

April 23, 1940.

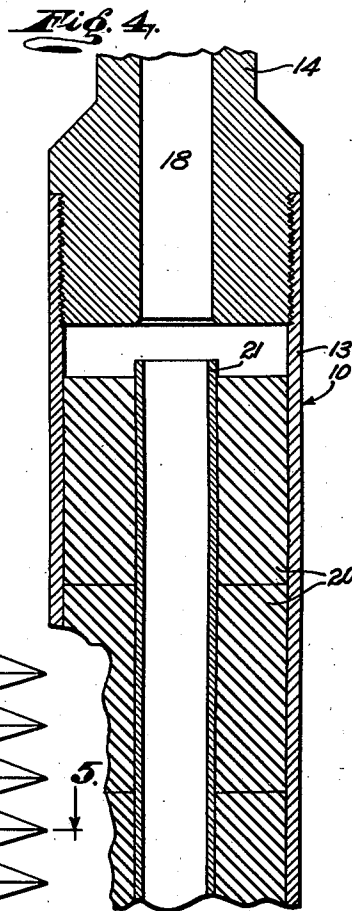
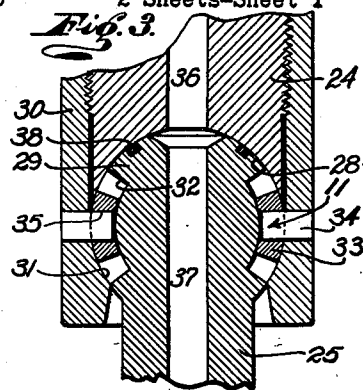
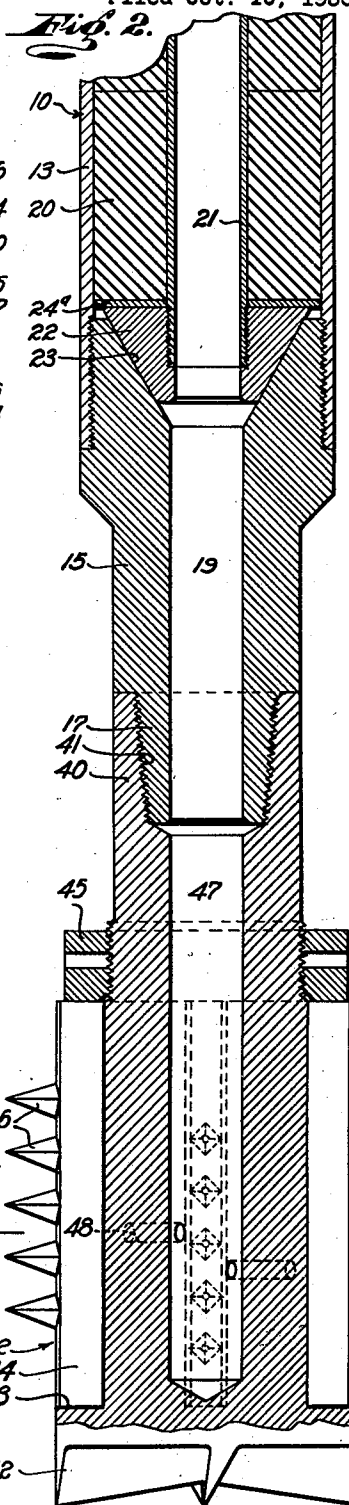
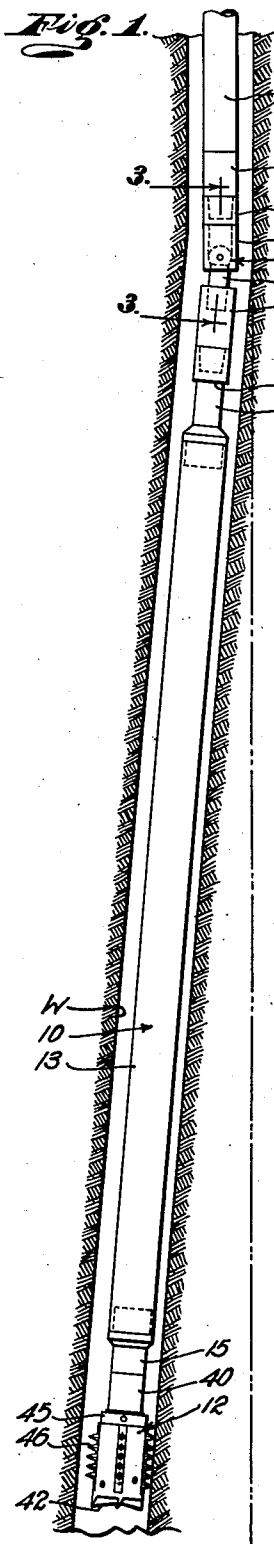
J. C. WRIGHT

2,197,991

TOOL FOR STRAIGHTENING WELL BORES

Filed Oct. 10, 1936

2 Sheets-Sheet 1



Inventor
JESSE C. WRIGHT
By
W. H. H. H. H.
His Attorney

April 23, 1940.

J. C. WRIGHT

2,197,991

TOOL FOR STRAIGHTENING WELL BORES

Filed Oct. 10, 1936

2 Sheets-Sheet 2

Fig. 5.

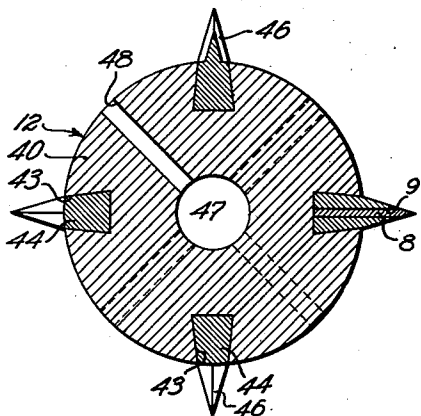


Fig. 6.

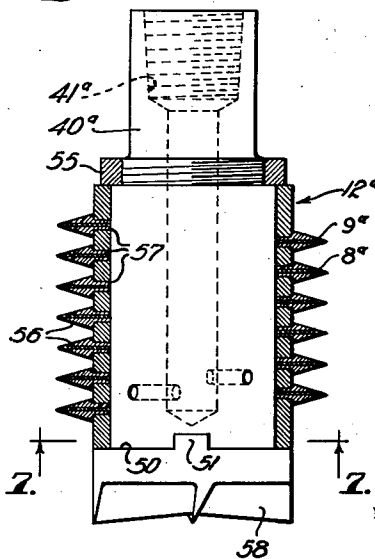


Fig. 7.

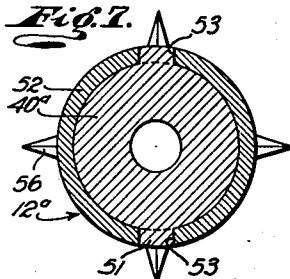


Fig. 8.

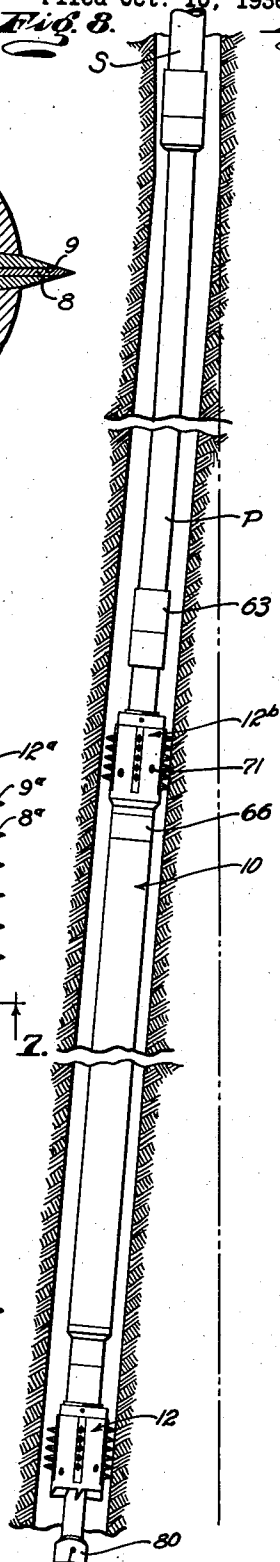
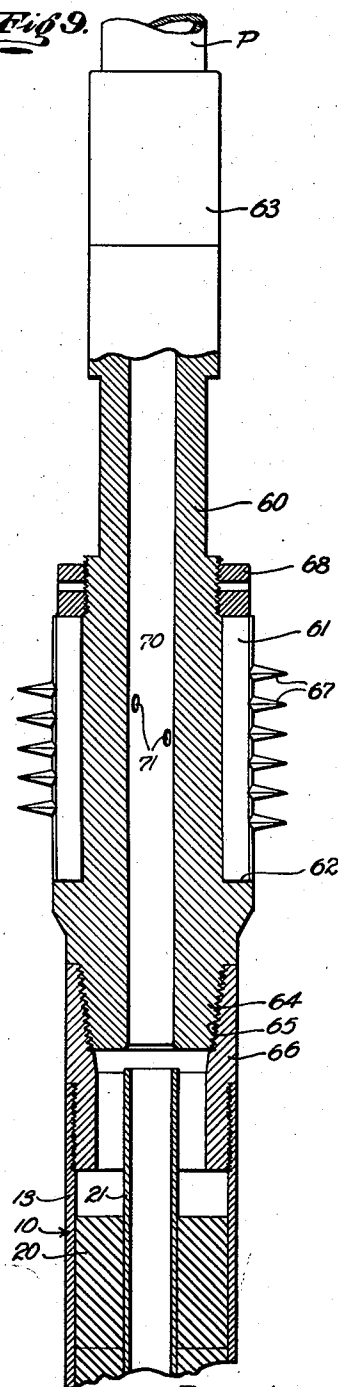


Fig. 9.



Inventor
JESSE C. WRIGHT
By *R. H. H. H. H.*
His Attorney

UNITED STATES PATENT OFFICE

2,197,991

TOOL FOR STRAIGHTENING WELL BORES

Jesse C. Wright, Los Angeles, Calif.; Martha H. Wright, executrix of Jesse C. Wright, deceased, distributed by court order to Martha H. Wright, widow

Application October 10, 1936, Serial No. 105,033

12 Claims. (Cl. 255—61)

This invention relates to a well drilling tool and relates more particularly to a tool for straightening well bores. A general object of this invention is to provide a simple, practical tool that is rapid and efficient in straightening crooked or inclined well bores.

Most deep well such as oil wells and gas wells are crooked or inclined, in whole or in part, due to the character of the earth formation penetrated, and the tendency of the drilling tools to take inclined paths when they encounter inclined strata. Various methods and tools have been proposed for straightening crooked well bores, but have proven costly or only partially effective.

Another object of this invention is to provide a tool for straightening crooked or inclined well bores that digs into and erodes the side wall of the bore to make it straight or vertical.

Another object of this invention is to provide a tool for straightening crooked well bores that is adapted to be rotated and moved longitudinally in the well and that embodies a weighted body which constantly urges or feeds the active parts of the tool toward a vertical position.

Another object of this invention is to provide a tool of the character mentioned that embodies a very heavy stem or drill collar connected with the drilling string by a universal joint or flexible connection and cutting parts carried by the drill collar that are urged against the side wall of the bore by the tendency of the weighted drill collar to assume a vertical position and, therefore, cut and scrape away the formation to make the bore vertical.

Another object of this invention is to provide a tool of the character mentioned that embodies fluid discharge ports adjacent the cutting parts that discharge jets of fluid against the side wall of the bore to erode away the earth formation being acted upon by the cutting parts.

Another object of this invention is to provide a tool of the character mentioned in which the weighted body or drill collar carries blocks of a high specific gravity whereby the heavy gravitational force tending to return the drill collar to a vertical position urges the cutting parts against the side wall of the well bore to effect their rapid efficient operation.

Another object of this invention is to provide a tool of the character mentioned that embodies wall cutting and eroding bit units spaced vertically of the heavy weighted body or drill collar.

Another object of this invention is to provide a well straightening tool that is simple and inex-

pensive and that is capable of employment with typical rotary well drilling equipment.

A further object of this invention is to provide a tool of the character mentioned having a cutting unit or bit embodying self-sharpening cutting teeth that are adapted to have maximum penetration of the formation at the side wall of the bore under a minimum force feeding them into the formation.

Another object of this invention is to provide a tool of the character mentioned in which the teeth of the bit are in staggered relation to have engagement with the side wall of the bore throughout a substantial vertical distance during each rotation of the tool.

Another object of this invention is to provide a tool of the character mentioned embodying a pilot bit operable to start the bore in a vertical direction after the tool has straightened the previously bored portion of the well.

Another object of this invention is to provide a well straightening tool embodying a flexible connection with the drilling string comprising drill pipe or the like of less diameter than the string that flexes under the tendency of the heavy drill collar to assume a vertical position and that has sufficient clearance in the well to allow the drill collar to move toward the vertical position as the well straightening operation progresses.

Another object of this invention is to provide a tool of the character mentioned in which the cutting parts are easily and quickly replaced when worn.

Another object of this invention is to provide a drill collar embodying a shell of sufficient strength to dependably transmit the strains to which it may be subjected and a quantity of lead or similar material in the shell having a specific gravity greater than steel whereby the drill collar is of great weight and yet may be relatively short.

A further object of this invention is to provide an improved drill collar for use with well drilling and well straightening tools that has a very great weight and yet has a minimum length, whereby the weight for feeding the tool is concentrated immediately above the tool.

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

Fig. 1 is a side elevation of one form of the invention in the operative position in a well.

Fig. 2 is a fragmentary enlarged longitudinal detailed sectional view of the lower portion of the tool illustrated in Fig. 1. Fig. 3 is an enlarged fragmentary longitudinal sectional view of the knuckle joint being a view taken as indicated by line 3—3 on Fig. 1. Fig. 4 is an enlarged fragmentary longitudinal detailed sectional view of the upper portion of the body or drill collar illustrated in Fig. 1. Fig. 5 is a transverse detailed sectional view taken as indicated by line 5—5 on Fig. 2. Fig. 6 is a side elevation of a slightly modified form of cutting unit for embodiment in the tool illustrating the sleeve and teeth in longitudinal cross section. Fig. 7 is a transverse detailed sectional view taken as indicated by line 7—7 on Fig. 6. Fig. 8 is a view similar to Fig. 1 illustrating another form of the invention in the operative position in the well, and Fig. 9 is an enlarged fragmentary longitudinal detailed sectional view of a portion of the tool illustrated in Fig. 8.

The form of the present invention illustrated in Figs. 1 to 5, inclusive, of the drawings, includes, generally, a heavy drill collar or body 10, a knuckle joint or universal joint 11 connecting the upper end of the body 10 with a drilling string S, and a cutting and eroding unit or bit 12 on the lower end of the body 10.

The drill collar or body 10 is an important element of the tool as it supports the bit 12 and provides a great weight for urging the bit laterally against the side wall of the well bore W, if the bore is inclined, and for holding the bit vertical in a vertical bore. The body 10 is an elongate structure or assembly and in practice may be from 20 to 40 feet, or more, in length. The drill collar or body 10 is proportioned to fit the well bore W with substantial clearance leaving a suitable space for the circulation of fluid. In accordance with the invention the body 10 includes an outer part or shell 13. The shell 13 is tubular and may be formed of one or more lengths of drill pipe or the like. The shell 13 is operable to transmit the torque or rotational strains to which the tool is subjected and has means at its upper end for connecting with the knuckle joint 11 and means at its lower end for carrying the bit 12. In the particular structure illustrated in the drawings a sub or connecting member 14 is threaded in the upper end of the body shell 13 and a similar sub 15 is threaded in the lower end of the shell. The sub 14 is reduced in diameter between its ends to present a downwardly facing annular shoulder 16 engageable by a fishing tool in the event the tool becomes lost in the well. The sub 15 extends downwardly from the body shell 13 and is provided at its lower end with a threaded pin 17. A central longitudinal fluid passage 18 extends through the sub or member 14 and its lower end has communication with the interior of the shell 13. A longitudinal fluid passage 19 extends through the connecting member 15 to the lower end of its pin 17.

The drill collar or body 10 further includes weight elements or weight blocks 20. The blocks 20 are arranged in superimposed relation within the shell 13. In the preferred construction the blocks 20 are annular or tubular and have heavy walls. A thin-walled circulation pipe 21 extends longitudinally through the stack of tubular blocks 20 and its lower end is threaded in a collar 22. The collar 22 has a downwardly and inwardly tapered lower end fitting a correspondingly shaped socket 23 in the upper end of the connect-

ing member 15. The multiplicity of blocks 20 is supported on the collar 22. In practice a washer 24^a may be interposed between the lowermost block 20 and the upper end of the collar 22. The wash pipe or circulation pipe 21 and the collar 22 facilitate the assembly of the blocks 20 in the shell 13. The lower end of the pipe 21 has communication with the upper end of the passage 19. The pipe 21 extends upwardly through the stack of blocks 20 to project above the uppermost block so that its upper end has communication with the passage 18.

The blocks 20 constitute the weight elements of the device and in accordance with the invention are formed of a material having a high specific gravity. In practice the blocks 20 are formed of lead or the like. It will be apparent how the elongate shell 13 and the multiplicity of blocks 20 within the shell constituting the body 10 have a very great aggregate weight. The number of blocks 20 of course determines the weight of the body 10 and any desired number of blocks may be employed. In practice the shell 13 may be substantially filled with the blocks 20 so that the uppermost block is adjacent the lower end of the connecting member 14. The blocks 20 may be fitted in the shell 13 around the pipe 21 to have little or no movement or play in the body. The pipe 21 serves to conduct the circulation fluid downwardly through the body 10 so that the blocks 20 are not eroded by the fluid. The tapered collar 22 fitting the socket 23 centralizes the pipe 21 and dependably seals off the lower end of the shell 13 so that there can be no circulation of fluid past or around the blocks 20.

The knuckle joint or universal joint 11 connects the upper end of the drill collar or body 10 with the drilling string S to rotate with the string and yet assume any angular position relative to the string at will. The joint 11 is such that the weight of the body 10 or the gravitational force acting on the body may at all times urge it in the direction indicated by the arrow in Fig. 1 to maintain the active parts of the bit 12 in contact with the side wall of the well bore in a manner to straighten the bore. In accordance with the broader principles of the invention the joint 11 may be varied considerably in type and construction. The particular joint 11 illustrated in the drawings includes an upper member 24 and a lower member 25. The upper member 24 may be secured to the lower end of the string S by a suitable sub 26. A connecting member or sub 27 connects the lower joint member 25 with the member 14 of the body 10. The upper member 24 is provided in its lower end with a spherically concaved seat 28. A spherically convex head 29 is provided on the upper end of the member 25 and cooperates with the seat 28. A sleeve 30 is threaded or otherwise rigidly secured to the member 24 and extends downwardly beyond its lower end. The sleeve 30 has an internal spherically concaved surface 31 which cooperates with the head 29 to prevent longitudinal separation of the members 24 and 25. The cooperation of the head 29 with the seats 28 and 31 permits relative angular movement or universal movement between the members 24 and 25.

Means is provided for transmitting rotation and torque between the joint members 24 and 25. Longitudinal or circumferential grooves 32 are provided in the head 29 and blocks 33 shiftably cooperate with the grooves 32. Trunnions or pins 34 project inwardly from the sleeve 30 and

pivotaly cooperate with openings 35 in the blocks 33. The pins 34 cooperating with the blocks 33 in the grooves 32 transmit rotation and torque between the members 24 and 25. A longitudinal fluid passage 36 is provided in the member 24 and has its lower end in communication with a similar passage 37 in the member 25. A sealing ring 38 may be provided on the head 29 to cooperate with the seat 28 and seal about the communicating ends of the passages 36 and 37. The passage 36 receives the circulation fluid from the string S while the passage 37 carries the circulation fluid downwardly to the sub to pass into the body 10. The joint 11 just described connecting the body 10 with the string S allows the body 10 to assume angular positions relative to the string so that the bit 12 may bear or act on the side wall of the well bore W under the heavy gravitational force exerted by the body 20 when the well bore is inclined.

The cutting unit or bit 12 is provided to cut away and erode the earth formation at the side wall of the well bore W to make the bore straight or vertical. The bit 12 includes a carrier or mandrel 40. The mandrel 40 may be a simple, integral member having a threaded socket 41 in its upper end for receiving the pin 17 of the connecting member 15. The major lower portion of the mandrel 40 may be enlarged in diameter. Suitable cutting teeth 42 may be provided on the lower end of the mandrel 40 to act downwardly in the event the tool encounters an obstruction in the well being straightened or the tool is operated at the bottom of the bore. Cutting parts 35 are provided on the mandrel 40 to act on the formation at the side wall of the well bore W. These cutting parts may vary somewhat in character and may be secured to the mandrel 40 in various manners. In the preferred construction 40 illustrated the major enlarged portion of the mandrel is provided with a plurality of longitudinal grooves 43. The grooves 43 may be equally spaced apart and extend downwardly from the upper end of the enlarged portion of the mandrel to a plane above the lower end of the mandrel. The side walls of the grooves 40 are outwardly convergent. Blades or bars 44 are inserted in the grooves 43 from their upper ends and are adapted to bear on the bottom walls of the grooves. The opposite sides of the bars 44 are outwardly convergent and cooperate with the side walls of the grooves to hold the bars against outward displacement. A nut 45 may be threaded on the reduced upper portion of the mandrel 55 40 to cooperate with the upper ends of the bars 44. The nut 45 prevents longitudinal displacement of the bars from the grooves 43.

Vertically spaced cutting teeth 46 are provided on the bars 44. The teeth 46 project radially or outwardly from the mandrel 40 to act on the earth formation at the side of the wall bore W. The teeth 46 are pointed, having flat sides tapered outwardly to points. In accordance with the invention the teeth 46 are self-sharpening through use. Openings 9 extend longitudinally through the teeth 46 and are occupied by tungsten carbide metal 8 or other hard cutting material. As the teeth 46 wear the metal 8 projects from their points to keep them sharp and effective. The teeth of adjacent bars 44 are offset and the teeth of the series of bars may be in a spiralled relation. The radially projecting teeth 46 are adapted to dig into and cut away the earth 75 formation at the side wall of the well bore W

when the tool is rotated or moved longitudinally in the well.

The bit 12 is provided with means for discharging jets of fluid under pressure against the side wall of the well bore to erode the formation and aid the cutting teeth. A longitudinal passage 47 extends through the mandrel 40 from its socket 41 where it has communication with the lower end of the passage 19. The passage 47 terminates above the lower end of the mandrel 40. Lateral or radial ports 48 are provided in the mandrel 40 and extend outwardly from the passage 47 to the periphery of the mandrel. The ports 48 may be relatively small in diameter to discharge jets of fluid under high velocity. The ports 48 may be in different horizontal planes and if desired may be arranged in a spiralled series, as illustrated. The ports 48 discharge at points between adjacent toothed bars 44.

In operation the tool illustrated in Figs. 1 to 5, 20 inclusive, of the drawings may be connected with a rotary drilling string S, as illustrated in the drawings, and lowered through the well to the portion of the well to be straightened. When the tool is in the desired position in the well water or circulation fluid under pressure is pumped downwardly through the string S to discharge from the ports 48. The string S is rotated in the usual manner to rotate the tool in the well. As the tool rotates the teeth 46 engage and cut 30 away the formation at the side wall of the well bore and the jets of fluid from the ports 48 erode or wash away the formation. Gravitational force acting upon the heavy tiltably suspended body 10 constantly urges the body to a vertical 35 position and, therefore, constantly feeds the unit 12 laterally against the wall of the well bore W. This force acts in the direction indicated by the arrow in Fig. 1 of the drawings to urge or force the cutting teeth 46 against the side wall of the well bore. The joint 11 forms a universal rotation transmitting connection between the string S and the body 10 whereby the action of gravity on the heavy body 10 may continue to act as the tool is rotated. The string S may be reciprocated or moved up and down from time to time or while being rotated so that the cutting teeth 46 may act upon a substantial portion or length of the inclined wall of the bore. The circulation of fluid, the rotation of the string S and the reciprocation of the string S may be continued until the cutting parts or teeth 46, acting in conjunction with the jets of fluid discharged from the ports 48 cut the well bore to a vertical or substantially vertical line, as indicated by the dot and dash line in Fig. 1. Throughout the entire operation the tendency of the extremely heavy body 10, connected with the string S by the flexible joint 11 to return to a vertical position effectively feeds the bit 12 into cutting and eroding engagement with the side wall of the well in a direction necessary to make the bore vertical. The above described operation may continue until the selected inclined portion of the well bore is vertical whereupon the tool may be withdrawn from the well and the usual drilling operations resumed.

Figs. 6 and 7 illustrate a modified form of bit 12^a that may be employed on the lower end of the body 10. The bit 12^a includes a mandrel 40^a 70 similar in shape and construction to the mandrel 40. A socket 41^a may be provided in the upper end of the mandrel 40 to receive the pin 17. The major lower portion of the mandrel 40 is enlarged in diameter and an annular upwardly 75

facing shoulder 50 is provided on the mandrel a short distance above its lower end. Clutch parts or lugs 51 project upwardly from the shoulder 50. The bit 12^a includes a sleeve 52 passed downwardly over the mandrel 40^a to rest on the shoulder 50. Notches 53 are provided in the lower end of the sleeve 52 to receive the lugs 51 whereby the sleeve 52 is rotated with the mandrel. A nut 55 may be threaded on the mandrel 40^a to engage the upper end of the sleeve 52 and hold the sleeve in proper engagement with the shoulder 50. Vertical series or rows of outwardly projecting cutting teeth 56 are provided on the sleeve 52. The teeth 56 may be similar to the above-described teeth 46. The teeth 56 may have shanks 57 set in openings in the sleeve 52 and may be welded to the sleeves as illustrated. Openings 9^a extend through the teeth 56 and contain hard cutting material 8^a whereby the teeth are self sharpening through use. The teeth 56 in the adjacent rows may be staggered or vertically offset. Cutting teeth 58 may be provided on the lower end of the mandrel 40^a to act on the bottom wall of the bore and to cut through any obstruction that may be encountered in the well bore being straightened. The unit 12^a illustrated in Figs. 8 and 9 operates in the same manner as the unit 12. The sleeve 52 may be readily removed from the mandrel 40^a when it is desired or necessary to replace the cutting teeth 56.

Figs. 8 and 9 of the drawings illustrate another form of the invention. In the structure illustrated in Figs. 8 and 9 of the drawings the body 10 and the bit 12 may be substantially the same as described above. If desired the body 10 may be somewhat shorter than the body in the tool disclosed in Figs. 1 to 5, inclusive. In the apparatus illustrated in Figs. 8 and 9 the upper end of the body 10 is connected with the string S by a pipe P. The pipe P is of less diameter than the pipe in the string S whereby it may more freely flex and has substantial clearance in the well. The pipe is sufficiently long to have the required flexibility whereby the body 10 may return to a vertical position under the gravitational influence. A cutting unit or bit 12^b is connected between the lower end of the pipe P and the upper end of the body 10 whereby the tool includes the vertically spaced bits 12 and 12^b. The bit 12^b may resemble the bit 12 including a mandrel 60 and toothed bars 61 set in grooves 62 in the mandrel. The mandrel 60 is provided with connecting means at its opposite ends. The upper end of the mandrel 60 may be connected with the lower end of the pipe P through the medium of a suitable sub 63. A pin 64 may be provided on the lower end of the mandrel 60 to cooperate with a socket 65 in the upper end of a sub 66. The sub 66 is in turn threaded in the upper end of the body shell 13. The bars 61 are provided with series of vertically spaced self-sharpening cutting teeth 67 and are locked in the grooves 62 by a nut 68 threaded on the mandrel to bear against their upper ends. In practice the toothed bars 61 may be identical with the above described bars 44. A central longitudinal fluid passage 70 extends through the mandrel 60 to conduct the circulation fluid from the pipe P to the pipe 21 of the body 10. If desired or believed necessary radial or lateral ports 71 may be provided in the mandrel 60 to communicate with the passage 70. The ports 71 may discharge jets of circulation fluid under pressure outwardly from the mandrel 60 to erode the formation at

the side wall of the well bore. A pilot bit 80 of reduced diameter extends from the lower end of the bit 12. The pilot bit 80 is operable to drill through any obstructions that may be encountered and is intended primarily to start the bore in a vertical direction after the previously drilled portion of the bore has been straightened.

The operation of the tool illustrated in Figs. 8 and 9 of the drawings is substantially the same as that of the previously described form of the invention. In operation the tool is rotated in the well and may be moved up or down from time to time. The gravitational force acting upon the heavy body 10 constantly urges the body toward a vertical position and, therefore, it urges the cutting parts of the bits 12 and 12^b against the wall of the well bore so that they rapidly cut the bore to have a vertical axis. The pipe P freely flexes allowing the body 10 to return to the vertical position, as described. The tool illustrated in Figs. 8 and 9 is particularly rapid in operation as it involves the vertically spaced cutting bits 12 and 12^b. The bits 12 and 12^b acting on the formation at vertically spaced points may assist in stabilizing the tool to more rapidly straighten the well bore.

Having described only typical preferred forms and applications 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 tool for straightening crooked well bores comprising, a body, a weight element of a higher specific gravity than ferrous material carried by the body to turn therewith, a flexible connection for connecting the body with a drilling string whereby gravity may urge the body laterally toward a vertical position when in an inclined bore, and vertically spaced cutting means on the body for acting laterally against the earth formation at the side wall of the well under said gravitational urge.

2. In combination, a rotary well drilling string, an elongate body having a higher specific gravity than ferrous material, a flexible connection between the body and the string, and vertically spaced bits carried by the body for acting on the earth formation each including laterally projecting cutting parts and laterally directed fluid discharge means.

3. Well straightening apparatus including, a rotary drilling string, a drill collar having an aggregate specific gravity greater than ferrous material, pipe of less diameter than the string rigidly connected with the drill collar and the lower end of the string and forming a limber connection between the string and the drill collar, and laterally projecting cutting elements on the drill collar urged laterally against the side wall of the well by gravitational force tending to return the drill collar to a vertical position.

4. A drill collar for use in a rotary well drilling string comprising, a tubular member of sufficient strength to transmit the torque and longitudinal forces to which the string is subjected, coupling means on the upper end of the member for connecting it with the drilling string whereby the member is rotated by the string, and a weight element of a higher specific gravity than ferrous materials within and supported by the member.

5. A drill collar for use in a rotary well drill-

ing string comprising, a tubular member of sufficient strength to transmit the torque and longitudinal forces to which the string is subjected, coupling means on the upper end of the member for connecting it with the drilling string whereby the member is rotated by the string, and a plurality of blocks in and supported by the member of a higher specific gravity than ferrous metals.

6. A drill collar for use in a rotary well drilling string comprising, a tubular member of sufficient strength to transmit the torque and longitudinal forces to which the string is subjected, means for connecting the member with the string to be rotated thereby, a fluid circulation tube extending longitudinally through the member, and a weight element in the member having a higher specific gravity than ferrous materials.

7. A drill collar for use in a rotary well drilling string comprising, a tubular member of sufficient strength to transmit the torque and longitudinal forces to which the string is subjected, means connecting the upper end of the member with the drilling string whereby the member is rotated by the string, a fluid circulation tube extending longitudinally through the member, and a stack of tubular weight blocks in the member around the tube.

8. A drill collar for use in a rotary well drilling string comprising, a tubular member of sufficient strength to transmit the torque and longitudinal forces to which the string is subjected, means connecting the upper end of the member with the drilling string whereby the member is rotated by the string, and a plurality of tubular weight elements in the member defining a longitudinal passage therethrough.

9. Apparatus of the character described for use on a rotary well drilling string including, a

body material having a higher specific gravity than ferrous metals carried by the body, a flexible connection between the body and the string, and a cutting unit carried by the body and including horizontally projecting teeth spaced vertically of the unit, the outer active ends of the teeth being substantially the same distance from the vertical axis of the body.

10. Apparatus of the character described for use on a rotary well drilling string including, a body carrying material having a higher specific gravity than ferrous metals, a flexible connection between the body and the string, and a cutting unit carried by the body and including circumferentially spaced rows of vertically spaced teeth projecting laterally from the unit to act on the side wall of the bore, the outer ends of the several teeth being substantially the same distance from the vertical axis of the unit.

11. Apparatus of the character described for use on a rotary well drilling string including, a drill collar body carrying material having a higher specific gravity than ferrous metals, a flexible connection between the upper end of the body and the string, and cutting units on the upper and lower end portions of the body, the cutting units having laterally projecting cutting parts.

12. Apparatus of the character described for use on a rotary well drilling string including, a body, material having a higher specific gravity than ferrous metals carried by the body, a flexible connection between the body and the string, a substantially cylindrical member on the lower end of the body, teeth of substantially the same length projecting laterally from the member for acting on the side wall of the bore, and a pilot bit of less diameter than the member extending downwardly from the member.

JESSE C. WRIGHT.