adjacent their cutting edges which lie substantially parallel with the walls of the bore. From the practical point of view, this is of great importance in drilling through layers or strata of material of varying hardness, especially where the strata run at an angle to the line of the bore. Under such conditions, the nearly vertical outside surfaces of the bits adjacent the wall of the bore serve as guides preventing the line of cut tending to follow the inclination of the strata or the general line of cleavage thereof, and resulting in forcing the drill head to cut directly through such material in the direction intended.

In Fig. 6 of the drawings there is illustrated a modification of the invention adapted for use in place of the so-called "rotary" method of drilling now frequently employed for drilling through soft formations like shale and clay. In this method a stream of water is forced downwardly to the bottom of the bore and continuously washes away the drillings which due to their fineness and the presence of the water usually are in the nature of a slime.

In this embodiment, the enlarged portion 1 is provided with an opening 20 extending therethrough and opening into the space surrounding the stem 3 to which water may be supplied under pressure by any suitable pipe connection, not shown. An impervious cylinder 21 replaces the screen structure 14-16 of the embodiment of Figs. 1 to 5 so as to form a water pressure box or chamber therewithin and extending from the portion 1 to the lower enlarged portion 2. Valves 11 are omitted, the bits being anchored by the couplings 12 which communicate directly with the pressure chamber, thus permitting free passage through the coupling downwardly into the passageways 10 of the bits. Otherwise than as specifically noted, the remaining portions correspond to those of the embodiment first described, and have therefore been designated by the same reference numerals.

The operation of this form of the invention will be apparent from the above description. Water supplied under pressure fills the pressure box or chamber, and thence
 5 flows downwardly through the pasageways of the bits. After reaching the conically shaped enlargements adjacent the cutting edges, which serves as an effective deflecting means, it reaches the periphery of the drill
 10 head and escapes upwardly through the bore or hole being drilled, carrying with it the drillings in the form of a slime, as previously indicated.

In accordance with the provisions of the
 15 patent statutes, the preferred embodiment of the invention has been illustrated and described. It is obvious, however, that various changes in details of construction and arrangement of parts may be made without
 20 departing from the spirit of the invention, and it is therefore not intended to limit the invention beyond that particularly pointed out and defined by the appended claims.

I claim:

25 1. A drill head comprising a body, a plurality of bits having continuous cutting edges carried by said body, the cutting edges of two of said bits being tangent to each other, and the maximum transverse dimension of one of said bits taken on a line
 30 passing through said point of tangency being not less than the distance of the most remote portion of the cutting edge of the head from the central longitudinal axis of the head.

35 2. A drill head comprising a body, a plurality of bits having circular continuous cutting edges, the cutting edges of at least two of said bits being tangent to each other, the said point of tangency being coincident
 40 with the central longitudinal axis of the head.

45 3. A drill head comprising a body, a plurality of bits having circular continuous cutting edges, the cutting edges of at least two of said bits being tangent to each other, the said point of tangency being coincident with the central longitudinal axis of the head, and the diameter of at least one of said bits
 50 being not less than the distance of the most remote portion of the cutting edges of the head from the central longitudinal axis of the head.

55 4. A drill head comprising a body, a plurality of bits carried by the body, circular in cross section at their lower extremities, the peripheries of the bits at said lower extremities forming cutting edges, the cutting
 60 edges of adjacent bits being tangent to each other.

5. A drill head comprising a body, a plurality of bits carried by the body circular in cross section at their lower extremities, the peripheries of the bits at said lower
 65 extremities forming cutting edges, the bits

being symmetrically arranged with respect to the longitudinal axis of the head with the cutting edges of adjacent bits tangent to each other.

6. A drill head comprising a body, a plurality of tubular bits provided with passageways extending upwardly therethrough carried by said body, said bits being circular in cross section at their lower extremities with the peripheries of said lower extremities forming cutting edges, the cutting edges of adjacent bits lying tangent to each other.

7. A drill head comprising a body, a plurality of tubular bits provided with passageways extending upwardly therethrough carried by said body, upwardly opening check valves in said passageways, said bits being circular in cross section at their lower extremities with the peripheries of said lower extremities forming cutting edges, the bits being symmetrically arranged around the longitudinal axis of the head with the cutting edges of adjacent bits tangent to each other.

8. A drill head comprising a plurality of tubular bits provided with passageways extending upwardly therethrough carried by said body, said passageways discharging into the space adjacent their upper ends, and a foraminated wall carried by the body surrounding the said space whereby to form a receiving chamber for the material discharged from the said passageways.

9. A drill head comprising a body having an enlarged lower extremity, a plurality of tubular bits provided with passageways extending upwardly therethrough anchored in said lower extremity, said passageway discharging into the space adjacent their upper ends, and an upwardly extending tubular screen carried by said lower extremity embracing the said space whereby to form a receiving chamber for the material discharged thereinto.

10. A drill head comprising a body having enlarged upper and lower extremities with a stem of reduced cross sectional area joining said extremities, a plurality of tubular bits provided with passageways extending therethrough anchored in said lower extremity and discharging at their upper ends into the space disposed between said extremities and surrounding the said stem, and a bodily removable foraminated cylinder having its opposite ends operatively engaging the said enlarged extremities, whereby to form a receiving chamber for the material discharged into the said space.

11. A drill head comprising a body provided with a plurality of continuous non-interrupted cutting edges, the ratio between the extent in numerical unit lengths of any portion of said cutting edges lying within a circle struck from the longitudinal axis of the body as a center and the area in

numerical unit areas of said circle being substantially constant. lengths of the cutting edges disposed within two circular zones of different sizes concentric with the body being substantially

12. A drill head comprising a body, a plurality of bits carried by the body, the peripheries of said bits at their lower extremities forming continuous unbroken cutting edges, the ratio between the areas of the said zones. 10

In testimony whereof, I sign my name.
MARTIN HOKANSON.