This invention relates to well drilling implements, and more particularly to a rotary drill hammer implement of the fluid-actuated type adapted to dig by a combination of rotary scraping action and pounding action.

A main object of the invention is to provide a novel and improved rotary drill hammer for use in well drilling and similar operations, the device being simple in construction, being easy to install, and being substantially automatic in operation.

A further object of the invention is to provide an improved well drilling device of the rotary hammer type, the device involving inexpensive components, being durable in construction, being usable either with hydraulic or pneumatic fluid, and providing efficient utilization of the pressure fluid driving same.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIGURE 1 is a vertical cross sectional view taken through an improved rotary drill hammer constructed in accordance with the present invention, shown with the main casing thereof elevated.

FIGURE 2 is a vertical cross sectional view, similar to FIGURE 1, but showing the vertical casing lowered to provide the pounding impact, immediately preceding the chopping action produced by the descent of the hammer member of the device.

FIGURE 3 is an enlarged horizontal cross sectional view taken substantially on the line 3-3 of FIGURE 2.

FIGURE 4 is an enlarged horizontal cross sectional view taken substantially on the line 4-4 of FIGURE 2.

FIGURE 2 is an enlarged horizontal cross sectional view taken substantially on the line 5-5 of FIGURE 2.

Referring to the drawings, 11 generally designates an improved rotary drill implement according to the present invention, the implement comprising a vertical main casing 12 to the top end of which is connected a head member 13, the head member being formed with the reduced collar portion 14 which is threadedly engaged inside the top end of main casing 12. Head portion 13 is further formed with a tapered connection portion 15 formed with external screw threads, whereby it may be fastened in the conventional manner to a supporting pipe section, and which may be thus connected to a suitable fluid pressure source, for example, to a source of drilling fluid under pressure.

The head member 13 is formed with a plurality of vent openings 16 to allow the drilling fluid to at times be vented from the main casing, as will be presently explained.

Secured in the lower end of the main casing 12 is a bearing collar 17, said bearing collar having the reduced externally threaded top portion 18 which is threadedly engaged in the bottom end portion of the main casing 12. The collar member is provided with the equally spaced depending guide fingers 19 and slidably engaging in vertical grooves 20 formed in a first tool supporting tube 21 whose reduced top portion 22 extends slidably through the bearing collar 17.

Secured in the tool supporting tube 21 is a first tool bit 23 which comprises a pair of diametrically opposed blade members 24, 24 formed with the bottom cutting edges 25, 25 and spaced apart at their inner vertical edges to define a vertical guide slot 26. Designated at 27 is a second tool bit which is slidably engaged with the first tool bit and which extends transversely thereto in the guide slot 26, the second tool bit being formed with the bottom cutting edge 28 which is perpendicular to the cutting edges 25, 25 of the first tool bit 23.

The second tool bit 27 is provided at its top end with a hollow annular head portion 29 which is threadedly engaged in the bottom end of a second tool supporting tube 30 which extends slidably through the first tool supporting tube 21, and which thus guides the second tool bit 27 for vertical sliding movement with respect to the first tool bit 23.

The head member 29 is provided with the frusto conical intermediate portion 31 which is formed with a plurality of relatively small vent openings 32 providing restricted venting of the pressure fluid.

Designated at 33 is a depending pressure fluid conduit which is axially secured in the head member 13 and which extends slidably into the second tool bit supporting tube 30. Secured on the top end of the tube 30 and in sliding engagement with the conduit 33 is the annular hammer member 34. As shown in FIGURES 3 and 2, the hammer member 34 is of substantial vertical height, and acts as a guide sleeve for the second tool-supporting tube 30. The hammer member 34 is formed at its bottom rim with a frusto conical annular valve surface 35 which is at times sealingly engageable with a mating frusto conical valve surface 36 formed in the top rim of a valve ring 37. The valve ring 37 is slidably engaged within a valve guide sleeve 38 which is secured to the top end of the first tool-supporting tube 21 by means of an annular connecting collar 39.

Thus, the guide sleeve 38 is threadedly engaged with the top end of the connecting collar 39 and the collar 39 is threadedly engaged on the top end portion of the first tool bit supporting tube 21 as shown at 40. The annular valve ring member 37 is yieldingly connected to the collar member 39 by a collar spring 41, the lower end of the spring being connected to the top of the collar member 39 and the top end of the spring being connected to the valve ring member 37, so that the spring acts to bias the ring member to a pre-determined position in the valve sleeve 38. As shown, the spring 41 is mounted axially inside the sleeve 38 and surrounds the second tool bit supporting tube 30.

The collar member 39 is slidably engaged in the main casing 12 and is formed with a plurality of fluid passages 43 which establish communication between the space immediately below the collar member 39 and the space within the valve sleeve 38.

Secured in the top portion of the sleeve 38 is a stop ring 44 which limits upward movement of the valve ring member 37. The first tool-supporting tube 21 is formed with respective upwardly facing shoulders 45 which cooperate with the downwardly facing shoulders 46 on the collar member 17 to support the main casing 12 on the first tool-supporting tube 21 during the drilling action, namely, the rotary movement of the main casing 12.

On the elevation of the main casing, the top surface of the collar member, namely, the top surface of reduced portion 18 thereof comes into engagement with the bottom surface of the collar member 39, as shown in FIGURE 1, blanking the passages 43.

When the casing 13 is lowered, the top portion 18 of collar member 17 descends relative to the collar member 39, providing a space 47 between member 39 and member 18, this space being placed in communication with the space inside the valve sleeve 38 through the passages 43. The second tool bit supporting tube 30 is formed with a plurality of vertical slots 49 which register with a plurality of passages 50 formed in the upper portion of the first tool bit supporting tube 21, the registration being effective in the various different relative operating positions of the members 30 and 33, because of the sub-
stantial vertical height of the slots 49. However, these ports are blanked in the elevated position of the casing 12 illustrated in FIGURE 1, since the member 17 moves into a position covering the ports 50 as well as the bottom ends of the passages 43. FIGURE 2 illustrates the positions of the parts during the operation of the device, with the chopping tool bit 27 being in position. The elevation of the tool bit 27 is caused by the pressure of the drilling fluid, which passes upwardly into the space beneath annular valve member 37, raising said valve member 37 into sealing contact with annular surface 35 and elevating the hammer member 34. The upward momentum of the hammer member causes it to continue to rise while spring 41 pulls valve member 37 downwardly, releasing the pressure fluid and allowing it to travel upwardly toward the vent passages 16. The passages 43 are relatively restricted, so that a substantial building up of pressure may occur inside the tube 30, the pressure eventually reaching a sufficient value to cooperate with the weight of hammer member 34 to drive the member 30 downwardly, causing the bit 27 to descend with substantial impact and to provide a chopping action which cooperates with the scraping and pounding action provided by the main bit 23. The downward movement of the tool bit 27 moves the hammer member 34 downwardly so that the valve surface 35 thereof may be brought once more into sealing contact with the valve surface 36 of the ring 37, preparing the device for the next cycle.

In the operating position of the casing 12, the pressure fluid acts on the hammer member 34 through the ring 37, causing the ring to be elevated somewhat with the hammer member, the spring 41 being yieldable to permit such elevation of ring 37. As previously mentioned, a sufficient amount of momentum is delivered to the hammer member 34 to allow the hammer member to rise a substantial distance, the upward movement of the ring being limited by the stop ring 44 provided in the top end of the valve sleeve 38. As shown in FIGURE 2, sufficient clearance is provided between the ring 37 and the hammer member 34 to allow the pressure fluid to escape toward the vent passages 16, but there is a sufficient delay to allow the building up of pressure inside the tool bit supporting tube 30 to drive the second tool bit 27 downwardly a relatively short time after the upward movement of the hammer member has taken place.

Spring 41 biases the ring member 37 to a position such as that shown in FIGURE 1 wherein the frusto conical sealing surface 35 of hammer member 34 will sealably engage the frusto conical sealing surface 36 of the ring member 37 when the casing 12 is in its elevated position.

In the device illustrated in the drawings and above described, the tool assembly comprises the main tool bit 23 and a chopping bit 27 which cooperates therewith to provide a chopping action along with the rotary scraping and pounding action provided by the blade members 24, 24. Instead of using the pounding and scraping main tool bit 23, a two-cone roller rock bit may be employed in conjunction with the chopping bit 27, within the spirit of the present invention.

While a specific embodiment of an improved well drilling device of the rotary hammer type has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. A well drilling device, a vertical main casing, a bearing collar secured in the lower end of said main casing, a first tool-supporting tube extending slidable through said bearing collar, a first tool bit secured to said tube, a second tool bit slidably engaged with said first tool bit and extending transversely thereto, being slidably vertically relative to said first tool bit, a second tool-supporting tube secured to the top end of said second tool bit and extending slidably in said first tool-supporting tube, an annular hammer secured on the top end of said second tool-supporting tube, a depending pressure fluid conduit secured axially in the top of said main casing and extending slidably through said hammer and into said second tool-supporting tube, an annular valve member secured tool-supporting said second tool bit and being suitably resiliently adapted to engage said hammer and being sealingly engageable with the hammer, means sealing the annular valve member with respect to the main casing to define a substantially fluid-tight space beneath the valve member, spring means connecting said valve member to a subjacent portion of the first tool-supporting tube and being suitably yieldable to allow upward force to be at times transmitted to the hammer member by said valve member, said subjacent portion and said tool-supporting tube being formed with fluid passages, means blanking said passages when the main casing is moved upwardly relative to the tool-supporting tubes, means establishing communication between said space beneath said annular valve member and said pressure fluid conduit through said passages when the main casing is moved downwardly relative to said tubes, the top portion of the main casing being provided with a vent passage and means to connect said pressure fluid conduit to a source of fluid under pressure, whereby said hammer is elevated by the pressure fluid acting upwardly on said valve member, disengaging the hammer from said valve member, allowing the hammer to subsequently drop and allowing the pressure fluid and the hammer to drive the second tool bit slidably relative to the first tool bit.

2. In a well drilling device, a vertical main casing, a bearing collar secured in the lower end of said main casing, a first tool-supporting tube extending slidable through said bearing collar, a first tool bit secured to said tool-supporting tube, a second tool bit and extending transversely thereto, being slidably vertically relative to said first tool bit, a second tool-supporting tube, an annular hammer secured on the top end of said second tool-supporting tube, a depending pressure fluid conduit secured axially in the top of said main casing and extending slidably through said hammer and into said second tool-supporting tube, an annular valve member secured tool-supporting said second tool bit and being suitably resiliently adapted to engage said hammer and being sealingly engageable with the hammer, means sealing the annular valve member with respect to the main casing to define a substantially fluid-tight space beneath the valve member, spring means connecting said valve member to a subjacent portion of the first tool-supporting tube and being suitably yieldable to allow upward force to be at times transmitted to the hammer member by said valve member, said subjacent portion and said tool-supporting tube being formed with fluid passages, means blanking said passages when the main casing is moved upwardly relative to the tool-supporting tubes, means establishing communication between said space beneath said annular valve member and said pressure fluid conduit through said passages when the main casing is moved downwardly relative to said tubes, the top portion of the main casing being provided with a vent passage and means to connect said pressure fluid conduit to a source of fluid under pressure, whereby said hammer is elevated by the pressure fluid acting upwardly on said valve member, disengaging the hammer from said valve member, allowing the hammer to subsequently drop and allowing the pressure fluid and the hammer to drive the second tool bit slidably relative to the first tool bit.
ing, a first tool-supporting tube extending slidably through said bearing collar, a first tool bit secured to said tube, said first tool bit comprising a pair of diametrically opposed blade mebers formed with a vertical guide slot therebetween, a second tool bit slidably engaged with said first tool bit and extending transversely thereto in said guide slot, being slidable vertically relative to said first tool bit, a second tool-supporting tube secured to the top end of said second tool bit and extending slidably in said first tool-supporting tube, an annular hammer secured on the top end of said second tool-supporting tube, a depending pressure fluid conduit secured axially in the top of said main casing and extending slidably through said hammer and into said second tool-supporting tube, a valve guide sleeve secured to the top portion of said first tool-supporting tube and being slidably and sealingly disposed in the main casing, an annular valve member slidably and sealingly positioned in said valve guide sleeve and surrounding said second tool-supporting tube subjacent said hammer and being sealingly engageable with the hammer, whereby to define a substantially fluid-tight space beneath the valve member, a coiled biasing spring axially mounted in said guide sleeve and connecting said valve member to a subjacent portion of the first tool-supporting tube and being sufficiently yieldable to allow upward force to be at times transmitted to the hammer member by said valve member, said subjacent portion and said tool-supporting tube being formed with fluid passages, means blanking said passages when the main casing is moved upwardly relative to the tool-supporting tubes, means establishing communication between said space beneath said annular valve member and said pressure fluid conduit through said passages when the main casing is moved downwardly relative to said tubes, the top portion of the main casing being provided with a vent passage, and means to connect said pressure fluid conduit to a source of fluid under pressure, whereby said hammer is elevated by the pressure fluid acting upwardly on the valve member, disengaging the hammer from said valve member, allowing the hammer to subsequently drop and allowing the pressure fluid and the hammer to drive the second tool bit downwardly relative to the first tool bit.

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