

Jan. 1, 1963

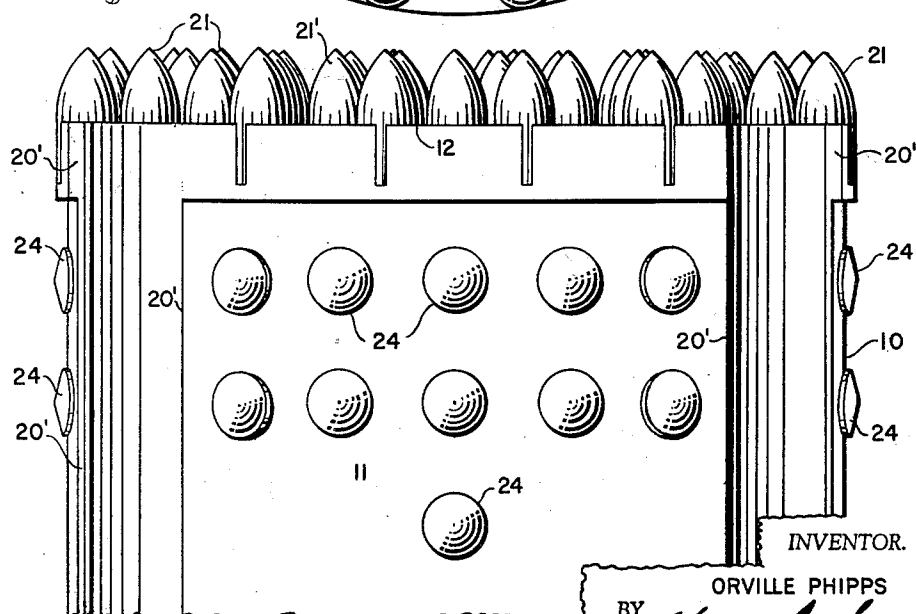
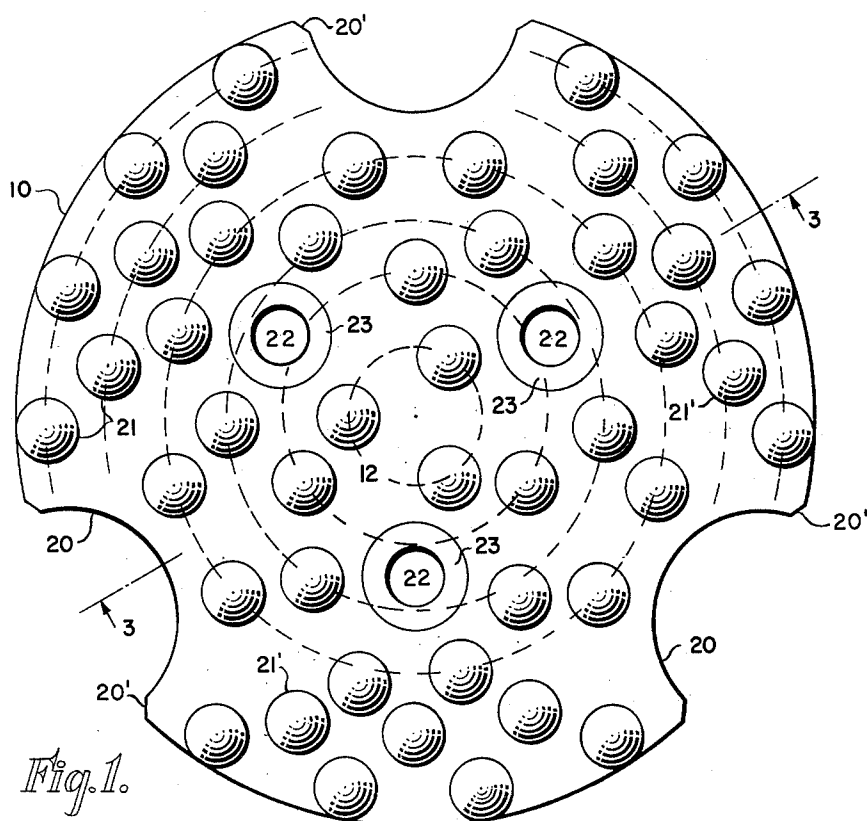
O. PHIPPS

3,071,201

PIERCING POINT ROTARY DRILL BIT

Filed March 9, 1959

5 Sheets-Sheet 1



INVENTOR.

ORVILLE PHIPPS

BY

ATTORNEY

Jan. 1, 1963

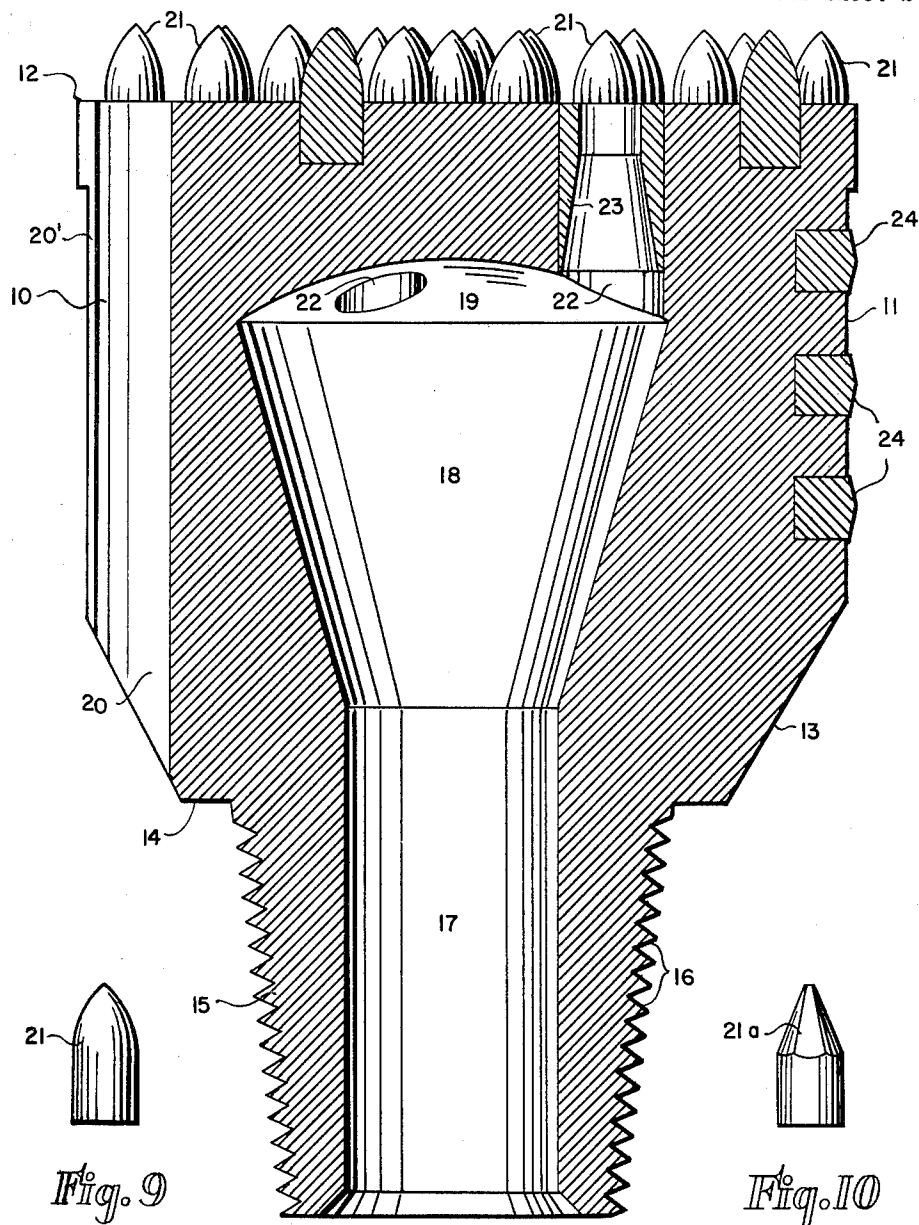
O. PHIPPS

3,071,201

PIERCING POINT ROTARY DRILL BIT

Filed March 9, 1959

5 Sheets-Sheet 2



Jan. 1, 1963

O. PHIPPS

3,071,201

PIERCING POINT ROTARY DRILL BIT

Filed March 9, 1959

5 Sheets-Sheet 3

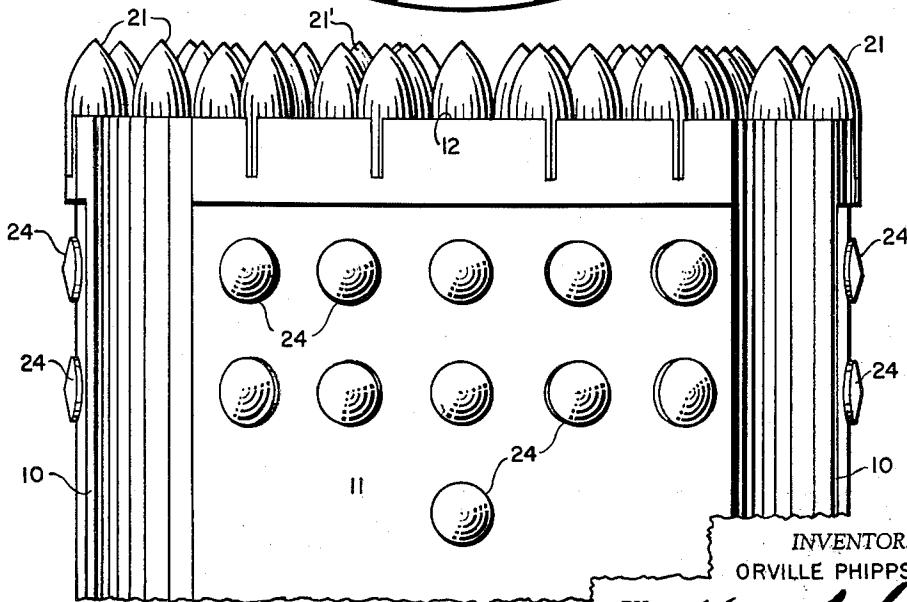
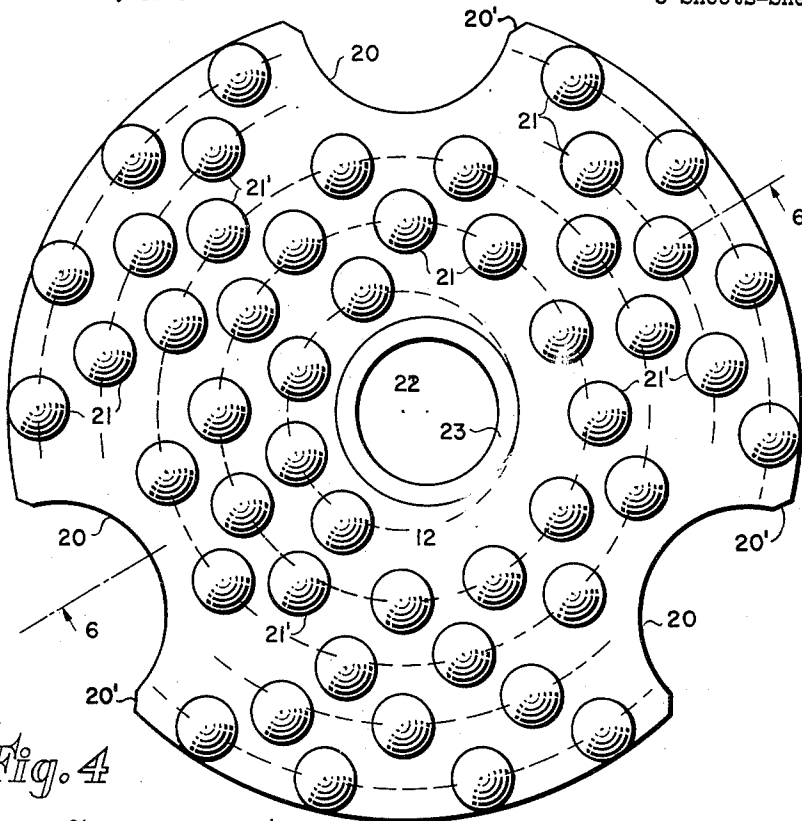


Fig. 5

INVENTOR.
ORVILLE PHIPPS

BY

Howard Sweet

ATTORNEY

Jan. 1, 1963

O. PHIPPS

3,071,201

PIERCING POINT ROTARY DRILL BIT

Filed March 9, 1959

5 Sheets-Sheet 4

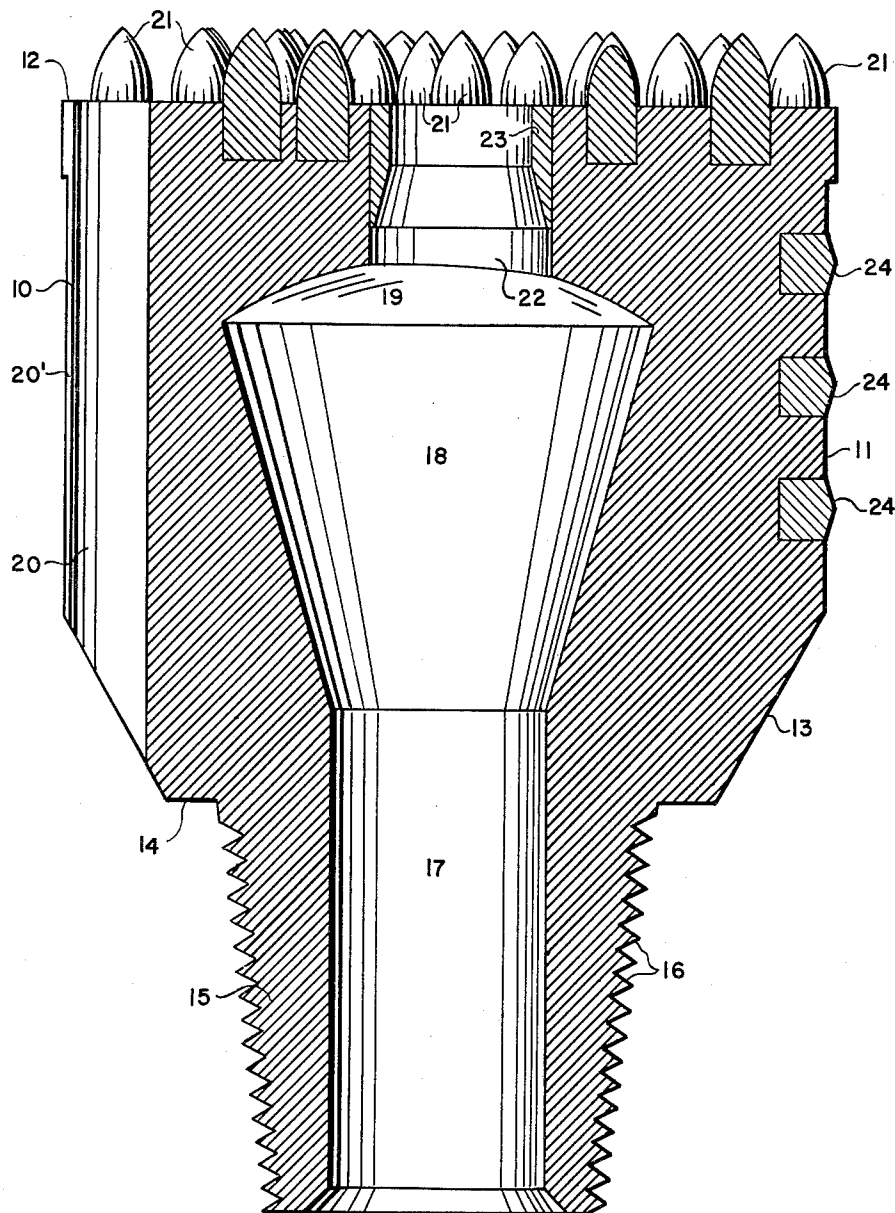


Fig. 6

INVENTOR.
ORVILLE PHIPPS

BY

BY *Thomas C. Sweet*
ATTORNEY

ATTORNEY

Jan. 1, 1963

O. PHIPPS

3,071,201

PIERCING POINT ROTARY DRILL BIT

Filed March 9, 1959

5 Sheets-Sheet 5

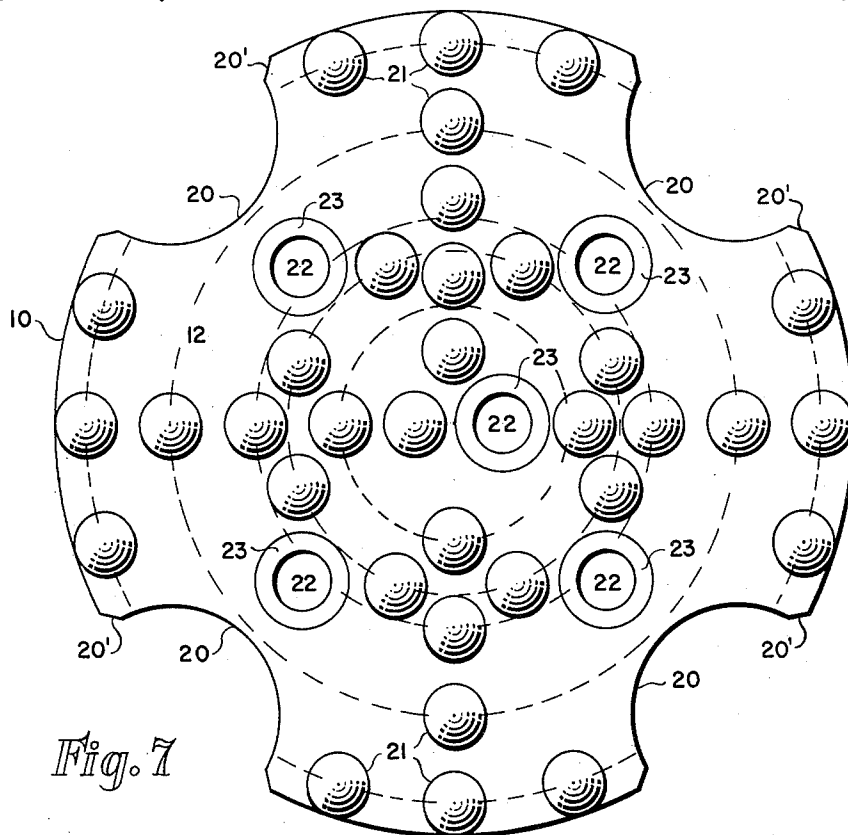


Fig. 7

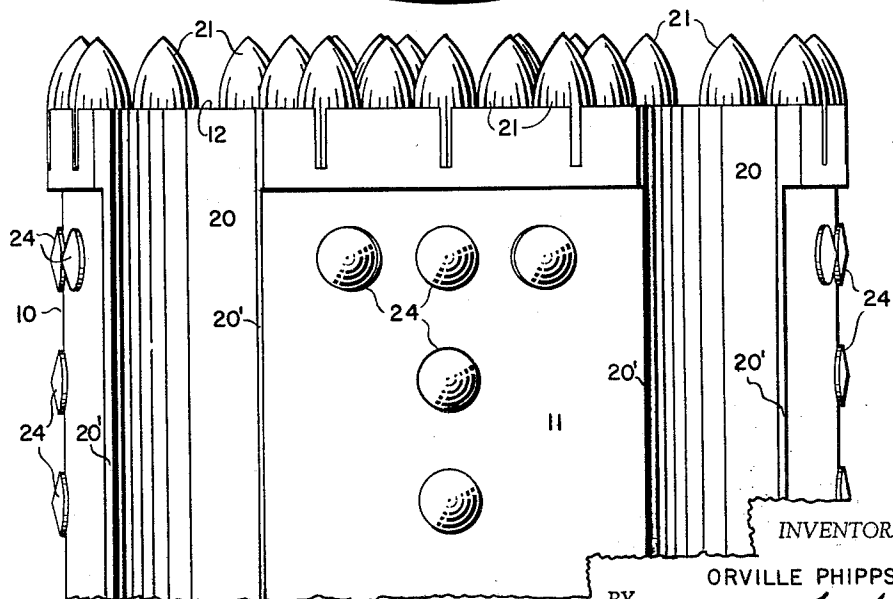


Fig. 8

INVENTOR.
ORVILLE PHIPPS
BY *Thomas H. Hurst*
ATTORNEY

1

3,071,201

PIERCING POINT ROTARY DRILL BIT

Orville Phipps, P.O. Box 69, New Iberia, La.

Filed Mar. 9, 1959, Ser. No. 797,966

4 Claims. (Cl. 175—410)

This invention relates to bits of a generically conventional type applicable in operative association with conventional actuating agencies to the generation of earth bores, such as oil wells, and has as an object to provide a novel and improved such bit of pronounced penetrating and excavating efficiency in driven cooperation with conventional powered facilities adapted to rotate the same about its axis as the terminal element of a tubular line, or string, functioning as a conduit for pressure-circulation of coolant therethrough to the end area of the bore under development by means of the bit.

A further object of the invention is to provide a novel and improved drill bit of rotary type uniquely operable with piercing effect on the area under excavation thereby in automatic reaction to conventional pressure-circulation of coolant therethrough.

A further object of the invention is to provide a novel and improved drill bit of rotary type that is effective in operative association with conventional actuating facilities to generate and to apply a highly efficient combination of piercing impacts and orbital stripping influences to the end area of a bore engaged thereby.

A further object of the invention is to provide a novel and improved drill bit of rotary type that is uniquely effective in operation to preserve desired alignment, circularity, and diametric size of bores excavated thereby.

A further object of the invention is to provide a novel and improved drill bit of rotary type that is characterized and distinguished by a unique and operatively-efficient form and arrangement of tungsten-carbide components constituting the excavating elements of the tool.

A further object of the invention is to provide a novel and improved drill bit of rotary type that is characterized and distinguished by an operatively-efficient form of tungsten-carbide components constituting the excavating elements of the tool in a unique cooperating arrangement with tungsten-carbide jet-inducing coolant outflow nozzles opening therethrough.

A further object of the invention is to provide a novel and improved drill bit of rotary type that is characterized and distinguished by an operatively-efficient form and cooperating arrangement of tungsten-carbide excavating point, outflow nozzle, and reaming point components.

A further object of the invention is to provide a novel and improved drill bit of rotary type armed with tungsten-carbide components in a cooperating arrangement promotive of superior excavating efficiency and prolonged effective utility.

A further object of the invention is to provide a novel and improved organization and operative combination of conventional metal and tungsten-carbide elements in and as a drill bit of rotary type.

A further object of the invention is to provide a novel and improved drill bit of rotary type applicable to the generation of deep earth bores that is simple and relatively inexpensive of production from known and available materials, that is adaptable in production through a range of sizes and diverse particularity, that is durable through extended periods of practical use, and that functions with high efficiency in conventional operative correlation with the equipment, facilities, and practices commonly employed in the drilling of deep earth bores.

With the foregoing and other objects in view, my invention consists in the construction, arrangement, and

2

operative combination of elements as hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawings, in which:

FIGURE 1 is a plan view of the excavating, or working, end of a drill bit exemplifying the principles of the invention as typically embodied in practical form.

FIGURE 2 is a side elevation of the organization according to FIGURE 1, a portion of the bit unit not essential to understanding of the invention being broken away to conserve space.

FIGURE 3 is a longitudinal section axially through the organization according to the preceding views taken substantially on the indicated line 3—3 of FIGURE 1.

FIGURE 4 is a plan view, similar to FIGURE 1, of the excavating, or working, end of a drill bit as alternatively organized within the contemplation of the invention.

FIGURE 5 is a side elevation, similar to FIGURE 2, of the arrangements according to FIGURE 4, a portion of the bit unit being broken away to conserve space.

FIGURE 6 is a longitudinal section, similar to FIGURE 3, axially through the arrangements according to FIGURES 4 and 5 taken substantially on the indicated line 6—6 of FIGURE 4.

FIGURE 7 is a plan view, similar to FIGURES 1 and 4, of the excavating, or working, end of a drill bit typifying a further alternative embodiment of the invention within the contemplation thereof.

FIGURE 8 is a side elevation, similar to FIGURES 2 and 5, of the arrangements according to FIGURE 7, a portion of the bit unit being broken away to conserve space.

FIGURE 9 is a detail elevation of a typical piercing point excavating component separate from and as utilized in multiple in the bit unit assemblies represented by the preceding views.

FIGURE 10 is an elevation similar to FIGURE 9 of an alternative form of piercing point excavating component appropriate for use in combination with or substitution for that shown in FIGURE 9.

Customary practice in the sinking of deep earth bores, such as oil and gas wells, involves power rotation of a tubular drill line or string about its substantially-vertical axis with an excavating bit replaceably associated with the lower end of the line or string and rotatable therewith in engagement with the foot of the bore under pressure imposed by the weight of the rotatable assembly. In such conventional operations, a liquid coolant, prepared mud or the like, is circulated under pressure downwardly of the line or string and outwardly through the associated bit for uprise through the bore exteriorly of the line or string, whereby to cool the working elements of the bit as they act in frictional engagement with the material being excavated and to scavenge detached material from the bore. Obviously, efficiency and economy of such drilling operations are determined by the penetrative efficiency of the bit utilized, the durability of the bit under the pressures and frictions to which it is subject, the effectiveness of the bit to maintain bore alignment and diametric size, and the capacity of the bit to effectively direct and apply the circulating coolant, and the instant invention is hence directed to the provision of a novel and improved bit appropriate for the conventional use above set forth with enhanced operative advantage.

In all of the practical embodiments typified by the views of the drawings, a feature of the invention is an integral bit body 10 expedient of production in a novelty of form and construction adaptable to the development thereon and therein of the various arrangements and combinations of operating elements illustrated and hereinafter described. Formed in any desired manner, as by forging or casting, from any appropriate tractable

metal, the body 10 is characterized by a generally-cylindrical terminal portion 11 of an axial length preferably moderately greater than its radius and a plane working face area 12 perpendicular to its axis at one end thereof. In axial extension away from its face 12, the body terminal portion 11 merges into an integral, coaxial, frusto-conical skirt 13 convergent in a direction away from said face to marginal conjunction with a concentric annular zone 14 disposed parallel to the face 12 in shouldered relation with and about an integral, frusto-conical stem 15 extending in coaxial relation with and away from the terminal portion 11 as the means for detachably associating the body 10 in operative connection with a conventional tubular drill line or string. The stem 15 is appropriately adapted, as by means of exterior threads 16, for attachment to the tubular line or string as a coaxial terminal extension thereof in a customary manner effective to apply rotation of the line or string to operative drive of the associated body, in which mounted interrelation the zone 14 functions as a seat for and coats in abutting relation with the end of the associated line or string. Adapted for flow-accommodating communication with the interior of the associated line or string, a straight bore 17 coaxially traverses and opens through the free end of the stem 15 in a diametric size large relative to the stem diameter to connect in the zone of the skirt 13 with the lesser end of a frusto-conical cavity 18 coaxially centered in the body terminal portion 11 wherein it is end-closed by a domed base 19 spaced inwardly from the exterior end face 12. The body 10 organized as shown and above described is, in all of its practical adaptations, formed or worked to provide an angularly-spaced plurality of like, transversely-concaved flutes or channels 20 longitudinally of and interrupting the exterior surfaces of the body terminal portion 11 and the contiguous skirt 13 as passages for the accommodation of liquid uprise within the bore exteriorly of the bit when working therein, which flutes or channels 20 are proportioned in capacity relative to the size of the associated bit to freely pass the volume of coolant circulated there-through, are uniformly spaced circumferentially of the bit, and differ in the alternative embodiments within the contemplation of the invention only as to the number thereof utilized in a particular bit organization; the bit arrangements typified by FIGURES 1 and 4 incorporating in each instance three of the flutes or channels 20 while the arrangement according to FIGURE 7 embraces four thereof. The sharp corners longitudinally of the bit body 10 marking intersection of the flutes or channels 20 with the exterior surface of the cylindrical portion 11 thereof are suitably chamfered and relieved, as at 20', to obviate any tendency of such corners to bind, gouge, or unduly erode in exposure to frictional coaction with the walls of a bore operatively accommodating the bit.

The several typical embodiments of the invention illustrated as adapted for development to give effect to the principles of the invention on and with the bit body 10 characterized by the elements and features 11-20', inclusive, as above described, distinguish one from another only in the number, position, and arrangement of piercing point, gauge point, and flow nozzle components therewith respectively associated, as hereinafter elaborated. The piercing point, gauge point, and flow nozzle components distinguishing the bit of the invention in all of its embodiments are identical in their constitution from extremely-hard, highly-wear-resistant, alloy material whereof the properties are well known to be inherent in a composition of tungsten, titanium, tantalum, nickel and cobalt, known as tungsten-carbide, resulting from repeated, tremendous compression of the properly-proportioned, powdered constituents and ultimate sintering of the components formed therefrom. Save as to specific size adapting the said components to use in bits of different sizes and to use in the diverse arrangements ap-

plicable to bits of the same size, the piercing points are throughout of similar conformation and identical nature, the gauge points are throughout alike in conformation and nature, and the flow nozzles are alike in nature and similar in conformation.

The piercing points distinguishing the instant invention are individually designated by the numeral 21 throughout the views of the drawings and are formed, as particularly represented in FIGURES 9 and 10, from the tungsten-carbide material above noted as generally-cylindrical, solid bodies of appropriate diameter small in relation to the bit body diameter having an individual length slightly exceeding twice the unit diameter, a flat base perpendicular to the unit axis at one end, and a penetrating point at the other end. Conformed as represented throughout the assembly views of the drawings and particularized in FIGURE 9, the penetrating point operatively terminating each of the components 21 may be of smooth ogive contour established to be practical and efficient for realization of the functions of the components in many diverse drilling operations, and, alternatively, the penetrating point portions of the said components may be worked to six-sided, pyramidal form convergent to a blunt apex, as a 21a in FIGURE 10, for consequent enhanced point strength and effectiveness useful to expedite penetration of hard, highly-abrasive natural formations. The point components 21 or 21a are socket-seated in and permanently affixed to the plane face 12 of the body portion 11 in a patterned spacing discussed hereinbelow with the component axes parallel to that of the bit body and the component tips defining a common plane parallel to the face 12 and spaced outwardly therefrom a distance exceeding the half length of said components. As will be obvious to those skilled in the pertinent art, permanent attachment of the point components 21 or 21a to and in the desired arrangement on the flat face 12 is readily accomplished through the provision in said face of cylindrical sockets adapted to snugly receive the blunt base ends of the components, treatment of said sockets and coating portions of the points with a suitable high-strength brazing alloy and flux, and appropriate heat treatment of the combination after insertion of the points to perfect a brazed bond between the material of the body portion 11 and the bases of the components 21 or 21a seated therein.

As the primary excavating instrumentalities of the improved bit in each practical embodiment thereof, the piercing points 21 and 21a react to influences acting upon the bit assembly to penetrate and dislodge material at the foot of a bore wherewith they are adapted to engage, and a feature of the invention is the unique excavating action of said points resulting from their form, arrangement, and operative correlation with the bit body. The piercing points 21 or 21a react to rotational drive of the bit body and to circulation of coolant therethrough with a combined penetrating and gouging effect of pronounced excavating merit. In any appropriate number and pattern arrangement on the plane face 12 of each bit organization, as represented by the views of the drawings and hereinafter particularized, the piercing points 21 or 21a of the bit apply powered rotation thereof with excavating effect on the material at the foot of the bore along individual circular paths concentrically related to traverse all major areas of the foot of the bore to which they are opposed under pressure of the tool assembly carrying the bit, and in such number and pattern arrangement the said points 21 or 21a react with piercing effect on the material under excavation to influences operable to reciprocate the excavating body axially of the bore into and away from engagement with the foot area thereof. Reciprocation of the bit axially of the bore for penetrative engagement of the points 21 or 21a in the material under excavation is accomplished in reaction to conventional circulation of coolant through the rotationally-powered tool assembly as ingeniously directed to jet

outflow through the bit face 12 by means and arrangements featuring the invention. High operating pressures being requisite to maintain effective coolant circulation through rotation-type drilling equipment operating at considerable depth, such circulation is customarily the function of reciprocatory, piston-type pumps and compressors productive of a pulsating flow marked by a succession of high-pressure impulses appropriate for axial agitation of the bit working in a bore. The pulsating character of the conventional coolant circulation is availed of for axial agitation of the bit within the contemplation of the instant invention by means of a unique arrangement of flow nozzles defining passages for the outflow of the coolant from the bit with effectively-directed jet action. The form and arrangement of the cavity 18 terminating in its domed base 19 provides a coolant reservoir within the bit for the collection of coolant supplied through the associated line or string under considerable pressure, and a unique characteristic of the improved bit organization is the provision of cylindrical outflow passages 22 opening from said cavity 18 through the domed base 19 thereof and the plane face 12 of the bit body in axially-parallel relation with the latter. Alike as to cylindrical form and disposition parallel to the bit axis, the outflow passages 22 of the several illustrated embodiments of the invention vary only as to number and proportional size as hereinbelow elaborated. The passages 22 serve in an obvious manner to direct outflow of coolant from the cavity 18 in a stream or streams, perpendicular to the plane face 12 of the bit whereby to apply the pulsations characteristic of coolant circulation directly against the foot of the bore opposed by the bit face 12 in a manner operable to intermittently separate the bit therefrom and such pulsation of the coolant circulation is applied with enhanced operative effect through the agency of flow nozzles 23 distinguishing the invention with structural as well as functional advantage. Externally cylindrical in a size snugly receivable in an outflow passage 22 wherewith it is adapted for association, each of the flow nozzles 23 is a tubular member of the tungsten-carbide material above discussed which is formed with a relatively-short cylindrical throat opening through one end thereof in coaxial communication with a relatively-longer frusto-conical throat opening to the other end of the nozzle. Finished to right-cylindrical form, a nozzle 23 of the tungsten-carbide material is engaged within each of the outflow passages 22 in a length no greater than the minimum depth of the associated passage between the cavity base 19 and the plane face 12 of the bit and is therein disposed with its end intersected by the cylindrical throat coplanar with said bit face 12 and its frusto-conical channel divergently opening to the cavity 18 interiorly of the associated passage 22. As so engaged and disposed, each of the nozzles 23 is permanently affixed in and to the bit body portion 11 by means of suitable brazing, or the equivalent, as above discussed in connection with the points 21 and 21a. In the association shown and described, the nozzles 23 arming the outlet ends of the passages 22 serve to substantially eliminate erosion of the outflow passages 22, particularly at their outlet ends, resulting from pressure-circulation of coolant through the passage, and in addition said nozzles function by virtue of their throat arrangements and dispositions to enhance the velocity of coolant flow there-through and to deliver such outflow with a jet action wherethrough pulsations of coolant circulation are reflected with operative advantage. In the number selected for a given bit embodiment within the contemplation of the invention, the outflow capacity of the passages 22 as modified and restricted by their associated nozzles 23 will be materially less than the input flow of coolant to the cavity 18, whereby to assure a condition of coolant pressure within the cavity adequate to maintain high-velocity outflow thereof through the restricted throats of the nozzles.

Completing the bit organization of the invention for realization of its intended purposes and advantages, the cylindrical surface areas of the body portion 11 between the flutes or channels 20 interrupting the same are armed with gauge points 24 of the tungsten-carbide material inset and affixed radially of the bit in patterned arrangements hereinafter described for reaming coaction with the walls of the bore as the bit is rotated and axially agitated therein. In a diametric size expediently the same as that of the points 21 and 21a and an axial length substantially less than that of the piercing points, the gauge points 24 are each furnished with one blunt end receivable in a socket radially of the bit portion 11 for secure attachment thereto, as by brazing, and with a flatly-conical, or convex, other end directed exteriorly of the associated bit. The bit portion areas carrying the gauge points 24 are desirably undercut with respect to the working diameter at the plane face 12 of the bit, whereby to dispose the gauge points 24 in a slight projection outwardly from the bit surfaces thereby intersected and to locate the exterior working tips of the gauge points coincident with a projection thereover of the cylinder established by the annulus embracing the working end of the assembly. Rotary and axial agitation of a bit armed with the gauge points 24 at the foot of a bore under development thereby applies said points to and with reaming effect upon the bore walls in an obvious manner effective to maintain substantially true circularity, diametric size, and axial alignment of the resulting bore.

The illustrated typical embodiments of the invention represent the development in a standard bit of eight and there-eights inch diameter of piercing point, gauge point, and flow nozzle organizations differing only as to arrangement pattern and number of components utilized, the several elements featuring the invention functioning exactly as above set forth in any preferred arrangement thereof. Common to all of the illustrated embodiments is a disposition of piercing points 21 or 21a peripherally of the bit plane face 12 in a uniform annular spacing arcuately of the bit face area between adjacent flutes or channels 20 and in a disposition radially of the bit face such as to register side zones of said points tangent to and with slight exposure through the annular bend margin defining the face 12, which arrangement assures effective excavation marginally about the foot of the bore in consequence of the impacts and stripping actions applied through said points. A second feature of arrangement common to all of the illustrated embodiments of the invention is the provision of three gauge points 24 aligned in a uniform spacing therebetween with their centers on a line longitudinally of and bisecting each cylindrical surface of the bit portion 11 interjacent successive flutes or channels 20. Diversities of arrangement distinguishing the typical embodiments of the invention are manifest in the organization according to FIGURES 1, 2 and 3, as the use of three flow passages 22, each armed with a nozzle 23, disposed at the apices of an isosceles triangle symmetrical with respect to the bit face 12 and its center, as the utilization of forty-five points 21 or 21a in a generally symmetrical orbital disposition on six circular paths concentric with the bit face, and as the provision of thirty-three gauge points 24 divided between the three cylindrical surface areas separating the flutes or channels 20 and similarly arranged in a T-pattern wherein two of the points 24 are spaced apart laterally and on each side of each of the two points 24 of the longitudinal row thereof most nearly adjacent the face 12. To eliminate the development of annular ridges at the foot of the bore being worked by the bit and to assure that the entire area at the foot of the bore shall be subject to gouging and stripping action of the points 21 or 21a during rotation of the bit one or more of said points in each circular row thereof within the peripheral sequence of the points is offset slightly and radially of the face 12,

7

in one direction or the other, from the circle common to the centers of the remaining points in a given orbit, as is clearly typified by the reference numeral 21' applied to designate such offset components. In the arrangement according to FIGURES 4, 5, and 6, a single flow passage 22 of relatively-large size, armed with its nozzle 23, is disposed to open eccentrically through and near the center of the face 12, forty-nine of the piercing points 21 or 21a are mounted in substantial symmetry as five generally circular rows, thirty-three of the gauge points 24 are utilized in a pattern identical with that of the embodiment previously described, and certain of the points 21 or 21a are offset out of true circular orbit, as at 21'. As above noted, the embodiment according to FIGURES 7 and 8 is characterized by four of the flutes or channels 20 and typifies an arrangement wherein four of the passages 22 delivering through their nozzles 23 define the corners of a square symmetrically centered on the face 12, a fifth such flow passage and nozzle opens symmetrically through the face in some eccentricity therewith, thirty-four piercing points 21 or 21a are symmetrically patterned with respect to the face 12 save for some offsetting of the individual points 21', and twenty gauge points 24 are provided on the cylindrical surfaces between the flutes or channels 20 in a pattern on each thereof the same as that of the previous embodiments except for elimination of certain of such points at each side of each longitudinal row thereof.

Secure permanent attachment of the tungsten-carbide piercing point, flow nozzle, and gauge point components to the bit body may be facilitated and enhanced to supplement the strength of the brazed bond therebetween through development and utilization of a temperature differential distinguishing the elements to be interrelated at the time of their actual combination. Giving effect to known principles in a practical manner, the bit body conditioned to receive the tungsten-carbide components may be moderately heated with consequent slight expansion of the open areas of the sockets and passages provided to receive the tungsten-carbide elements and the latter may be simultaneously chilled to a very low temperature with consequent contraction of their diametric dimensions, in which condition of bit and components the latter may be readily entered to their respective seats in the bit where they are firmly gripped as the temperature differential between the bit and components abates to contract the seats engaged by the components and to expand the latter therewithin. As so gripped in and bonded to their seats, the tungsten-carbide components of the bit organization are secure against any tendency to dislodge during the working operations of the assembly.

Applied to actual drilling operations in a customary association with conventional rotary-type drilling equipment and coolant-circulating means, the improved bit of the invention is effective, in every practical embodiment typified by the views of the drawings, to penetrate natural earth formations of diverse character with pronounced efficiency in terms of excavating speed and bit life for the development of smooth-wall, straight, true-diameter bores of great depth. In a demonstrated superiority of penetrative efficiency, the improved bit is uniquely conservative of drilling time and expense by reason of its operative durability in all types of earth formations with consequent minimizing of occasion for withdrawal of the bit from the bore for any reason whatever.

Since changes, variations, and modifications in the form, construction, and arrangement of the elements shown and described may be had without departing from the spirit of my invention, I wish to be understood as being limited solely by the scope of the appended claims, rather than by any details of the illustrative showing and foregoing description.

I claim as my invention:

1. In a drill bit adapted for detachable connection

8

with, and as the excavating terminus of, a rotatably driven tubular drill line, the combination of a generally cylindrical hard rigid body formed with a plane circular face perpendicular to the axis of said body, said face being disposed at one end of said body, a stem of reduced diameter projecting from the opposite end of said body and adapting said body for removable and replaceable connection thereof with a drill line extending coaxially therewith, said body having a plurality of socket recesses opening onto said circular face, said circular recesses being disposed with the medial axis thereof lying in concentric circular loci concentric with the axis of said body, a plurality of axially tapered and pointed elongated tip members, said tip members being formed of tungsten carbide material, and being fixed in said socket recesses with the points thereof projecting axially beyond said circular face, the points of said tip members terminating at least substantially equi-distantly from said circular face, said body having a cylindrical portion extending from said circular face toward said stem and an inwardly tapered portion extending from said cylindrical portion toward said stem and a shoulder extending between said inwardly tapered portion and said stem, said body having a frusto-conical cavity therein, said cavity tapering inwardly in the direction from said circular face toward said stem and said cavity being coaxial with the axis of said body, said stem and the adjacent portion of said body having a cylindrical inlet passageway extending therethrough, one end of said inlet passageway opening onto the end of said stem and the other end of said passageway merging into and being coextensive with the adjacent end of said cavity, said cavity being concavely shaped at the end thereof remote from said end adjacent said inlet passageway, said body having an outlet passageway therein extending at least substantially perpendicularly from said circular face to said concavely shaped end of said cavity, said outlet passageway being tapered inwardly intermediate said concavely shaped end of said cavity and said circular face and in the fluid path direction therebetween, said outlet passageway being disposed in eccentric relation to said axis of said body but parallel thereto, said body having a plurality of circularly concave channels extending axially of said body and symmetrically thereabout, said channels opening onto and forming part of the periphery of said cylindrical portion and said inwardly tapered portion of said body, the edges of said channels adjacent the outer periphery of said cylindrical and inwardly tapered portions of said body being bevelled.

2. The combination defined in claim 1 wherein said body has at least one additional outlet passageway therein extending at least substantially perpendicularly from said circular face to said concavely shaped end of said cavity, said additional outlet passageway being tapered inwardly intermediate said concavely shaped end of said cavity and said circular face and in the fluid path direction therebetween, said additional outlet passageway being disposed in spaced relation to the first mentioned outlet passageway and in eccentric relation to said axis of said body but parallel thereto, said first mentioned outlet passageway and said additional outlet passageway being formed at least in part by tungsten-carbide partially inwardly tapered ring members fixed in said body.

3. The combination defined in claim 1 wherein said cylindrical portion of said body has fixed therein and projecting radially beyond the periphery thereof, a plurality of gauge points, said gauge points being of tungsten-carbide material, said gauge points being disposed in groups defining a plurality of rings of gauge points, said rings being parallel to one another and concentric with said cylindrical portion of said body, said rings being disposed in spaced relation to said circular face and to one another.

4. The combination defined in claim 1 wherein the maximum diameter of said outlet passageway is smaller

than the diameter of said inlet passageway and wherein said outlet passageway is formed at least in part by a tungsten carbide partially inwardly tapered ring member fixed in said body.

References Cited in the file of this patent**UNITED STATES PATENTS**

1,063,982	Larnce	June 10, 1913
1,077,772	Weathersby	Nov. 4, 1913

8

2,121,202
2,197,991
2,493,178
2,696,973
2,725,216
2,774,571

763,676

Kilgore	June 21, 1938
Wright	Apr. 23, 1940
Williams	Jan. 3, 1950
Baumgartner	Dec. 14, 1954
Brown	Nov. 29, 1955
Morlan	Dec. 18, 1956

FOREIGN PATENTS

Great Britain	Dec. 12, 1956
---------------	---------------