Aug. 4, 1936. A. W. KAMMERER 2,049,543

WELL BIT

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Fig. 1.

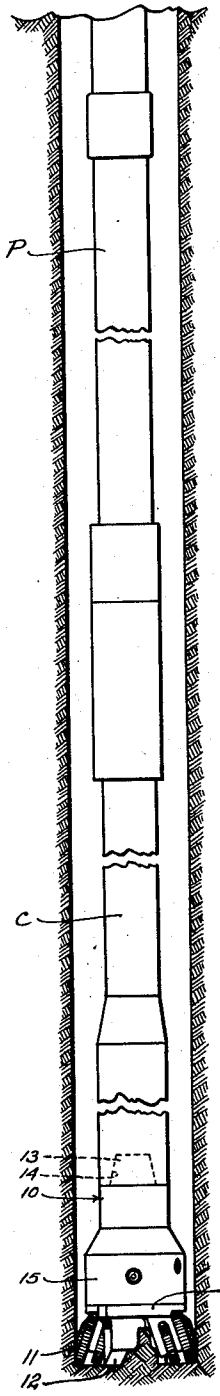

Fig. 2.

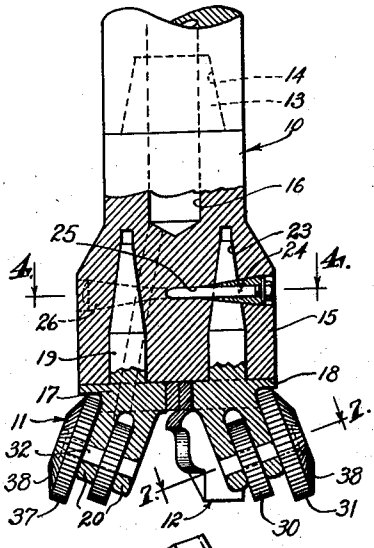

Fig. 5.

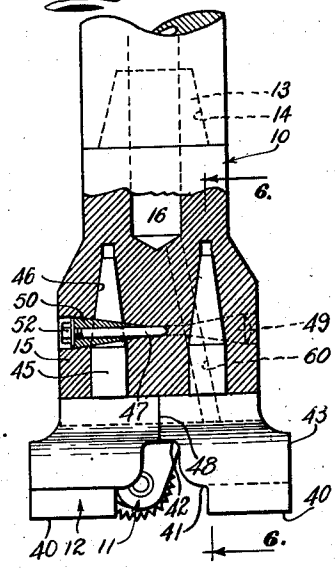

Fig. 3.

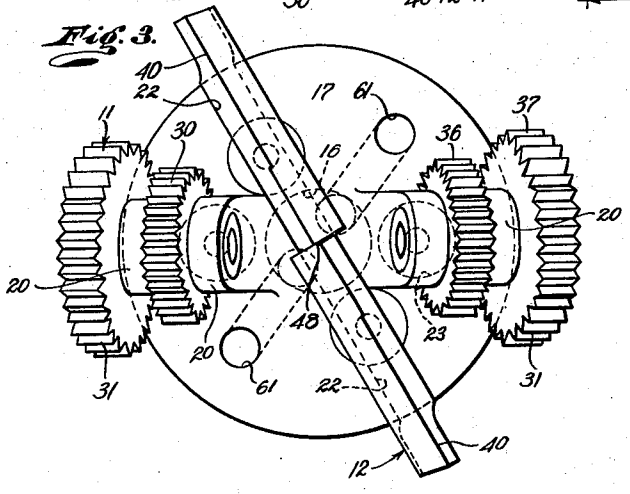

Fig. 4.

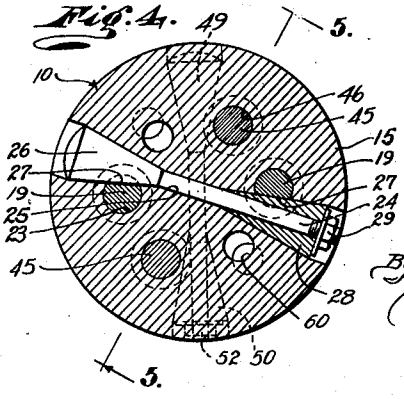

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Fig. 6.

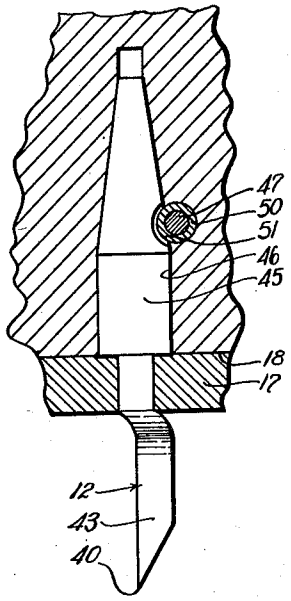


Fig. 7.

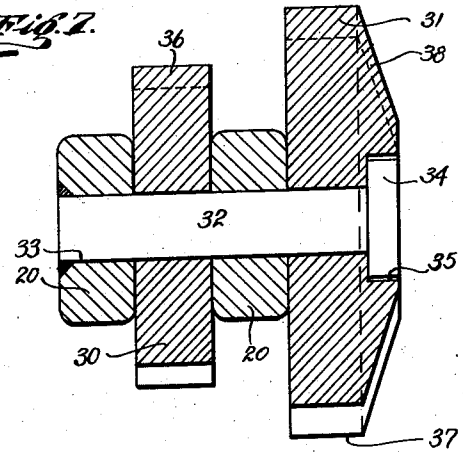


Fig. 8.

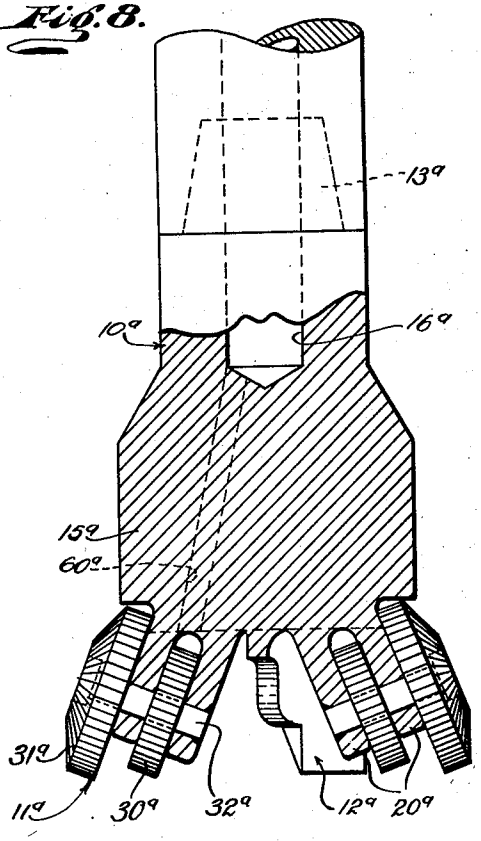
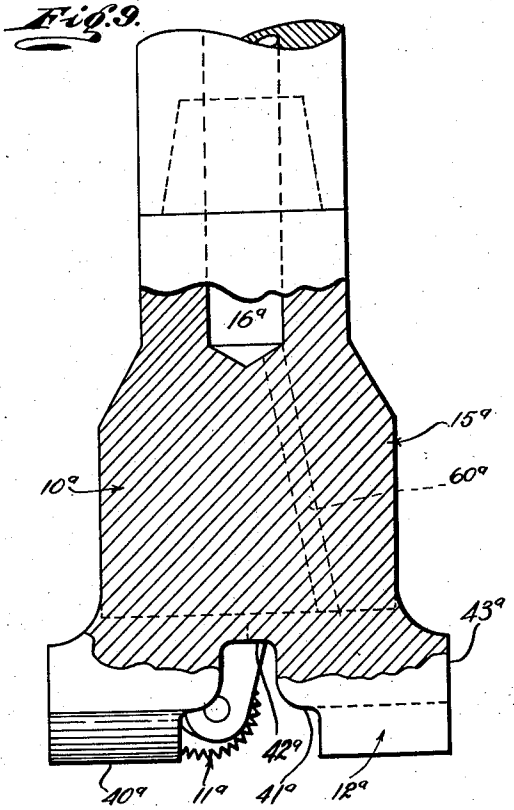


Fig. 9.



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UNITED STATES PATENT OFFICE

2,049,543

WELL BIT

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Application July 12, 1935, Serial No. 31,012

10 Claims. (Cl. 255—71)

This invention relates to a well drilling tool, and relates more particularly to a well bit for use in connection with the rotary method of well drilling. It is a general object of the invention to provide a practical and effective well drilling bit combining the operative features of the drag type bit and the rock or roller type bit.

There are two general or main classes of bits employed in the rotary method of well drilling, viz., the drag type bit, and the rock or roller type bit. The drag type of well bit involves cutting blades or teeth fixed on the body or shank of the tool and operable to remove the formation through a scraping or shearing action. The drag type of well bit is particularly adapted for use in comparatively soft earth formations. The rock or roller type of bit includes one or more roller cutters rotatably mounted on the shank and provided with cutting parts at their peripheries for crushing the formation. In certain districts, shale or other earth formations are encountered in which the drag type of drilling bit is of little utility, as its cutting blades slide or skid over the formation upon being dulled so as to have very little cutting action. The roller type of drill is not effective in certain types of formations, as the cutting parts soon become filled or covered with the cuttings so that the rollers merely roll or track over the formation without crushing or cutting it.

It is an object of the present invention to provide a well drilling bit including both cutters of the drag type and cutters of the roller or rock type.

It is another object of the invention to provide a well drilling bit of the character mentioned that is particularly effective in shale formations or other formations that are usually very difficult to drill by means of the usual roller or drag types of drills. In accordance with the present invention, roller type cutters are mounted ahead of blades or drag type of cutters, so as to roughen or make the formation irregular so that the drag blades or cutters are effective in removing it.

It is another object of the invention to provide a well drilling tool of the character mentioned that is simple, practical, and inexpensive of manufacture.

Another object of the invention is to provide a well drilling bit of the character mentioned that includes mounting means for the cutters whereby each of the cutters or sets of cutters is mounted so as to be independently detachable from the shank.

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

Fig. 1 is a side elevation of one form of the bit provided by my present invention, showing it mounted on the lower end of an operating string and in operation within a well bore. Fig. 2 is a enlarged vertical detailed sectional view of the bit, being a view taken through the mountings of the roller cutters. Fig. 3 is an enlarged bottom elevation of the bit. Fig. 4 is an enlarged transverse detailed sectional view taken as indicated by line 4—4 on Fig. 2. Fig. 5 is a vertical detailed sectional view of the bit, being a view taken substantially as indicated by line 5—5 on Fig. 4. Fig. 6 is an enlarged vertical detailed sectional view taken substantially as indicated by line 6—6 on Fig. 5, showing a blade cutter and its mounting pin in elevation. Fig. 7 is an enlarged detailed sectional view taken as indicated by line 7—7 on Fig. 2. Fig. 8 is a vertical detailed sectional view through the roller cutter mountings of another form of the invention, and Fig. 9 is a fragmentary detailed sectional view through the cutting blades of the bit shown in Fig. 8.

The bit provided by the present invention and illustrated in Figs. 1 to 7 includes, generally, a body or shank 10, rock or roller cutters 11 detachably mounted on the shank 10, and blade or drag type cutters 12 detachably mounted on the shank.

The body or shank 10 is adapted to be mounted and operated on the lower end of an operating string P of drill pipe. In Fig. 1 of the drawings, I have illustrated the shank 10 attached to the lower end of a typical drill collar C on the lower end of the operating string P. The body or shank 10 of the bit may be a simple integral member and may be cylindrical in its general configuration. A tapered pin 13 may be provided on the upper end of the shank 10 to thread into a socket 14 in the lower end of the drill collar C. The lower end part 15 of the shank is preferably of greater diameter than the upper end portion of the shank. A main or central fluid passage 16 is provided in the upper end of the shank 10 to communicate with the fluid passage of the drill collar C.

The roller cutters 11 are mounted at the lower end of the shank 10 to act on the formation at the bottom of the well bore B. In accordance with the broader aspects of the invention, there may be any desired number of roller cutters pro-

vided on the bit and they may be mounted and related in various manners. In the simple preferred embodiment of the invention illustrated in the drawings, there are two like pairs or sets of roller cutters 11 mounted below the lower end of the shank 10. Each pair or set of roller cutters 11 is detachably mounted on the shank 10.

The mounting means for each pair of rock cutters 11 includes a flange 17 to engage against the lower end 18 of the shank, a pin 19 projecting from the flange, and spaced downwardly projecting legs 20 for carrying the cutters. The two flanges 17 seat directly against or directly about the lower end 18 of the shank. The two mounting flanges 17 are preferably alike in size and shape and are segmental in their plan configuration, having their outer edges flush with the periphery of the lower portion 15 of the shank. The chordal or inner sides 22 are straight and spaced apart at opposite sides of the central longitudinal axis of the shank.

The mounting pins 19 may be integral with the flanges 17 and may be of round cross sectional configuration. There may be a single centrally located pin 19 projecting upwardly from each flange 17 into an opening or socket 23 in the shank 10. The upper end portions of the pins 19 are tapered or frusto-conical and the upper portions of the socket 23 are shaped to effectively receive or carry the pins. In accordance with the invention, means is provided for holding the pins 19 against movement in the sockets 23. A rod or bolt 24 is arranged through a diametric opening 25 in the main portion 15 of the shank. An enlarged part or head 26 is provided on one end of the bolt 24. The head 26 is tapered or provided with outwardly divergent sides, and the end portion of the opening 25 is shaped to conform to the configuration of the head. The enlarged end portion of the opening 25 intersects an edge part of one of the sockets 23, and a notch 27 is provided in the pin 19 to register with the intersecting portion of the opening 25. The head 26 cooperates with or fits into the notch 27 to positively hold the pin 19 against movement in the socket 23. A tapered or frusto-conical sleeve 28 is slidably mounted on the plain end of the bolt 24. The end part of the opening 25 is shaped to receive the sleeve 28 and intersects the notch 27 of the other mounting pin 19. The sleeve 28 fits into the notch 27 to hold the pin against movement. A nut 29 is screwed-threaded on the rod 24 to clamp the head 26 and the sleeve 28 in position. In the preferred construction, the end of the head 26 and nut 29 are inset or countersunk within the opposite ends of the opening 25.

The legs 20 project downwardly from the flanges 27 to mount or carry the roller cutters 11. In the embodiment of the invention being described, there are two spaced parallel legs 20 projecting downwardly from each flange 17. In the particular case illustrated, the legs 20 project downwardly and outwardly from the flange. Each pair of roller cutters 11 consists of an inner cutter 30 rotatably mounted between a pair of legs 20 and an outer cutter 31 at the outer side of the outermost leg 20. A single pin 32 may be carried by each pair of legs 20 to carry a pair of roller cutters 11. The pins 32 extend through transverse openings 33 in the legs 20. A head 34 is provided on the outer end of each pin 33 to fit a socket 35 in the outer end of a cutter 31. The inner ends of the pins 32 may be welded in the openings 33 of the innermost legs 20. The cutter-carrying pins 32 are inclined upwardly and outwardly relative to the axis of rotation of the bit so that the cutters 31 and 32 are rotatable about axes inclined relative to the axis of rotation of the tool. The axes of rotation of the two pairs of roller cutters 11 may be in a vertical plane diametric of the vertical or longitudinal axis of the shank 10.

The inner cutter 30 of each pair of roller cutters is cylindrical and is provided at its periphery with cutting parts or teeth 36 for acting on the formation at the bottom of the well bore. The outer cutters 31 have inner cylindrical parts provided with cutting parts or teeth 37 for acting on the formation at the bottom of the well bore. The cutters 31 may be of larger diameter than the inner cutters 30 so as to have their cutting parts 37 in the same horizontal plane as the cutting parts 36. The outer roller cutters 31 are provided with tapered outer ends provided with cutting parts 38 for engaging or forming the side walls of the well bore B. The conical or tapered outer ends 38 of the outer cutters, in engaging the side walls of the well bore, operate to effectively guide the bit and prevent eccentric or undesirable movement of the drill. In the drawings, the cutting parts 36 and 38 are cylindrical and concentric with the axes of the cutters 30 and 31, it being understood that they may be pitched or inclined as desired.

The drag type or blade cutters 12 are mounted behind or at the rear of the roller cutters 11 to engage and act on the formation after it has been acted upon by the roller cutters. In the embodiment of the invention illustrated in the drawings, where there are two sets or pairs of roller cutters 11, the bit may be provided with only two drag type cutters or blades 12, one spaced at the rear of each pair of roller cutters 11. The cutters 12 may be in the nature of simple integral blades having their upper ends arranged between the spaced chordal edges 22 of the flanges 17 and in engagement with the lower end 18 of the shank. The two blade cutters 12 project downwardly from between the flanges 17 to engage the formation at the bottom of the well bore. The blades or cutters 12 may be bowed or bent to have their lower projecting parts offset rearwardly of their upper ends, as illustrated in Fig. 6 of the drawings. The lower or active ends of the blades 12 are provided with suitable cutting edges. In the particular case illustrated in the drawings, each blade 12 is provided with a main outer cutting edge 40 and stepped inner cutting edges 41 and 42. The inner portions of the blades 12 are stepped upwardly and inwardly to provide the cutting edges 41 and 42 for destroying the core or formation at the center of the bore. The cutting blades 12 may project outwardly beyond the lower end portion 15 of the shank to have vertical cutting edges 43 at their outer ends. The cutting edges 43 are adapted to engage the formation at the side walls of the well bore B. The cutting blades 12 are spaced at suitable distances rearwardly of the roller cutters 11 relative to the direction of rotation of the bit so that their cutting edges 40, 41 and 42 engage the formation at the bottom of the well bore after it has been acted upon by the roller cutters 30 and 31. It is to be noted that, in the particular construction illustrated in the drawings, the cutting edges of the blades 12 do not fall in or make cuts of the same configuration as the roller cutters 30 and 31. It is to be understood that

the cutting edges of the blades 12 may be shaped to follow in and act upon the cuts made by the roller cutters 30 and 31 if desired.

The means for detachably mounting the blades 12 on the lower end of the shank 10 may be similar to the means for mounting the flanges 17, i. e., it may include a pin 45 projecting upwardly from each blade and held in a socket 46 in the shank by a transverse bolt 47. The two blades 12 may be independently attached to the shank 10; however, their abutting inner edges 48 may be welded together if desired. When the edges 48 of the two blades 12 are welded together, the two cutting blades form an assembly that may be detached from the shank as a unit. The retaining bolt 27 is provided at its one end with a tapered enlargement or head 48 which fits a notch in a pin 45 to hold it in the socket 46. A tapered sleeve 50 is provided on the other end of the bolt 47 to cooperate with a notch 51 in a pin 45 to hold the pin against displacement. A nut 52 is screw-threaded on the outer end of the bolt 47 to clamp the head 49 and the sleeve 50 in their retaining positions.

The invention provides means for passing circulation fluid through the bit to discharge into the bottom of the well bore. Branch openings or fluid passages 60 extend downwardly and outwardly from the lower end of the passage 16 to the lower end 18 of the shank. Openings 61 are provided in the flanges 17 to register with the lower ends of the openings 60 and to discharge the circulation fluid downwardly into the well bore. In the particular construction illustrated in the drawings, the openings 61 occur at points spaced forwardly of the roller cutters 11, it being understood that they may be positioned at other points relative to the cutting parts of the bit if desired.

It is believed that the operation of the drilling bit illustrated in Figs. 1 to 7, inclusive, will be readily apparent from the foregoing detailed description. During operation, the bit is rotated in a forward or clockwise direction so that the roller cutters 30 and 31 act on the formation at the bottom of the well bore ahead of the drag blades 12. The cutting parts or teeth 36, 37, and 38 of the roller cutters operate to crush and roughen the formation so that it is readily cut and removed by the cutting edges of the blades 12. As the formation is first roughened by the roller cutters 30 and 31 and is then cut or removed by the blade cutters 12, the roller cutters are not subject to becoming mudded up, and the cutting blades 12 act to cut the formation rather than skid or slide on the formation. In practice, the bit is very effective and rapid in its operation, as it has the desirable operative characteristics of both the roller type bit and the drag type bit. The cutters 11 and 12 are mounted on the shank so as to be easily and quickly removed and replaced. It is to be noted that the cutters may be replaced by cutters of various sizes and cutter units in which the cutting parts are related in various manners. Accordingly, the invention is not to be construed as restricted to the specific number and arrangement of cutting parts illustrated in the drawings.

Figs. 8 and 9 illustrate a form of the invention in which the roller cutter mountings and the drag type blades are integral with the shank or body. The bit shown in Figs. 8 and 9 includes a body 10^a which is a simple, integral member of substantially the same general configuration as the body 10. A tapered threaded pin 13^a is provided on the upper end of the body 10^a to facilitate the connection of the body with a drill collar or the like. The lower end portion 15^a of the body is enlarged and a main central fluid passage 16^a enters the body from the upper end of its pin 13^a. Two sets or pairs of roller cutters 11^a are mounted on the lower end of the body 10^a. Two pairs of spaced parallel legs 20^a project from the lower end of the body 10^a to carry the roller cutters 11^a. In accordance with the form of the invention being described the legs 20^a are integral with the body 10^a. The legs 20^a project downwardly and outwardly and the two pairs of legs are disposed at diametrically opposite points on the lower end of the body. The inner cutters 30^a of each pair of cutters 11 is disposed between two adjacent legs 20^a and the outer cutter 31^a of each pair is positioned at the outer side of the outermost leg 20^a. Pins 32^a extend through openings in the legs 20^a to support the cutters 30^a and 31^a for rotation. The pins 32^a may be welded or otherwise secured to the legs 20^a. The cutters 30^a and 31^a are rotatable about axes inclined downwardly and inwardly relative to the vertical axis of the bit. The roller cutters 30^a and 31^a are of the same shape as the cutters 30 and 31 and operate in the same manner.

The drag type cutters or the blade cutters 12^a project downwardly from the lower end of the body 10^a at points spaced at the rear of the pairs of roller cutters 11^a. In the form of the invention being described the blades 12^a are integral with the body 10^a. The blades 12^a are of the same shape and have the same operation as the blades 12 of the previously described form of the invention. Each blade 12^a has an outer cutting edge 40^a and an upwardly stepped inner cutting edge 41^a at its lower end. An inner cutting part or edge 42^a may occur between the blades 12^a. Each blade 12^a has an outer cutting edge or reaming edge 43^a. Ports 60^a extend downwardly from the passage 16^a to discharge at the lower end of the body. The operation of the bit illustrated in Figs. 8 and 9 of the drawings is the same as the previously described form of bit. The mountings for the roller cutters 11^a and the blades 12^a being integral with the body 10^a make the bit simple and inexpensive of manufacture.

Having described only typical preferred forms of my invention, I do not wish to limit myself to the specific details set forth, but wish to reserve to myself any changes or variations 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 including, a body, roller cutters, means for mounting the roller cutters including, flanges engaging the lower end of the body, the inner edges of the flanges being spaced apart, legs projecting downwardly from the flanges, and cutter carrying pins on the legs, and a blade cutter attached to the body and projecting downwardly between the inner edges of the flanges.

2. A well bit including, a body, roller cutters, means for mounting the roller cutters including, flanges engaging the lower end of the body, the inner edges of the flanges being spaced apart, legs projecting downwardly from the flanges, and cutter carrying pins on the legs, a blade cutter projecting downwardly between the inner edges of the flanges, and means for detachably securing the blade cutter to the body.

3. A well bit including, a body, roller cutters,

means for mounting the roller cutters including, flanges engaging the lower end of the body, the inner edges of the flanges being spaced apart, legs projecting downwardly from the flanges, pins on the legs rotatably carrying the cutters, a pin projecting from each flange and fitting a socket in the body, a bolt in an opening in the body intersecting the two sockets, a tapered head on the bolt cooperating with a notch in one of the pins, and a sleeve on the bolt cooperating with a notch in the other pin.

4. A well bit including, a body, rollers cutters, means for mounting the roller cutters including, flanges engaging the lower end of the body, the inner edges of the flanges being spaced apart, legs projecting downwardly from the flanges, and cutter carrying pins on the legs, a blade cutter projecting downwardly between the inner edges of the flanges, and means for detachably securing the blade cutter to the body including, a pin on the blade fitting a socket in the body, a bolt in an opening in the body, and a part on the bolt cooperating with a notch in the said pin.

5. A well tool including a body, roller cutters, means for mounting the roller cutters including flanges held against the lower end of the body, the inner edges of the flanges being spaced apart, and legs projecting from the flanges and carrying the roller cutters, blade cutters projecting downwardly between the inner edges of the flanges, and means independently detachably securing the blades to the body.

6. A well tool including a body, roller cutters, means for mounting the roller cutters including flanges held against the lower end of the body, the inner edges of the flanges being spaced apart, and legs projecting from the flanges and carrying the roller cutters, blade cutters projecting downwardly between the inner edges of the flanges, and means independently detachably securing the blades to the body including a pin on each blade fitting a socket in the body, and a removable member engaging the pins in the sockets to hold the pins against downward movement.

7. A well tool including a body, roller cutters, means for mounting the roller cutters including flanges held against the lower end of the body, the inner edges of the flanges being spaced apart, and legs projecting from the flanges and carrying the roller cutters, blade cutters projecting downwardly between the inner edges of the flanges, the upper ends of the blades bearing directly against the lower end of the body, pins projecting from the upper ends of the blades and extending into sockets in the body, and removable means holding the pins against displacement from the sockets.

8. A well tool including a body, two roller cutter carrying units detachably mounted on the lower end of the body, each unit including a flange seating directly on the lower end of the body, the inner edges of the flanges being spaced apart, a blade cutter projecting downwardly between the inner edges of said flanges, the upper ends of the blade cutter seating against the lower end of the body, and a pin projecting from the blade cutter and removably held in a socket in the body.

9. A well drilling bit including a body, pairs of roller cutters, means for carrying the roller cutters including pairs of spaced legs projecting from and integral with the lower end of the body, and a pin carried by each pair of legs rotatably supporting a pair of roller cutters, and blade cutters projecting from the lower end of the body and spaced at the rear of the legs, the blade cutters being integral with the body.

10. A well bit including, a body, spaced pairs of legs projecting from the lower end of the body, a pin carried by each pair of legs, roller cutters supported by each pin for rotation about downwardly and inwardly inclined axes, and cutting blades rigid with the body and projecting from its lower end in spaced relation to the pairs of legs.

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