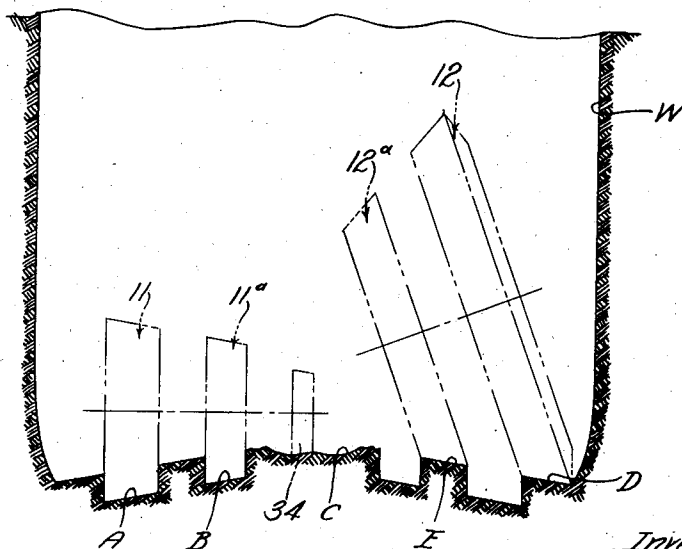


L. A. GAUTHEY

ROCK BIT

Filed April 12, 1937

2 Sheets-Sheet 2



Inventor
LOUIS A. GAUTHEY

By B. H. Hall
His Attorney

UNITED STATES PATENT OFFICE

2,160,852

ROCK BIT

Louis A. Gauthey, Glendale, Calif., assignor of
one-half to Charles Eeder, Los Angeles, Calif.

Application April 12, 1937, Serial No. 136,343

3 Claims. (Cl. 255-71)

This invention relates to well drilling tools and has particular reference to a rock bit for use in the rotary method of well drilling. A general object of this invention is to provide a practical, improved, and very effective roller bit or rock bit.

Another object of this invention is to provide a rock bit for use in the rotary method of well drilling that is very rapid in its operation or its penetration of the earth formation.

Another object of this invention is to provide a rock bit in which the cutters are arranged and related to have a chipping and breaking down action on the formation as distinguished from the roller cutters of typical rock bits which have a rolling and crushing action.

Another object of this invention is to provide a rock bit embodying roller cutters operating in advance of other cutters to form annular cuts or channels leaving upstanding ridges of earth formation that are easily and rapidly broken down and cut away by the said other cutters thereby increasing the rate of penetration of the bit.

Another object of this invention is to provide a well bit of the character mentioned in which the roller cutters have relatively short cutting teeth whereby heavy feed pressures are applied to the cutting teeth per lineal unit of length without exerting increased feed pressure on the bit. The roller cutters of the bit provided by the present invention being relatively short or narrow in comparison with the cutters of rock bits now in general use are much more rapid in their penetration of the earth formation.

Another object of this invention is to provide a rock bit of the character mentioned in which the pilot roller cutters are spaced apart to assure the independent rotation of the cutters, to assure the proper flushing of the cutters and to form spaced annular channels or cuts in the earth formation which center the bit and which provide or leave upstanding ridges of earth formation that are rapidly broken down by the trailing and higher roller cutters.

Another object of this invention is to provide a roller bit or rock bit in which the outer cutters for cutting the well bore to gauge act on the formation in a plane above the inner cutters and, therefore, are relieved of an appreciable amount of the cutting action at the bottom of the bore and the resultant wear. The outer cutters of the bit of the present invention act in planes above the planes of action of the inner cutters and, therefore, are only required to cut the bore to gauge and to break down and shatter the up-

standing ridges left by the pilot cutters or inner cutters.

Another object of this invention is to provide a rock bit embodying means for handling the circulation fluid in such a manner that it fully and effectively flushes the cuttings and mud from the cutters and shank parts without cutting into or abrading the cutters.

The various objects and features of the invention will be fully understood from the following detailed description of a typical preferred form and application of my invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a side elevation of the improved rock bit provided by this invention. Fig. 2 is an enlarged vertical detailed sectional view of the bit. Fig. 3 is a fragmentary vertical detailed sectional view of the bit taken in a plane at right angles to the plane of sectioning of Fig. 2. Fig. 4 is an enlarged fragmentary vertical detailed sectional view illustrating the mounting for the central cutter. Fig. 5 is a transverse detailed sectional view taken as indicated by line 5-5 on Fig. 2 illustrating the principal cutters in broken lines to show the relationship between the fluid discharge ports and the cutters. Fig. 6 is an enlarged fragmentary side elevation of one of the body legs illustrating the means for locking the cutter pins against rotation. Fig. 7 is a fragmentary vertical detailed sectional view taken as indicated by line 7-7 on Fig. 6 and Fig. 8 is a schematic or diagrammatic view illustrating the action of the cutters of the bit in the well bore.

The improved roller bit or rock bit of this invention includes, generally, a body 10 adapted to be connected with a rotary well drilling string, sets of pilot cutters 11 and 11^a rotatably supported on the body 10 to make annular grooves A and B in the earth formation at the bottom of the well bore, and sets of roller cutters 12 and 12^a supported on the body 10 to act on the formation between the grooves A and B and around the groove A to cut the well bore to gauge.

The shank or body 10 of the bit may be an integral member as illustrated and is provided to carry the sets of cutters 12 and 12^a and 11 and 11^a. The body 10 is provided at its upper end with suitable means for connecting with the lower end of the well drilling string. In the particular case illustrated a tapered screw threaded pin 13 is provided on the upper end of the body 10 to facilitate its connection with the string. In accordance with the invention the bit body 10 is provided with sets or pairs of depending legs 14 and

15. The legs 14 are diametrically opposite and may be substantially vertical or parallel with respect to the longitudinal axis of the bit. The legs 15 are diametrically opposite and are spaced substantially 90° from the legs 14. The inner sides 16 of the legs 15 are inclined downwardly and outwardly relative to the vertical axis of the body 10. The exterior or periphery of the body 10 may have vertically extending ribs 17 joining the legs 14 and 15 to strengthen the body structure. In accordance with the invention the legs 14 are longer than the legs 15, that is, the lower ends of the legs 14 are in a plane spaced below the lower ends of the legs 15. Reinforcing webs 18 may connect the upper inner parts of the legs 14 with the lower end of the body 10. The bit body 10 further includes a substantially central web 19. The web 19 projects downwardly from the lower end of the body 10 as illustrated in the drawings.

20 The sets of cutters 11 and 11^a are provided to act on the earth formation at the bottom of the well bore W in advance of the cutters 12 and 12^a to make the annular cuts or grooves A and B as illustrated in Fig. 8. While I have termed the cutters 11 and 11^a pilot cutters, they may also be termed inner cutters, as they act on the earth formation entirely within the perimeter of the bore W. The inner cutters or pilot cutters 11 and 11^a are in the nature of roller cutters supported to rotate about their individual axes and to cut into the earth formation by a crushing and rolling action.

35 There are preferably two sets of cutters 11 and 11^a each set being located between a leg 14 and the opposing surface 20 of the body web 19. The number of pilot cutters embodied in each set may be varied in accordance with the size of the bit. In the simple form of the invention 40 illustrated in the drawings there are two pilot cutters 11 and 11^a provided in each set of cutters. The cutters 11 and 11^a are frusto-conical, that is, they have pitched or inclined peripheries. Axially extending cutting teeth 22 and 22^a are provided on the respective peripheries of the cutters 11 and 11^a. The cutters 11 and 11^a are arranged with their small ends facing inwardly relative to the central vertical axis of the body 10. The pilot cutters 11 and 11^a are graduated 50 in size, that is, the cutters 11^a are smaller in diameter than the cutters 11 and are spaced inwardly from the cutters 11 with respect to the center of the bit. The cutters 11 and 11^a of the sets of cutters are in the same respective positions relative to the central vertical axis of the body 10 so that both the cutters 11 operate in and form the groove A and both cutters 11^a operate in and form the groove B. As best illustrated in Fig. 8 the cut or groove A is spaced some distance inwardly from the perimeter of the well bore W and the cut B formed by the cutters 11^a is spaced between the groove A and the center of the well bore.

65 The means for rotatably supporting the pilot cutters 11 and 11^a include shafts or pins 24 extending between and supported by the legs 14 and the web 19. The pins 24 are passed inwardly through openings 25 in the legs 14 and the inner portions of the pins are threaded in openings 26 in the web 19. In the preferred construction illustrated the cutter supporting pins 24 are substantially horizontal and are radial relative to the vertical axis of the body 10. The pins 24 may be simple, cylindrical parts of uniform diameter. The cutters 11 and 11^a are ro-

tatably supported on the pins 24 by suitable roller bearings 27 and 27^a respectively. Suitable thrust washers 28 are interposed between the outer ends of the cutters 11 and the inner sides of the legs 14. Similar thrust bearings 29 may be provided on the pins 24 between the inner ends of the cutters 11^a and the surfaces 20 of the web 19. Washers 30 may be provided on the pins 24 to space the adjacent cutters 11 and 11^a and their bearings 27 and 27^a. The washers 30 may directly bear on the pins 24 and if desired may be in the form of star washers to rotate at will. The opposing ends of the cutters 11 and 11^a may be provided with bosses or hubs, as illustrated, so that the cutters have more extensive engagement on the bearings 27 and 27^a.

The invention provides novel means for locking the cutter carrying pins 24 against unthreading. Diametric dove-tailed grooves 31 are provided in the outer ends of the pins 24. Similar grooves 32 are provided in the outer sides of the legs 14 to register with the grooves 31. Dove-tailed keys 33 are driven into the grooves 32 and 31 to positively lock the pins 24 against unthreading when the pins have been properly threaded in place. The grooves 31 in the ends of the pins 24 may be utilized as screw driver slots to facilitate the threading of the pins. The ends of the keys 33 may be lightly welded to the legs 14 or the outer portions of the grooves 32 may be closed with welding to prevent the accidental displacement of the dove-tailed keys 33.

The invention preferably includes a cutting means for acting on the central portion of the bore within the groove B formed by the cutters 11^a. This central cutting means may include a disc-like roller cutter 34. The cutter 34 is rotatably supported in a pocket 35 in the lower end of the body web 19 and is adjacent but offset from the central vertical axis of the bit. The means for rotatably supporting the cutter 34 in the pocket 35 may include a reduced extension 36 on one of the pins 24 which extends horizontally through the pocket 35. The outer portion of the extension 36 may be supported in a socket 37 in the other pin 24. The cutter 34 may be rotatably supported on the pin extension 36 through a suitable roller bearing 38. The opposing ends of the pins 24 may protrude into the pocket 35 and may act as thrust receiving surfaces at the opposite ends of the cutter 34. The cutter 34 projects downwardly beyond the lower end of the pocket 35 and has pitched peripheral cutting teeth 39 for acting on the formation. The cutter 34 being adjacent the center of the well bore has a rolling and scraping action in its engagement with the earth formation to cut away the formation at a substantially central groove C as illustrated in Fig. 8.

60 The cutters 12 and 12^a are rotatably supported at the lower end of the bit body 10 to act on the earth formation in a plane or planes above the lower ends of the cutters 11 and 11^a and therefore trail or follow the cutters 11 and 11^a in their action on the earth formation. The cutters 12 and 12^a are in the nature of roller cutters and are rotatably supported in sets or pairs between the legs 15 and the body web 19. The cutters 12 and 12^a are arranged in sets or pairs each including a cutter 12 and a cutter 12^a. The cutters 12 and 12^a of each set are co-axial and are rotatable about downwardly and inwardly inclined axes. The cutters 12 are supported at a greater distance from the central axis of the bit than the cutters 12^a and, therefore, are consid-

erably larger in diameter than the cutters 12^a. The cutters 12 and 12^a are thin or short with relation to the outer roller cutters employed on typical rock bits. In practice the cutters 12^a may be somewhat thinner or shorter than the cutters 12. The cutters 12 and 12^a are frusto-conical having their peripheries pitched or inclined relative to their axes of rotation. Suitable peripheral cutting teeth 40 and 40^a respectively are provided on the peripheries of the cutters 12 and 12^a. In accordance with the invention the pitch or inclination of the axes of rotation of the cutters 12 and 12^a is such that the edges of the teeth 40 and 40^a are inclined downwardly and outwardly when they come into contact with the earth formation at the bottom of the well bore. Thus the surfaces at the bottom of the bore acted on by the teeth 40 and 40^a are inclined upwardly and inwardly relative to the axis of the well bore W and the cooperation of the teeth with these conical or inclined surfaces center and stabilize the bit.

The cutters 12 act on the ridge D of earth formation between the groove A and the wall of the bore W and serve to cut the bore to gauge. The lower portions of the cutters 12 project downwardly and outwardly beyond the lower ends of the legs 15 to act on the earth formation. It is to be particularly noted that the teeth 40 of the cutters 12 act on the formation in a plane above the plane of action of the cutters 11 and 11^a and, therefore, rapidly break down and cut away the ridge D which is unsupported at its inner side due to the presence of the groove A. The outer ends of the teeth 40 are preferably bevelled off to be substantially vertical when the teeth engage the formation at the bottom of the bore to properly cut the well bore W to gauge to pass the bit with proper clearance.

The cutters 12^a act on the earth formation at the upper surface of the ridge E occurring between the annular grooves A and B. The teeth 40^a of the cutters 12^a act on the earth formation in substantially the same plane as the cutters 12 having their plane of action above the plane of action of the cutters 11 and 11^a. The inner cutters 12^a act to quickly break down and cut away the ridge E as the ridge is unsupported at its inner and outer sides due to the presence of the grooves A and B. It is believed that it will be understood how the cutters 12 and 12^a are operable to rapidly break down the ridges D and E respectively with a minimum of drilling pressure and thereby greatly increase the rate of penetration of the bit.

The means for rotatably supporting the cutters 12 and 12^a on the body 10 to operate in the manner described above may be varied somewhat without departing from the spirit of the invention. In the form of the invention illustrated in the drawings the means for rotatably supporting or mounting the cutters 12 and 12^a include pins 42 passed inwardly through downwardly and inwardly inclined openings 43 in the legs 15. Reduced extensions 44 are provided on the inner ends of the pin 42 and are threaded in sockets 45 in the body web 19. Annular shoulders 46 occur on the pins 42 at the bases of the reduced extensions 44 and these shoulders are in spaced opposition to the surfaces 21 of the body web 19. The cutter supporting pins 42 may be locked against unthreading in the same manner as the pins 24. Dove-tailed keys 47 are arranged in dove-tailed grooves in the outer sides of the legs 15 and the outer ends of the pins 42 to prevent

rotation and unthreading of the pins. The key receiving grooves in the outer ends of the pins 42 may be employed as screw driver slots to facilitate the threading in and removal of the pins 42.

The cutters 12 and 12^a of each set or pair of cutters are rotatably supported on the pins 42. In the preferred arrangement suitable roller bearings 48 rotatably mount the cutters 12 and 12^a on the pins 42. Spacing washers 49 may be provided on the pins 42 between the bearings 48. The opposing sides of the cutters 12 and 12^a may have hubs 50 whereby the cutters have extensive cooperation with the bearings 48. Spacing washers 51 may be recessed in the hubs 50 to act as thrust washer between the cutters. Thrust washer 52 are provided on the pin extensions 44 and are clamped between the shoulders 46 and the surfaces 21 of the body web 19. The washers 52 take the inward thrusts from the cutters 12^a. Suitable thrust washers 53 are arranged on the pins 42 between the outer sides of the cutters 12 and the inner surfaces 16 of the legs 15. The cutters 12 and 12^a mounted as just described may independently rotate about their own axes to act on the ridges D and E of the earth formation as described above.

The invention provides particularly effective means for flushing the cutters 11 and 11^a and 12 and 12^a and the bit generally to clear the cutters of mud, etc. and to prevent the bit from becoming balled up. A central circulation passage 54 extends downwardly into the body 10 from the upper end of its pin 13. The passage 54 may be of substantially the same capacity as the fluid passage in the drill collar of the drilling string. Fluid discharge ports 55 are provided in the body 10 to discharge streams of circulation fluid downwardly against the sets of cutters 11 and 11^a. The ports 55 extend downwardly and outwardly from the lower portion of the passage 54 to the lower end of the body 10. In accordance with the invention the ports 55 are of substantial fluid capacity to discharge substantial volumes of fluid at a low velocity. It is a feature of the invention that the streams of fluid discharged from the ports 55 impinge against the cutters 11 and 11^a at the rear of their axes of rotation relative to the direction of rotation of the bit. Fig. 5 of the drawings clearly illustrates this relationship. In this figure X designates the vertical plane of the axes of rotation of the cutters 11 and 11^a. The ports 55 are preferably elongate in transverse cross section to discharge broad flat streams of fluid which fully flush both cutters 11 and 11^a of each set of cutters and that flush between the cutters and at the outer ends of the cutters 11 and the inner ends of the cutters 11^a. The long transverse axes of the ports 55 preferably extend outwardly and slightly rearwardly relative to the planes X of the axes of rotation of the cutters 11 and 11^a so that the streams of fluid impinge against substantially corresponding parts of the graduated cutters. This relationship between the ports 55 and the plane X of the axes of the cutters 11 and 11^a is best illustrated in Fig. 5. The large streams of fluid of low velocity discharge from the ports 55 against the cutters 11 and 11^a at points behind their axes of rotation to fully flush the cutters of mud and cuttings without injuring the cutters. The solid matter in the fluid issuing from the ports 55 at a relatively low velocity does not abrade or cut into the cutters to destroy their cutting parts. The fluid discharged from the elongate ports 55 fully washes about the

cutters 11 and 11^a and the adjacent legs 15 to prevent mud from accumulating on the same.

The flushing means further includes ports 56 in the body 10 extending downwardly from the passage 54 to the lower end of the body. The ports 56 are provided to discharge streams of fluids against the cutters 12 and 12^a. The ports 56 are located to discharge the streams downwardly behind the axes of rotation of the cutters 12 and 12^a relative to the direction of rotation of the bit. This relationship is clearly illustrated in Fig. 5 of the drawings where Y represents the vertical plane of the axes of rotation of the cutters 12 and 12^a. The ports 56 are shaped to discharge broad streams of fluid to flush the adjacent cutters 12 and 12^a of each set. The ports 56 are elongate in transverse cross section having their longest transverse axes extending in a general radial direction with respect to the central axis of the bit and extending outwardly and slightly rearwardly with respect to the plane Y. The ports 56 formed and located in this manner operate to discharge broad streams of fluid at a low velocity to impinge against the cutters 12 and 12^a throughout their lengths at points behind the vertical plane Y of the axes of rotation of the cutters. The streams of circulation fluid from the ports 56 flush between the adjacent cutters 12 and 12^a and between the cutters 12 and the legs 14 and between the cutters 12^a and the web 19 to prevent the cutters and the adjacent parts of the bit body from becoming balled up. The solid matter carried by the fluid discharged from the ports 57 at a relatively low velocity does not erode or abrade the cutting teeth of the cutters 12 and 12^a.

It is believed that the operation of the improved bit provided by this invention will be readily understood from the foregoing detailed description. In operation the bit body 10 is secured to the lower end of a rotary well drilling string and the tool is operated in a well bore in the usual manner. The bit is rotated and fed downwardly by means of the drilling string and circulation fluid is pumped through the string to discharge from the ports 55 and 56. As described above, the cutters 11 and 11^a are spaced below the cutters 12 and 12^a to act on the formation at the bottom of the bore W in advance of the cutters 12 and 12^a and cut or form the grooves A and B, respectively. The cutters 11 and 11^a follow annular courses and cut into the formation to produce the concentric annular grooves A and B. The cutters 11 and 11^a are short or narrow to rapidly cut into the earth formation and produce the grooves A and B with a minimum of vertical pressure. The central cutter 34 acts on the formation at the bottom of the web 19 to form the substantially central depression or groove C.

The roller cutters 12 and 12^a follow annular paths and act on the formation at the upper faces of the ridges D and E, respectively. The large cutters 12 also engage the formation to cut the bore W to gauge. The cutters 12 are operable to rapidly break down and cut away the ridge D as the ridge is relatively narrow and is unsupported at its inner side due to the presence of the groove A. In a like manner the cutters 12^a rapidly cut and break down the ridge E between the grooves A and B. It is understood, of course, that the grooves A and B are formed simultaneously with the breaking down of the ridges D and E so that the grooves A and B are always present to leave the easily drilled ridges D and E. The relationship between the cutters 11 and 11^a and the

cutters 12 and 12^a thus assures the rapid and efficient penetration of the earth formation. It will be observed that the cutters of the bit, and more particularly the cutters 12 and 12^a, operate to shatter or break down the narrow ridges of earth formation as distinguished from the roller cutters of typical well bits that act on broad extensive faces of the earth formation to cut away the same by a rolling and crushing action.

The circulation fluid discharged from the ports 55 and 56 completely flushes the sets of cutters 11 and 11^a and 12 and 12^a and washes about the legs 14 and 15 and the web 19 to maintain the bit free of mud and cuttings. The circulation fluid is discharged in such a manner that it does not erode or cut away the cutters and sufficiently large volumes of the fluid are discharged to properly carry away the cuttings. The cutters and the cutter supporting means are all readily replaceable so that the bit may be easily reconditioned after use.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A well bit comprising, a body having spaced legs and a web depending between the legs, the legs having openings and the web having a pocket and openings joining the pocket, pins passed through the openings in the legs and extending into the openings in the web, cutters on the pins, a cutter in the pocket projecting from the lower end of the web, and an extension on one of the pins rotatably supporting said cutter.
2. A well bit comprising, a body having spaced legs and a web depending between the legs, the legs having openings and the web having a pocket and openings joining the pocket, pins passed through the openings in the legs and extending into the openings in the web, cutters on the pins, a cutter in the pocket projecting from the lower end of the web, one of the pins having a socket in its inner end, and an extension on the other pin extending through the pocket to rotatably support the last named cutter and having its outer end supported in said socket.
3. A rotary rock bit including a body to be rotated in the well, two sets of roller cutters, each of said sets comprising a plurality of cutters in axial spaced relation, means supporting the sets of roller cutters at the lower end of the body for rotation about a substantially horizontal axis and with the said sets at opposite sides of the central vertical axis of the body so that the cutters of the sets make spaced annular cuts in the bottom of the well, the outermost cut being spaced inwardly from the side wall of the well, two second sets of roller cutters, and means supporting each of said second sets of roller cutters at the lower end of the body for rotation about an inclined axis and in trailing relation to one of the first sets of cutters and in leading relation to one of the first sets of cutters relative to the direction of rotation of the body and with the cutters of the said second set of cutters in spaced axial relation and in positions to act on the ridges of earth formation remaining between said cuts and remaining around the said outermost cut, the lowermost parts of the said second cutters being above the plane of the lowermost parts of the said first cutters.

LOUIS A. GAUTHY.