June 27, 1961 M. L. TALBERT ET AL 2,990,025

BIT

Filed June 16, 1958

Fig. 1

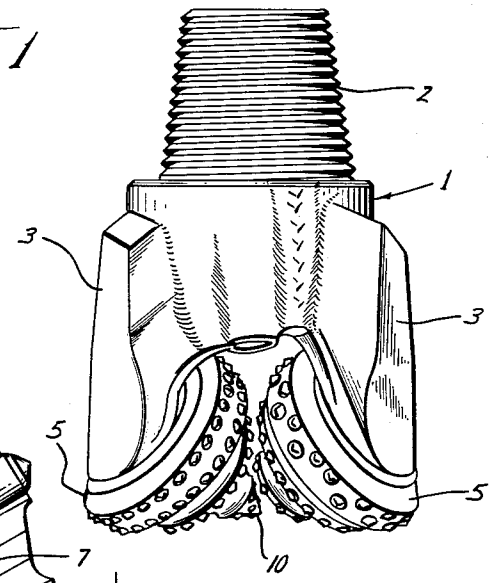


Fig. 2

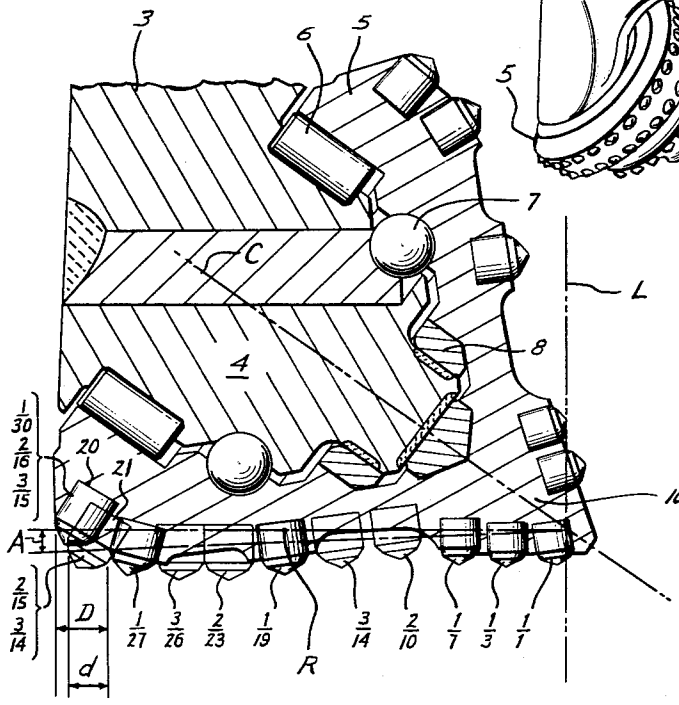
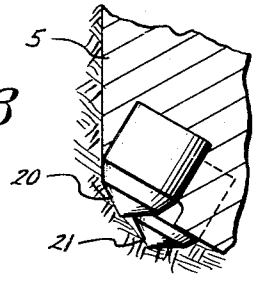


Fig. 3



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United States Patent Office 2,990,025 Patented June 27, 1961

2,990,025

BIT

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Filed June 16, 1958, Ser. No. 742,210
6 Claims. (Cl. 175—375)

This invention relates to a well drill bit of the rolling cutter type and particularly to one in which an improved arrangement of wear resistant inserts is provided to maintain the hole being drilled at gage.

It is customary in the rolling type of earth boring drill bits to provide the roller cutters with wear resistant inserts or compacts arranged to crush the formation. In this type of bit, the disintegration of the formation is by a crushing or shattering action as distinguished from a chiseling or chipping action as in bits having sharpened teeth. Thus the compacts or inserts present a blunt surface to the formation and with sufficient bottom hole weight applied to the bit, formations susceptible of crushing such as chert, quartzite or the like, can be readily drilled.

With such type of bit, one particular problem has been the maintenance of the desired diameter or gage of the borehole. Usually a row of inserts are provided at the heel of each cutter to cut the borehole to gage while other rows are spaced inwardly on the cutters to cut the remainder of the borehole bottom. The gage row of inserts are naturally exposed to a more rigorous drilling reaction than are the inserts in the inner rows not only because they must drill a larger area of the hole, but also because the formation outwardly of the gage row of inserts is not being drilled and hence provides some degree of lateral support for the formation being drilled by the gage row. These more rigorous drilling reactions have resulted in the gage inserts becoming loosened and lost from the bit with consequent rapid loss of hole gage. It has also caused excessive wear of the gage inserts.

It is accordingly a general object of this invention to provide a drill bit having a roller cutter with an improved arrangement of wear resistant inserts or compacts for maintaining the gage of the hole being drilled.

It is also an object of the invention to provide a roller cutter having an improved gage cutting structure comprising wear resistant inserts arranged so that the formation being removed by the gage cutting inserts is reduced in amount and also the difficulty of removal thereof is decreased.

Another object of the invention is to provide a bit and cutter therefor in which the work load of a gage row of wear resistant inserts is reduced whereby the effective life of these inserts may be increased.

Other objects, advantages and features of the invention will be apparent to one skilled in the art upon consideration of the specification, the claims and the attached drawings wherein:

FIG. 1 is a view illustrating a three-cone bit embodying the invention;

FIG. 2 is a sectional view of a typical No. 1 cone and further shows in superposed relationship the inserts of all the cutters of a well drill embodying the invention as they move across a selected radial plane of a well bore being drilled; and

FIG. 3 is a fragmentary view showing the relative positions of the cutter inserts at the heel of a cutter and the relative positions thereof with respect to the side wall and bottom of a well bore.

In accordance with this invention, a band of wear resistant inserts or compacts are arranged at the heel of a cutter in such a manner that the track of some of the

inserts overlaps but is spaced inwardly of the track of the other inserts, the latter being situated to cut the hole to gage. Thus, the inwardly spaced inserts disintegrate the formation adjacent the vertical wall of the borehole but since they are not concerned with maintaining gage, failure or wear of some of these inserts does not result in an under-gage hole. Moreover, these inner inserts remove the inner lateral formation support for the formation material they leave outwardly of their track so that the gage cutting inserts can more readily remove the remaining material, due to its reduced lateral support, and have only a comparatively minor amount of formation material to remove. As a result, their work load is less than it would be without the inner inserts and they tend to maintain gage for a longer period of time.

An embodiment of the invention, as shown in a three-cone drill bit in FIG. 1, comprises a head 1, having a threaded shank 2 for attachment to the lower end of a drill string or stem. The downwardly extending legs 3 on the head are provided with downwardly and inwardly extending shafts 4, a portion of one of which is shown in FIG. 2. Cutters 5 are rotatably mounted upon the shafts by suitable roller bearings 6 at the heel end of the cutter, ball bearings 7 and a friction bearing 8 at the nose end of the cuter. The bearing arrangement can be of many forms and the foregoing is illustrated as one of the more conventional types.

The cones or cutters inwardly of their heels can take any desired form suitable for the intended drilling operation. The illustrated bit includes cones arranged in conventional form. Thus the No. 1 cone has a spear point 10 approximately at the longitudinal axis of the bit. The innermost row of cutting elements of the No. 2 cone are the next outwardly from the spearpoint of the No. 1 cone, and successively, the innermost row of cutting elements on the No. 3 cone are the next outwardly from the inner row on the No. 2 cone. As illustrated, the rows of cutting elements inwardly of the heel are preferably in circumferential lands arranged on the peripheries of the cones. Each of the lands is provided with a row or rows of wear resistant inserts. With this arrangement, the cutter elements on the lands substantially cover bottom and the inserts of a given row have an inter-fitting relationship with the rows of adjacent cutters.

The arrangement of the inserts in the various rows is perhaps best shown in FIG. 2. In this figure, the No. 1 cone is shown in section and at the bottom thereof is illustrated the insert arrangement for all the cutters, the showing being in conventional form. Thus, the numerator of the fraction for each insert designates the number of the cone bearing the inserts. The denominator designates the number of inserts in that particular row. For example, cone No. 2 has 10 inserts in its innermost row, cone No. 1, 19 inserts, and cone No. 3, 14 inserts.

Turning now to a more particular description of the band of inserts which cooperate to provide the improved gage cutting structure of this invention, it will be seen in FIGS. 2 and 3 that this band comprises a row of gage cutting inserts 20 and another row of inner inserts 21. As shown, these two rows of inserts are arranged so that their tracks overlap. Stated in another manner, the cutting width D of the band is greater than the corresponding lateral cutting dimension d of one of the inserts but is less than twice the lateral dimension d. As a result, the row of inserts 21 disintegrate formation along a track on the bottom of the borehole of a width of at least d. Since the track of these inserts is closely adjacent the vertical wall of the borehole, the row of inserts 20 need disintegrate only material within the band corresponding approximately to a lateral dimension equal to D minus d. It will be seen that the work load on the

row of inserts 20 is much less than it would be in the absence of the overlapping row of inserts 21. Hence inserts 20 are able to maintain gage for a much longer time. While the work load on row of inserts 21 may be substantial, wear of these inserts and even loss of some of them from the row does not immediately affect the maintenance of gage of the borehole. Thus loss of some of these inserts or their excessive wear will merely increase the work load on the row of inserts 20 and since this will not happen until a substantial drilling time has elapsed, it will be apparent that the bit life, insofar as gage maintenance is concerned, will be appreciably extended.

In a preferred form, the rows of inserts 20 and 21 are arranged in two rows with inserts in one row alternating with inserts in the other row. This yields a staggered arrangement which could be termed two staggered rows of inserts. The staggering of these inserts not only causes more uniform cutting but also permits a greater reduction in the amount of material which must be removed by the gage row of inserts and hence increases their life.

In one preferred embodiment, the row of inserts 20 is disposed at a smaller oversize angle than is the row of inserts 21. In the most preferred form, the row of inserts 20 is at substantially zero oversize angle while row 21 has a substantial oversize angle. In other words, the cutting surfaces of inserts 20 are situated at a higher level in the borehole than those of inserts 21. A designer of bits would express this difference by saying that inserts 21 are situated on bottom while inserts 20 are pulled up from the bottom. This arrangement has several advantages. First, by placing inserts 21 at a lower level than inserts 20, inserts 21 remove more inner lateral support of the formation being cut by inserts 20 and as a result, the cutting duty of inserts 20 is reduced. Another important advantage is that the cutter body 5 can be maintained at desired strength by providing ample material between the race for rollers 6 and the rows of inserts 20 and 21 while using the largest possible bearing. In other words, the larger the radial spacing of inserts 20 and 21 from the longitudinal axis of the cone, the larger can be the bearing containing rollers 6 and therefore the stronger and more useful the bit.

As is well known in the art, the term "oversize angle" is a measure of the placement of a cutting surface on a cone with respect to the true conical surface of the cone. Thus the oversize angle of the row of inserts 21 is the angle A as shown in FIG. 2. This angle is determined by drawing a line R at right angles to the longitudinal axis line L of the bit from the common intersection of line L and the longitudinal axis line C of the cone. The oversize angle is computed by using the lowermost point of any cutting element which would touch the side of the borehole if such cutting element were cutting gage.

It will be noted that the row of inserts 20 are at substantially zero oversize angle although they can be at either a positive or a negative finite oversize angle. However, by placing these inserts at zero oversize angle, they tend to roll without slippage along the formation being cut since they are substantially at the true base periphery of a cone. Since these gage cutting inserts are preferably located substantially at the zero oversize angle, they impart a crushing action against the wall of the borehole and they do not impart any substantial scraping action which would tend to wear the inserts. Their life is therefore enhanced and hence the bit can maintain gage for a longer time.

As illustrated, the inserts have a cylindrical base with a nose in the form of a double cone. They may be pressed into the cone by drilling holes in the latter to provide an interference fit with the inserts. They may also be brazed into the cone or a combination of interference fit and brazing may be used. The inserts may be made of any suitable hard metal such as tungsten carbide or other metal carbides such as chromium, tantalum, titanium or vanadium.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A rotary well drill bit comprising a head, inwardly extending shafts thereon, rolling cutters rotatably mounted on said shafts, a first circumferential row of gage cutting wear resistant inserts situated at the heel of at least one cutter, a second circumferential row of wear resistant inserts on at least one of said cutters and spaced inwardly of the first row toward the longitudinal axis of the head with the spacing between the first and second rows being such that the track of the second row on the bottom of the hole being drilled overlaps the track of the first row, said first row being situated at a substantially zero oversize angle and the second row being situated at a larger oversize angle than is said first row so that the second row affects disintegration of the earthen formation closely adjacent the wall of the hole at a level below the first row, whereby the formation to be disintegrated by the first row is left without substantial inner lateral support thereby facilitatiing cutting the hole to gage by the first row.

2. A rotary well drill bit comprising a head, inwardly extending shafts thereon, rolling cutters rotatably mounted on said shafts, a circumferentially disposed band of wear resistant inserts on at least one cutter, the inserts being arranged so that the width of the band is greater than the corresponding width dimension of an insert but is not greater than twice such width dimension, some of said inserts being situated at the heel of said cutter to cut gage, the gage cutting inserts being disposed at a substantially zero oversize angle and the other inserts in said band being disposed at a larger oversize angle than are said gage cutting inserts.

3. A rotary well drill bit comprising a head, inwardly extending shafts thereon, rolling cutters rotatably mounted on said shafts, a circumferentially disposed band of wear resistant inserts alternate ones of which are situated at the gage surface of the cutter and positioned at a substantially zero oversize angle with the remainder of the inserts being positioned at a larger oversize angle than are said gage inserts and spaced laterally inwardly of said gage inserts toward the longitudinal axis of the head a distance not greater than the corresponding lateral dimension of the gage inserts so that the inwardly spaced inserts affect disintegration of the earthen formation closely adjacent the gage of the hole whereby the formation to be disintegrated by the gage inserts is left without substantial inner lateral support thereby reducing the work load of the gage inserts.

4. A conical cutter for rotary drill bits comprising, a conical body, a first circumferential row of gage cutting wear resistant inserts situated at the heel of the conical body, a second circumferential row of wear resistant inserts on said body and spaced inwardly of the first row toward the apex of the conical body with the spacing between the rows being such that the track of the second row on the bottom of the hole being drilled overlaps the track of the first row, said first row being situated at a

substantially zero oversize angle, said second row being situated at a larger oversize angle than is the first row so that the second row affects disintegration of the earthen formation closely adjacent the wall of the hole to thereby leave the formation to be disintegrated by the first row without substantial inner lateral support thereby reducing the work load of the first row.

5. A conical cutter for rotary drill bits comprising, a conical body, a circumferentially disposed band of wear resistant inserts on the body, the inserts being arranged so that the width of the band is greater than the corresponding width dimension of an insert but is not greater than twice such width dimension, some of said inserts being situated at the base of the conical body to cut a hole being drilled to gage, the gage cutting inserts being disposed at a substantially zero oversize angle and the other inserts in said band being disposed at a larger oversize angle than that of the gage cutting inserts.

6. A conical cutter for rotary drill bits comprising, a conical body, a circumferentially disposed band of wear resistant inserts on said body, alternate ones of said inserts being situated at the base of the conical body at a substantially zero oversize angle to cut gage and the remainder being situated at a larger oversize angle than that of the gage inserts and being spaced laterally inwardly of said gage inserts toward the apex of the conical body a distance not greater than the corresponding lateral dimension of the gage inserts so that the laterally spaced inserts affect disintegration of the earthen formation closely adjacent the gage inserts so that the formation cut by the gage inserts is without substantial inner lateral support thereby reducing the work load of the gage inserts.

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