Feb. 28, 1967 H. L. JOHNSON 3,306,377

COLLAPSIBLE DRILL BIT

Filed Dec. 23, 1963

FIG. 1.

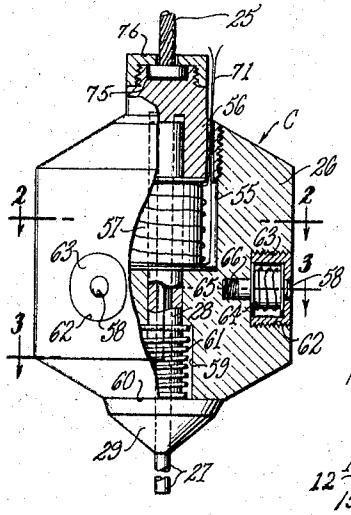


FIG. 2.

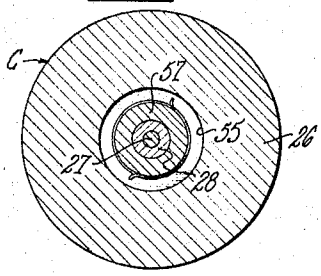


FIG. 3.

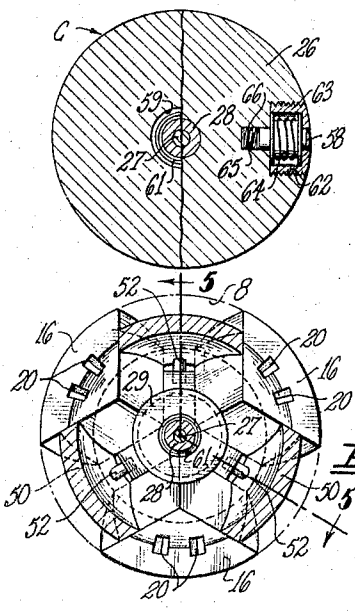


FIG. 4.

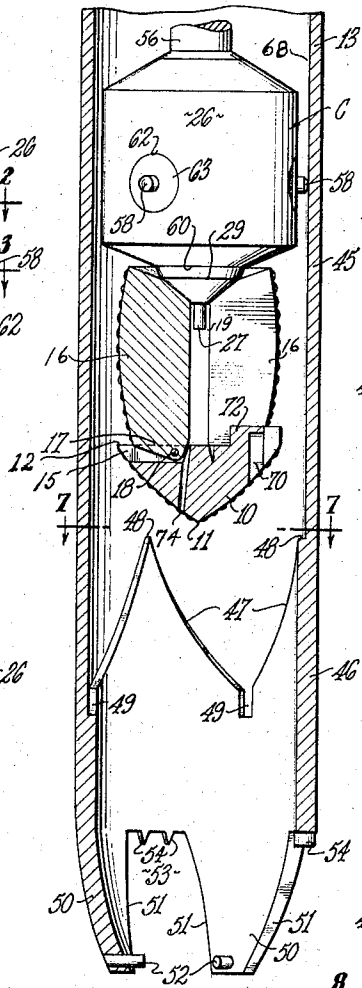


FIG. 5.

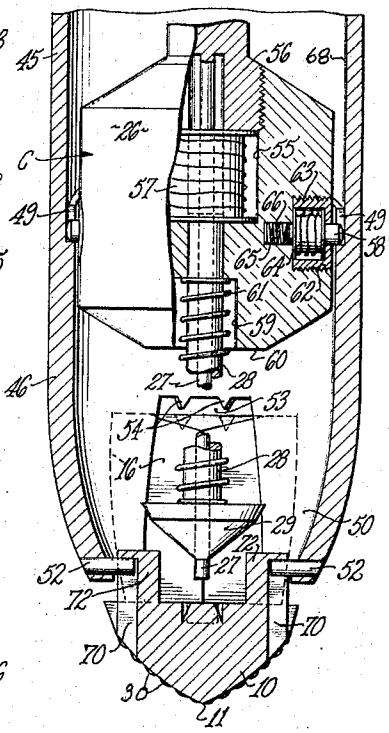


FIG. 6.

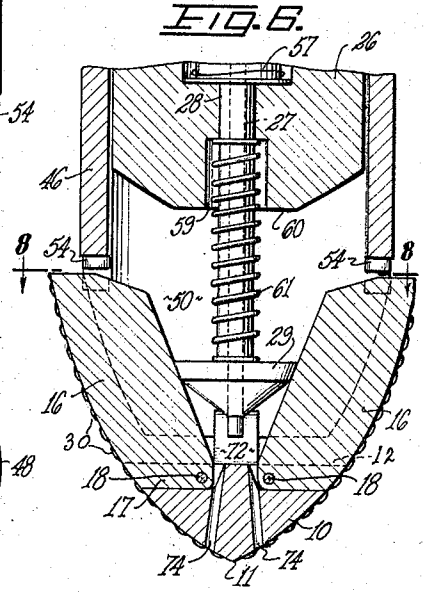


FIG. 7.

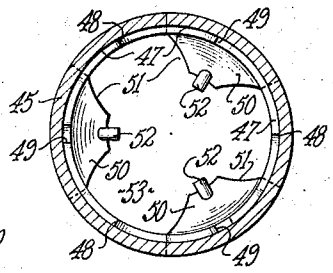


FIG. 8.

INVENTOR.

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3,306,377

COLLAPSIBLE DRILL BIT

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This is a continuation-in-part of my application S.N. 105,590, filed April 26, 1961, now Patent 3,164,215, which was a continuation-in-part of S.N. 823,548, filed June 29, 1959, now abandoned.

This invention relates to drill bits, particularly exemplified by the type which is used to drill oil and gas wells and for other deep earth boring. Such a bit, connected to the bottom of a tubular drill string which is progressively lengthened by addition of successive tubular segments to the top of the string, is moved against the bottom or face of the bore by rotation of the whole drill string from the surface. The descending bit must form a larger bore than the outside diameter of the drill string so that the latter may continue to sink within the deepening hole without engaging the periphery of the bore. This annular space between the outer perimeter of the drill stem and the circumference of the bore is usually employed for the return circulation of fluid or "drilling mud" which is pumped down through the tubular drill string and out at the bottom around the bit to cool and lubricate it, as well as to pick up chips and cuttings which it then carries to the surface through the clearance provided by the surrounding annular space. The gross solids are then filtered out and the fluid is recirculated in a continuing cycle, with more additives as required for viscosity, etc. Sometimes drilling is effected during reverse circulation of fluid, i.e. up the center of the drill stem after being pumped down through the outer annular space.

After some duration of drilling, a length of several miles of drill pipe may be rotating or standing in the hole, and when it becomes necessary from time to time to replace the bit on the bottom because it has worn down or broken, when using a conventional bit which is externally screwed onto the lowermost drill stem segment it is necessary to pull up this whole length of pipe, stopping to uncouple it into its component segments as it emerges, in order to get the bit to the surface for detachment from the lower end of the drill stem. Thus, as the well deepens, more time may eventually be spent in "pulling the pipe" than in actual drilling, particularly when penetrating very hard rock which may dull a fresh cutting edge in a few hours.

Most rotary drilling currently uses roller bits, typically three cones which individually turn by contact with the end face of the bore as the rotating drill stem (or its bottom bearing-mounts) press them thereagainst. In contrast, a preferred form of my present bit employs a non-rolling cutting face which sweeps the face of the bore in unison with the rotating drill string. There being no relative movement between the drill stem and the attached drill bit, no bearing mount is required between them. In addition, not being threadedly attached to the bottom drill segment, my bit can be mounted and demounted on the bottom of the drill string while the latter remains in the bore, so that the bit may thus be replaced any number of times by movement (in collapsed form) through the tubular center of the drill string without "pulling the pipe." At the same time, such retractable bit can be expanded at the bottom of the drill stem and thrust-attached thereto so as to still form a bore larger than the inner perimeter of the drill string through which it has passed, and even if desired, larger than the outer perimeter of the drill string. In either case, the required diameter of the bore is progressively maintained, and the rotating bit is further stabilized by nearby reamers or side cutters carried by the drill stem; these latter are longer lasting than bottom rollers, particularly when not required to enlarge the bore appreciably. The reamers may be mounted on the drill stem (permanently) or on the retractable bit (or both).

Also the transversely disposed frame of the retractable bit can dependently carry conventional rolling cutters if desired, but preferably the lowermost (central) portion of the bit is formed with a more-or-less conic or convex contact face which thus presents a bulbous bore-engaging core externally having a spiral series of downward projecting, elongated teeth individually disposed at a sheer angle or bias to a theoretical spiral pattern eminating from the center of the drill stem. In fabrication, such abrasive teeth may be inserted (e.g. diamond chips), over-laid (e.g. tungsten carbide) or cast on or with the body of the bit as described in my earlier applications S.N. 823,548, filed June 29, 1959, and S.N. 105,590, filed April 26, 1961.

The present collapsible bit construction is based on a plurality of axially directed, wedge-shaped, externally arcuate-faced segments which are individually pivotally attached at their lower end to a base cone in a collective circle so as to be radially tiltable between a contracted position wherein they are collectively receivable within the drill stem, and an outspread position wherein the larger circle formed by their centrifugally out-tilted tops are thus held in drilling position by the downthrust end of the tubular drill stem. The base cone (which drills the center of the bore) is of less perimeter than the interior of the drill stem so that it can be moved up and down within the length of the standing drill stem, when the intilted segments are held together over its transverse top.

These hinged segments of my collapsible bit are formed with top-opening sockets along their top edge, which sockets are laterally spaced apart to form a circular pattern (when all the segments are out-tilted), the sockets being adapted in such position to receive corresponding-spaced teeth in thrust engagement. Also, the lower edge of the annular drill stem is formed with linear extensions which are alternately in the form of (one or more) short teeth and spade-shaped inserts having laterally downward converging edges, both of which elements are bayonet-inserted respectively into the sockets and in edgewise abutment between the outspread segments of the bit in rotary driving position.

Thus another object of the invention is to provide a terminal drill collar or bit-mounting pipe segment which can be coupled to the distal end of a conventional rotary drill stem as the final tube length, such segment having a circle of such bit-engaging bottom-edge projections. By use of such a rotary drill bit the present bit may be mounted on the bottom of a rotary drill stem by thrust engagement and thus be functionally rotated by such ring of bayonet extensions. The teeth engage successive sockets along the upper edge of the out-tilted bit segments while the axially arcuate, spade-shaped projections occupy the gap between (and thus laterally connect) the upper portions of successive segments; accordingly there are the same number of such projections as segments—in the illustrated embodiment three segments and three spade-inserts. On the other hand, the number of teeth and coresponding sockets per segment may increase with the diameter of the bit.

Still another object is to provide such a terminal drill collar which has means for holding the descended, retractable drill bit from dropping out free from the open bottom of the drill stem. Each of the spade shaped inserts carries an inturned prong or suspension pin for jointly cradling the partially ejected bit in position for out-tilting and thrust engagement.

Although the drill bit might in some cases be mounted on the bottom of the drill stem simply by dropping it down from the top through the column of liquid within

the tube (so long as it remains longitudinally aligned), and raising the distal end of the standing drill stem off the bottom to position it for thrust engagement; and similarly it could be withdrawn through the tube simply by use of a magnet suspended down the drill stem by a cable from the surface, especially adapted means are also provided for conveying it up and down within the column and aiding its mounting and demounting on the bottom. Thus a cylindrical bit-carrier is suspended by an electric cable within the liquid column. It carries an electromagnet for dependently holding the bit. It can also carry an electric motor for propelling itself through the fluid within the column while holding the bit or moving lengthwise by itself. By self-propulsion it can thus move the attached bit in either direction through the liquid of the tube, quicker and more satisfactorily than it might be hauled up simply by cable or faster than when permitted to sink by its own weight through the viscous column of "drilling mud." Alternate to being connected to a surface-located, power source by an electric cable, the carrier can of course carry its own power source such as a battery, etc.

In addition to the dependent bit being centered relative to the carrier, the latter additionally has retractable locating means for circumferentially positioning the bit at the bottom preparatory to mounting. That is, the locating means on the carrier, by sliding contact with curvedly descending guideways formed about the inner face of the terminal drill collar, is rotated into position of alignment for dropping its carried bit, onto the suspension pins of the spade-inserts. Such a feature of the drill collar is also new.

Other objects and advantages will become apparent as the description proceeds, having reference to the presently preferred embodiment of the invention particularly illustrated in the accompanying drawing wherein:

FIG. 1 is a side elevation, partly in axial section, of the carrier, with the lateral contact elements in retracted position;

FIGURES 2 and 3 are transverse sections taken respectively along the lines **2—2** and **3—3** of FIG. 1;

FIG. 4 is an axial section taken through the terminal segment—which forms the distal end—of the tubular drill stem or drill pipe, showing therein the descending carrier (in elevation) and the collapsed drill bit (in axial section) attached to the carrier, with the contact elements of the latter shown in position (upon further descent) to slidingly engage the spiral guideways of the inner face of the drill stem so as to rotate the descending bit to its mounting or attachment position;

FIG. 5 shows in longitudinal section taken along the line **5—5** of FIG. 8, with portions in elevation, the distal end of the terminal segment of the drill stem surrounding the fully descended carrier, with the extended contact elements resting at the bottoms of the guide slots, and its carried bit dropped to its lowermost position partially projecting from the open bottom of the drill stem, the out-tilted position of the bit segment being indicated in broken lines;

FIG. 6 is a similar view of the lower portion of FIG. 5 but showing the axially dependent, magnetic bumper of the carrier, projected downward to radially out-tilt the upper ring of collapsible segments of the drill bit;

FIG. 7 is a transverse section taken through the drill stem along the line **7—7** of FIG. 4; and

FIG. 8 is a transverse section taken through the terminal spade-shaped inserts of the drill stem along the line **8—8** of FIG. 6, and showing in top plan the circle of completely out-tilted segments of the collapsible bit, engaging the side wall of the earth bore.

In the form of rotary drill bit illustrated in FIGS. 4, 5, 6 and 8, there is provided a dependent, downwardly converging, generally conical casting or bulbous body **10**, the bottom point **11** of which corresponds to the center of the earth bore **8** which is drilled thereby. The transverse supporting body **10** has a generally annular top **12** with a maximum perimeter less than that of the interior of a tubular drill stem or pipe **13** through the length of which pipe the body **10** is thus able to be moved up and down (without tilting) to and from its mounted position on the bottom end of the pipe. The circular top **12** is theoretically divided into a number of equal, pie-slice areas (here three in number), above each of which is disposed an upstanding segment **16**, arcuately curved along its outer face like segments of the bore curvature **8**. Each segment **16** is generally wedge-shaped in horizontal section, and formed with a bisecting, radially directed, dependent rib **17**, longitudinally aligned with and proportioned similar to a channel **15** which is formed along the top face of the body **10** so as to receive the respective rib **17** therein and thus anchor the segment **16** against lateral or rotational displacement.

Adjacent its inner extremity, each rib **17** is transversely apertured to journal a cylindrical hinge pin **18** which is inserted therethrough by way of a corresponding, generally horizontal bore in the body **10**, and then welded or otherwise secured in place. The center of gravity of each segment **16** is spaced radially outward from the hinge pin **18** so that each segment is biased to drop gravitationally to its out-tilted position (FIGS. 6 and 8) when not positively held in-tilted or clustered together (FIG. 4). When thus indrawn, with touching sides the cluster of segments **16** delineate an axial well **19** and the outer circumference of the collective segments does not exceed that of the body **10** (FIG. 4) so that the collapsed bit as a unit is readily movable up and down the length of the drill stem **13**. Upon out-tilting, the segments **16** collectively have an (interrupted) perimeter greater than the exterior of the drill stem **13**. In the out-tilted position, the underface of each segment **16** on each side of the rib **17** rests upon the top face **12** of the base **10**, while adjacent sides of successive segments **16** at the outer edge of the top **12** register with an upstanding abutment **72** formed in the body **10** and characterized by a bottom-opening recess **70**. Centrally the body **10** is also provided with fluid outlets **74** to channel drilling fluid passing from within the drill stem **13** outward to the face of the bore **8**. When the segments **16** are out-tilted, their upper face is formed with upward-opening sockets **20** aligned with the curvature of the drill stem **13** and thus disposed to receive in thrust engagement, correspondingly shaped teeth **54** which are located along the lower margin of the terminal drill stem segment **45**.

The lowermost or terminal segment **45** of the tubular drill stem is formed with its most distal length **46** radially thickened inwardly so as to dispose along the upper boundary of the thickened portion, a peripheral series of contact guideways **47** each curvedly descending symmetrically from opposite sides of an apex **48** (here three in number) to an ultimate, short, axially directed, closed-bottom slot **49** (likewise three in number). More distally therefrom (i.e. adjacent the open bottom of the tube **45**) the tube wall extends only as a similar number (three) of spade-shaped bayonet inserts **50** each having downwardly converging side edges **51**. The free end of each insert **50** is radially inturned to form or carry a centrally directed projection **52**, each of which is located linearly downstream from the respective drop-slot **49**. Each projection **52** is disposed to be received in a corresponding recess **70** of the bit, and thereby keep the bit (partially projecting from the bottom or open end of the drill stem **13, 45**) from completely passing out of the tube **13**, after it has descended in collapsed form. The side edges **51** of each insert **50** mutually converge descendingly, and the side walls of the bit segments **16** are correspondingly slanted, for out-tilting in the open areas **53**.

The carrier C may be self-propelled (especially for ascent) or it may be suspended and moved lengthwise within the column of fluid in the upstanding drill stem by a flexible cable **25** from the surface drilling rig (not

shown). It has a body **26**, conveniently cylindrical, of a size calculated to pass easily along the inner length of the tubular drill stem **13**. Axially dependent therefrom is a striker rod **27** fixedly projecting downward from a top closure plug **56**, which striker along its lower length carries an axially reciprocable, tubular plunger **28** bearing a frustro-conic, downwardly tapered, magnetic bumper **29** secured adjacent its lower or distal end. The upper end of the reciprocable plunger **28** is movable lengthwise in a top-opening, axial bore **55** of the carrier **26**, the open end of which bore is closed by the threaded plug **56**. The latter also provides an anchorage socket **75** for the flexible cable **25**, held in place by the apertured cap **76**.

Immediately beneath the closure plug **56** is located a solenoid **57** (energised from a surface generator or power source by means of a conductor **71** carried alongside or through the cable **25**), the solenoid coil being centrally traversed by the bumper-carrying plunger **28**. Within an axial counterbore **59** which extends upward from the bottom face **60** of the carrier **26**, is housed a coil compression spring **61** having its lower end seated against the upper face of the bumper **29** so as normally to urge the bumper-carrying plunger downward. Contrariwise, activation of the solenoid **57** holds the bumper **29** adjacent the underface **60** of the carrier.

The outer cylindrical face of the carrier **26** is radially drilled and tapped to provide (three) circumferentially spaced sockets **62**, in each of which is inserted a threaded plug **63** holding a solenoid **64** centered about a radially extensible, contact arm **58** terminally holding a roller ball, which arm is outwardly urged by a compression spring **65** seated in a smaller and deeper bore **66**. All the lateral solenoids **64** are simultaneously activated through an electric line from the surface so as normally to hold the contact pins **58** retracted and thus not interfere with the usual clearance between the cylindrical wall of the carrier **26** and the adjacent surrounding wall **68** of the drill stem. However, when the descending carrier C with an attached bit B approaches the apices **48** of the guideways **47**, the several contact elements **58** are projected toward the inner face or wall **68** of the tube **45**. Further descent of the carrier C and attached bit B causes the extended pins **58** to slide or roll along the spirally curved guideways **47** (thereby correspondingly rotating the carrier and bit) to the position at which the guide pins **58** drop into the slots **49** and the bit body **10** extends out of the open end of the drill stem (FIG. 5).

Deactivation of the electromagnet **57** then causes the spring **61** to push the rod **27** and its bumper **29** downward, thus spreading apart the clustered bit segments **16** and forcing them (to the extent that they fail to drop gravitationally) into a the aligned openings **53**. The drill stem **13** at this time is being held (from the surface) elevated a small amount above the bottom of the bore **8** so as to permit the descended bit **10** to be projected through the end. Lowering the drill stem then causes the teeth **54** to enter the sockets **20** and the side edges **51** of the inserts **50** to frictionally engage the corresponding side edges of the out-tilted bit segments **16** (FIG. 8). The carrier C is then withdrawn up the drill stem **13** and drilling is carried on by rotating the drill stem from the surface in the usual manner.

To demount the bit, rotation of the drill stem by the surface-located rotary table (not shown) is stopped, and the drill stem is raised a small distance off the bottom of the bore. The carrier C is dropped down the drill stem so that its momentum causes the extended striker rod **27** to hit the center of the bit body **10** and drop it to the position of FIG. 5 where it hangs suspended on the projections **52**. Upward movement of the magnetic bumper **29** (by energization of the solenoid **57**) then causes the (steel) bit segments **16** to infold or cluster together (to the position of FIG. 4), and the carrier and attached bit are raised up the drill stem **13** to the surface.

The bottom and side contact faces of the bit may carry outward or downward projecting, elongated, abrasive teeth **30** collectively arranged in a spiral pattern eminating from the theoretical center of the drill stem, and individually disposed at a sheer angle relative to the (rotary) direction of movement across the bore face, so that collectively they sweep the entire dished or concave face of the bore upon each rotation of the drill string. Alternately, however, as long as the cutting points or edges cumulatively wipe the whole area of the bore, they may be located without regard to such spiral pattern. In fabrication, the steel face of the bit may be overcast with any pattern of wear resistant, abrasive elevations such as cemented carbide, aluminum oxide ceramics, metallic borides, diamond chips or bortz, etc. or the entire bit and teeth may be cast of special alloy steel, replaceable on the teeth from time to time as worn away.

However the whole contact surface of the bit, and in particular the conic or bulbous center may be formed of self-abrasive material, that is (in contrast to just a knife edge of a severing or chipping tool), wherein the contact face of the bit is formed of abrasive material which as it is worn away by use, still continues to present an abrasive surface. Raised teeth of the same material may initially be formed on the underlying abrasive surface. Desirably comminuted abrasive particles (e.g. metallic carbide) are bonded to the steel alloy bit body by a matrix or mutual binder for metallic carbide and steel. In general, they are compositions which "wet" the carbon particles and are ferrous or other alloys having comparatively high concentrations of one or more of: nickel, cobalt, molybdenum, vanadium, titanium, tungsten; chromium, uranium, tantalum, columbium, chromium may be present in minor amounts. It should be noted that the melting point of the abrasive particles (e.g. 20 to 60 mesh) is considerably higher than that of either the binder or of the core alloy so that they substantially retain their shape and texture within the molten alloy. In casting, when the abrasive particles are tungsten carbide, for example, they should not be heated (by contact with the molten alloy) above about 2400° F. for say 15 minutes, or not above 2700° F. for a much shorter time.

As the pattern of cast teeth is worn away, the abrasive particles held in the matrix sheath continue to act as cutting points upon rotations of the bit, although with less uniform effectiveness than when they constituted a unitary pattern of teeth.

I claim:

1. A tubular bit-engaging segment adapted to form the distal terminus of a rotary drill stem, which segment is adapted for thrust engagement in rotary driving relation with a collapsible drill bit of the character described, said tubular segment being formed with a circular series of downward extending, bottom edge projections consisting of bit-engaging teeth alternating with longer, downwardly converging inserts, the inserts corresponding in number to the number of radially tiltable, upstanding segments forming a segment-engaging circle of a collapsible bit to which said tubular segment may be coupled, each insert being frictionally longitudinally receivable between an adjacent pair of such segments when out-tilted for lateral edge engagement therewith and the teeth being receivable in corresponding upward-opening sockets which may be laterally spaced apart about the top edge surfaces of said out-tilted segments.

2. The tubular segment of the preceding claim **1** wherein said inserts have their lower ends radially inturned and each includes a centrally directed projection, said projections being adapted to jointly suspend the protruding body of the collapsible drill bit at the lower end of the tubular segment and to prevent its complete distal separation from said drill stem.

3. In combination with a tubular rotary drill stem, an externally convex drill bit detachably secured to the distal end thereof and jointly rotatable in unison there-

with, said bit being formed with a dependent body and an upper circle of axially extending, upstanding segments jointly embracing the outer perimeter of said drill stem by mutually interlocking thrust insertion means extending around a substantially complete circle about the bottom end of said drill stem generally perpendicular to its plane of rotation, said upstanding segments being adapted to form a bore of greater perimeter than the drill stem and having outer abrasive elements, said segments being secured to said dependent body by pivot means and adapted to be radially in-tilted upon detachment from the drill stem whereby the collapsed bit is movable longitudinally through the drill stem while the latter remains in a bore, the engagement between the circle of segments and the end of the tubular drill stem forming the sole rotary driving connection between the bit and the drill stem.

4. The combination of the preceding claim **3** wherein said drill stem carries terminally projecting, bayonet inserts individually having a centrally-directed projection located jointly to suspend the protruding body of the collapsible drill bit at the lower end of the drill stem and to prevent its complete distal separation from said drill stem, the dependent body of said bit being formed with bottom-opening peripheral recesses individually disposed to receive one of said projections from the suspending insert.

5. A collapsible drill bit comprising a dependent body carrying pivot means and a plurality of axially extending, upstanding segments pivotally coupled thereto in a ring, the upper end of which segments is radially movable between an expanded position wherein said expanded ends may jointly embrace the drive end of a tubular drill stem so as to be rotatable thereby, and a collapsed position wherein said bit is receivable within said drill stem so as to be movable longitudinally therealong, said upstanding segments carrying outward-projecting cutting elements and being adapted to drill a bore of greater perimeter than the drill stem by reason of the expanded perimeter of said segments being greater than the exterior of the drill stem, said segments being formed with frictionally engageable side edges disposed convergingly downward therealong upon out-tilting of said segments, whereby a correspondingly shaped bayonet insert of the drill stem may be thrust-inserted jointly between each such adjacent pair of segments from the drive end of a tubular drill stem, thus to hold said ring of segments in out-tilted position and to frictionally engage them for functional rotation within a bore.

6. A collapsible drill bit adapted in contracted form to be moved longitudinally within an upright tubular drill stem and after expansion and mounting on the bottom end thereof, adapted to drill an earth bore of greater diameter than said drill stem by joint rotation of the coupled bit and drill stem, said bit comprising: a transverse supporting member having an outer perimeter less than the inner perimeter of said tube; a plurality of generally axially directed upstanding segments disposed about the perimeter of said supporting member in a ring and pivotally attached thereto so as to be radially tiltable between a contracted position wherein said bit is receivable within the drill stem and an expanded position wherein the extremities of said segments describe a perimeter greater than that of the exterior of the drill stem, said expanded segments carrying outward-projecting cutting elements, adapted to form an earth bore upon rotation thereof, said transverse supporting member also carrying bottom-projecting cutting elements adapted to sweep a bore area corresponding to the interior of the drill stem; and coupling means for holding said segments in expanded position embracing the lower edge of the drill stem and for securing the drill stem to the bit in driving relation when said segments are disposed out-tilted and transversely aligned with corresponding sockets of adjacent segments so as jointly to receive the edges of a bayonet insert frictionally held between each pair of out-tilted segments, said segments additionally having thrust attachment means along a top end thereof for engagement by the lower edge of the drill stem intermediate such bayonet inserts.

7. The drill bit of the preceding claim **6** wherein individual segments each have a dependent rib receivable in a generally radial groove of the supporting member and a transverse hinge pin mounted jointly in said supporting member and rib adjacent the inner end of the rib.

8. The drill bit of claim **6** wherein at least some of said cutting elements comprise projecting teeth formed of comminuted abrasive particles retained in a metallic matrix.

9. A collapsible drill bit adapted in contracted form to be moved longitudinally within an upright tubular drill stem and after expansion and mounting on the bottom end thereof, adapted to drill an earth bore of greater diameter than said drill stem by joint rotation of the coupled bit and drill stem, said bit comprising: a transverse supporting member having an outer perimeter less than the inner perimeter of said tube and carrying dependent cutting elements adapted to sweep a bore area corresponding to the interior of the drill stem; a ring of generally axially directed segments disposed atop said member, pivotally connected thereto adjacent their lower margins for generally radial tilting movement between a contracted position wherein the ring of segments is receivable within the drill stem and an expanded position wherein the upper extremities of said segments describe a perimeter greater than that of the exterior of the drill stem, said segments carrying outward-projecting cutting elements and being adapted upon rotation of the expanded drill bit to enlarge the bore formed by the dependent cutting elements to a diameter greater than the exterior of said drill stem; cooperative thrust engagement means carried adjacent the upper margins of said segments for engagement with the lower edge of the drill stem in driving relation; and locking means between the lower margins of said segments and said supporting member for rotationally anchoring the member and segments together when the segments are out-tilted in drilling position.

10. In a drill bit adapted for terminal attachment to the edge of a tubular drill stem for rotary earth boring of a bore larger than the exterior of said drill stem, the improvement comprising, in combination therewith: a dependent, externally convex body and an upper ring of bore-enlarging segments, both formed with outward-projecting teeth of abrasive material, said ring of segments being pivotally mounted atop said dependent body for generally radially intilting to a collapsed position within a columnar area defined by the periphery of said body which body and collapsed segments are thus movable lengthwise within said drill stem for mounting and demounting on the remote end of the drill stem, said ring of pivoted segments having attachment means adapted for remote-actuated coupling to the terminal edge of said tubular drill stem in rotary driving relation.

11. The drill bit of the preceding claim **10** wherein said outward-projecting teeth of abrasive material consist essentially of comminuted abrasive particles retained in a metallic matrix.

12. A carrier having a body movable lengthwise through an upstanding tubular drill stem of the type having spiral guideways along at least a distal terminal portion of its inner surface; a plurality of extensible and retractable contact elements spaced apart circumferentially about said body and adapted jointly upon general radial extension to slidingly contact the drill stem wall along said guideways and thus to rotationally align said body when moving lengthwise, therealong; means operable from a remote, operating end of said drill stem for selectively extending and retracting said contact elements while the carrier is disposed within said drill stem adjacent the distal terminal end thereof in position to contact said guideways; and means for moving the carrier and an attached drill bit lengthwise through said drill stem from one end to the other, said carrier having attachment means

at its distal end for selectively holding a collapsible drill bit in rotational alignment relative to said contact elements, whereby it may be located at the distal terminal end of said drill stem in rotational position for expansion and mounting on the end of the drill stem.

13. The carrier of the preceding claim **12** wherein the means for moving said contact elements and for attachment of a collapsed drill bit thereto comprise electromagnets carried by said carrier and are remotely activated from the operating end of said drill stem.

14. The carrier of the preceding claim **13**, which has a dependent, generally axial, striker rod disposed to displacingly abut a collapsible drill bit from its mounted position on the distal terminal end of said drill stem, and also carries magnetic means adapted subsequently to intilt against it, upstanding segments of such displaced collapsible bit whereby the bit may then be withdrawn by the carrier through the drill stem.

References Cited by the Examiner

UNITED STATES PATENTS

1,326,509	12/1919	Humason	175—261 X
1,766,253	6/1930	Hollestelle	175—261
1,833,134	11/1931	Stokes	175—259
2,173,018	9/1939	Hurley	175—261

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