

Jan. 5, 1943.

P. W. APPLEBY

2,307,658

WELL WASHING TOOL

Filed Oct. 13, 1941

3 Sheets-Sheet 1

Fig. 1

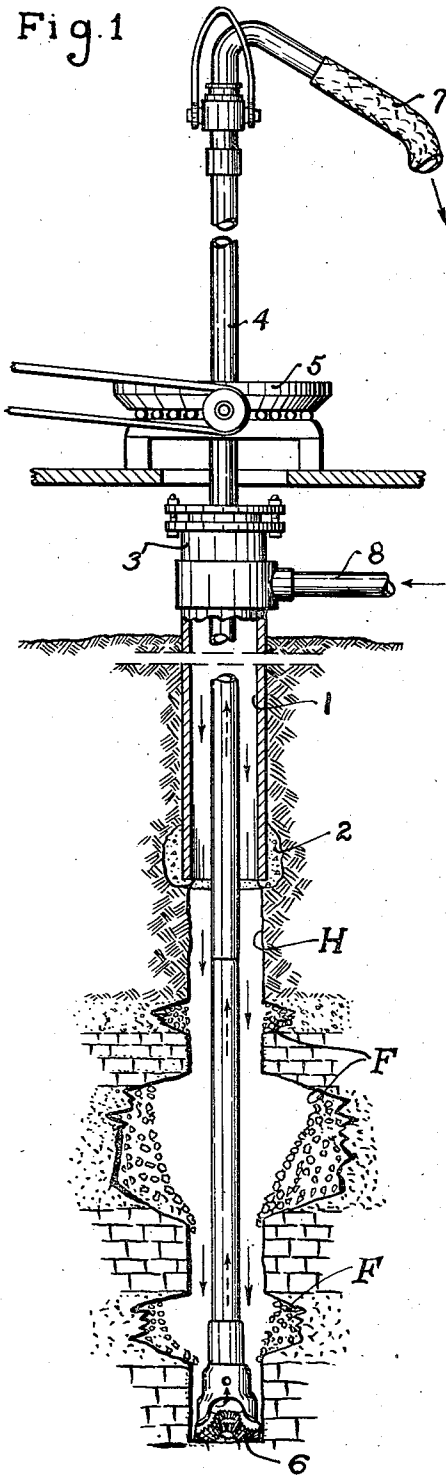
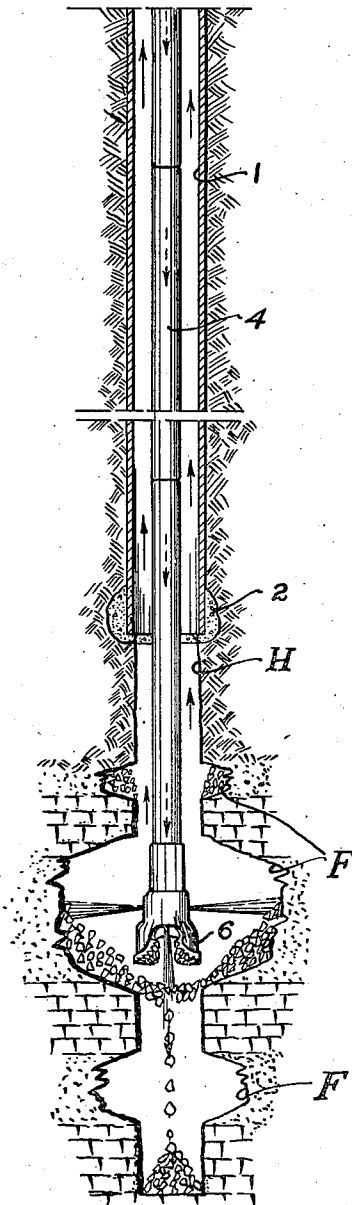


Fig. 2



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Fig. 3

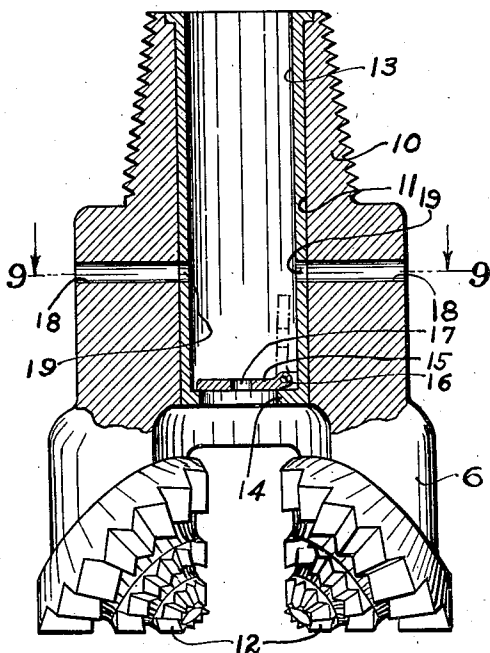


Fig. 5

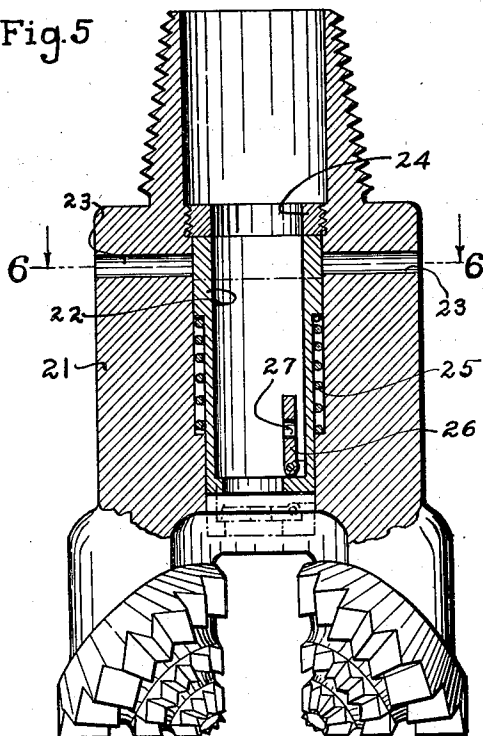


Fig. 4

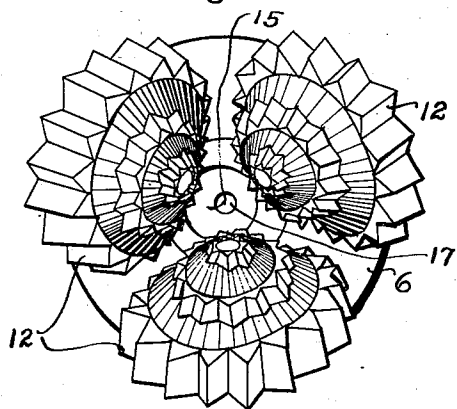
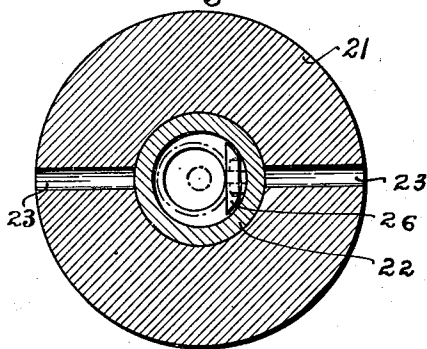


Fig. 6



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Fig. 7

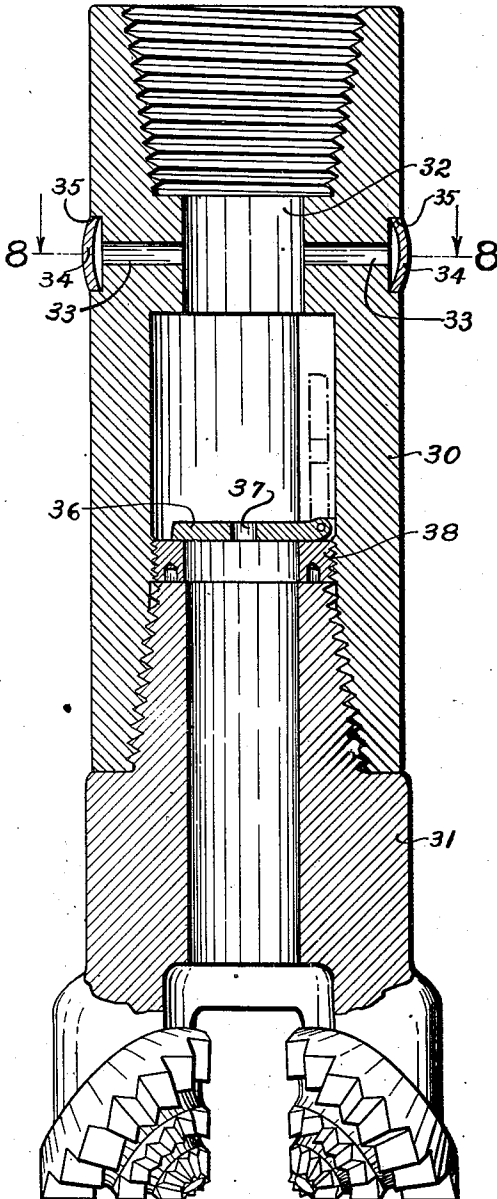


Fig. 8

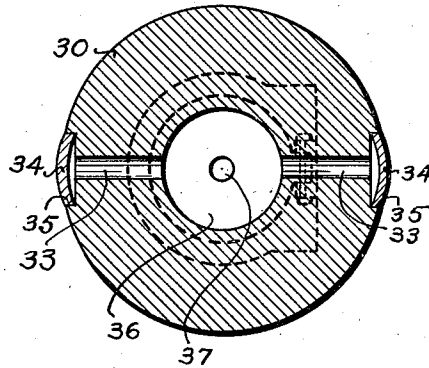
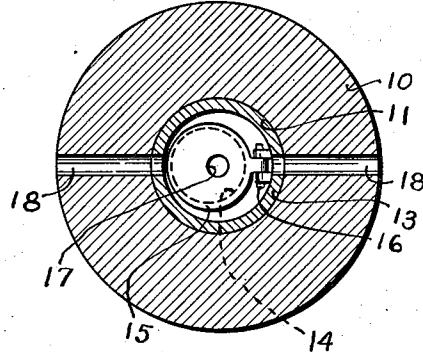


Fig. 9



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UNITED STATES PATENT OFFICE

2,307,658

WELL WASHING TOOL

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Application October 13, 1941, Serial No. 414,861

7 Claims. (Cl. 255—24)

This invention relates to an improvement in well washing tools, particularly of the character set forth in my prior patent on Well washing apparatus, No. 2,239,586, granted April 22, 1941.

In the use of well washing apparatus of the character shown in my prior patent, No. 2,239,586, jets of fluid are discharged against the walls of the bore hole, after first closing the downward passage through the tool, and when the tool is lowered in the hole to wash the sides thereof, the rock and debris frequently causes a bridging over in the hole beneath the bit, especially at the bottom of a fissure that may be formed in the bottom of the hole by an explosion therein. Heretofore, when such a bridge was encountered, it was necessary to reverse the circulation and discharge the material from beneath the bit upward through the drill stem by reverse circulation of the fluid. This resulted in loss of time, and when it happened frequently in a single well, considerable time would be thus wasted.

The object of this invention is to discharge a fluid jet downward through the bottom of the bit simultaneously with the lateral discharge of jets during the washing of the well. The lateral jets would accomplish the washing action on the walls while the axial jet directed down from the bit would keep the material therebelow broken up and separated to such an extent, that a bridge could not be formed beneath the bit, thereby causing the material washed from the side walls of the bore hole to settle to the bottom of the hole or in such position that it could be washed out readily when circulation is again reversed.

This object is accomplished, together with other resultant advantages, by providing means which will constrict, without closing, the axial opening through the drill stem, tool or bit, and thus form an axial jet when fluid is circulated downward through the drill stem in the normal direction, simultaneously with the discharge of the fluid through the radial ports in the form of lateral jets, which axial jet is discharged through the bottom of the bit with sufficient force and velocity as to break up and eliminate a tendency of the material to form a bridge beneath the bit. This constricting means may be provided by an orifice formed in a disc pivoted at one side of the drill stem passage, whereby the passage will be somewhat constricted at a point below the radial ports, causing the fluid to be discharged in an axial direction in the form of a jet. At the same time, pressure will build up sufficiently within the drill stem, so as to discharge the fluid in the form of radial jets to accomplish the washing action on the walls of the bore hole and in the fissures at the bottom of the well.

This constricting means may be provided either in a part of the drill bit or in a separate tool interposed between the drill bit and stem, and is illustrated in different embodiments in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view through a well and well casing, showing in side elevation a rotary drilling unit, having the invention applied thereto;

Fig. 2 is a similar view of the lower portion of the well, showing the invention used during the washing action;

Fig. 3 is a vertical sectional view, partly in elevation, showing the invention in one form applied to a drill bit;

Fig. 4 is a bottom plan view thereof;

Fig. 5 is a view similar to Fig. 3, showing a modified form of the tool portion of the bit;

Fig. 6 is a cross section therethrough, on the line 6—6 of Fig. 5;

Fig. 7 is a vertical sectional view through another form of tool separate from the bit, and embodying this invention;

Fig. 8 is a cross section therethrough on the line 8—8 of Fig. 7; and

Fig. 9 is a similar view on the line 9—9 of Fig. 3.

The invention is shown in Figs. 1 and 2 in connection with the bore hole H of a conventional oil well, or other deep well bored in the earth. The upper portion of this bore hole H is usually lined with a casing 1, which extends downward from the surface of the ground and has its lower end cemented at 2, while its upper end usually has a head 3 thereon surrounding the drill stem 4 and closing the space therebetween. The drill stem 4 is of the character conventionally used for drilling a well by rotary drilling apparatus, and comprises a string of pipe suspended in the well from above the usual rotary table 5 and passes therethrough in driving relation therewith. The drill stem 4 carries a drill bit 6 on the lower end thereof, which is shown as a rock bit having a plurality of rotary cutters mounted thereon.

During the normal drilling action with such rotary apparatus, a source of fluid under pressure is connected with the upper end section of the drill stem 4 through the usual hose pipe 7, and is forced downward through the drill stem discharging therefrom at the bit, and then flowing up through the casing 1 for discharge through a pipe 8 connected with the head 3. Provision is made usually for reversing the direction of circulation by connecting the source of fluid supply alternately with the pipe 8, so that the fluid is forced down through the casing and discharged through the drill bit and stem as shown by the arrows in Fig. 1, the discharge being through the

hose pipe 7. This is the reverse circulation which is used to wash out the cuttings from the bottom of the well during the drilling operation.

In the course of drilling the well, it is frequently necessary to discharge nitroglycerine or other explosive in the bottom thereof, for the purpose of loosening up the rock, and this often causes the formation of deep fissures, such as are designated at F, especially in the soft rock formations, where the rock may be broken up but would not be removed therefrom by the usual reverse circulation system of cleaning out. The drill bit is permitted to pass down through the accumulated material, such as crumbled rock, lodged in these fissures, without its being cleaned out by the normal reverse circulation.

To remove the accumulated material that may lodge on the surrounding wall of the bore hole or in the fissures thereof, the present invention utilizes a tool, either as a part of the drill bit or separately, that will produce a lateral washing action thereon, together with an axial jet to keep the space open beneath the bit. This tool is shown in Fig. 3 as a part of the drill bit 6 being formed by the body 10 of the drill bit. The body 10 has an enlarged axial bore 11 extending therethrough, with an open lower end above the cutters 12. The bore 11 slidably receives a removable sleeve 13 which extends therethrough. The lower end of the sleeve 13 is provided with a surrounding shoulder 14. A disc 15 is pivotally mounted at 16 on the shoulder 14 at one side of the axial opening through the sleeve 13, and is of a size to extend over the shoulder 14 substantially from side to side of said axial opening, but the disc 15 is formed with an orifice 17 therein, approximately axially thereof in position to discharge a jet of fluid downward through the space between the cutters, beneath the drill bit. The disc 15 is pivoted for swinging movement from its full line to its dotted line position in Fig. 3 by the upward circulation of the fluid through the tool and turning down again to its constricting position upon downward circulation of the fluid through the drill stem. The body 10 of the tool is provided with radial ports 18 therein at a point above the constricting disc 15 which ports are open to the axial passageway through the tool, having registering orifices 19 in the sleeve 13.

During cleaning out of a well, after the discharge therein of an explosive or otherwise, the customary practice is to reverse the circulation, as indicated by the arrows in Fig. 1, while drilling down through the accumulated material in the bottom of the well. This causes the broken up or loosened rock to be carried out through the drill stem and discharged with the fluid from the circulating system. During this manner of operation, the constricting disc 15 will be held in its dotted line position by the circulation of the fluid thereby.

When it is desired to wash the well so as to loosen the accumulation of debris, rock, and the like, from the side walls of the bore hole and from the fissures F, the circulation is restored to normal direction down through the drill stem and out through the casing as shown by the arrows in Fig. 2. This normal circulation of the fluid causes the disc 15 to turn down to its constricting position if it has not already assumed that position upon the withdrawal of pressure when the reverse circulation was stopped. This so constricts the passageway through the body so as to discharge the fluid from the bottom thereof, be-

low the drill bit, and due to the constricting of the axial passageway, pressure will be built up within the sleeve 13 sufficient to discharge the fluid laterally through the ports 18 in the form of radial jets which are thus directed against the sides of the bore hole and into the fissures, to wash down and remove the accumulated material, debris and rock therein.

The tool is moved upward as the washing action progresses, from the position shown in Fig. 1 to that shown in Fig. 2, so that the loosened debris and rock washed from the sides of the bore hole and from the fissures F is caused to settle in the bottom of the hole, which settling is facilitated by the axial jet produced by the constricting means. This axial jet also prevents the bridging over of the rock and debris from opposite sides of the fissures due to its lodging therein as washed out by the lateral jets.

The cones 12 of the drill bit should be spaced sufficiently far apart, or drilled out at the center so as to provide an enlarged opening therein as shown in Figs. 3 and 4 for the discharge of the jet through the bottom of the bit.

Thus the wash tool may be operated much more efficiently than heretofore without the axial jet, due to the elimination of the necessity for boring out formed bridges in the hole, resulting in a material saving of time in accomplishing the cleaning-out operation.

At the same time by providing open ports 18, as shown in Fig. 3, sufficient liquid will be admitted directly therethrough when operating the apparatus in reverse circulation, as shown in Fig. 1, to dilute the mud and cavings inside the drill pipe and tool, thereby preventing it from becoming plugged.

The removability of the sleeve 13 with the constricting means for forming the axial jet, permits this to be transferred from one bit to another, when desired, or when a bit is to be sharpened or becomes too worn for use.

In the form shown in Fig. 5, the body 21 of the tool which is shown as integral with the drill bit carrying the cutters, has a sleeve 22 slidably mounted therein lengthwise of the body 21 in position to cover ports 23 formed in the periphery of the body. One end of the sleeve 22, is confined by a retaining ring 24, against which the sleeve is pressed by a coil spring 25 surrounding the sleeve 22. The lower end of the sleeve 22 extends through the central opening in the body 21 and carries a constricting disc 26 pivotally mounted therein with an opening or port 27 therein in position to discharge a fluid jet at the bottom of the bit.

In the use of this tool during reverse circulation, the sleeve 22 covers the port 23, and the force of the fluid passing up through the body 21 tends to hold the constricting disc 26 in its raised position. However, when the fluid is directed downward through the drill stem for washing action the disc is turned to its constricting position as shown in full lines in Fig. 5, and the force of the fluid, as pressure is built up by the constricting means, will move the sleeve 22 downward to its dotted line position, uncovering the ports 23 and causing radial discharge of the fluid from the tool. The radial jets thus formed at the ports 23 accomplish the washing action as described above while the axial jet formed by the port 27 causes the washed down debris and rock to pass to the bottom of the hole, and prevents the formation of bridges beneath the bit, as described above.

It will be evident from Figs. 3 and 5 that the discharge ends of the ports 18 and 23, respectively, will be located in close proximity to the surrounding wall of the bore hole. This increases the force applied to the debris thereon, aiding in the washing effect obtained by the radial jets.

In the form shown in Figs. 7 and 8, the tool body is shown at 30 separate from the drill bit 31 and adapted to be coupled between the drill bit and the drill stem substantially in the manner of a drill collar. The body 30 has an axial opening 32 therethrough for the circulation of the fluid to and from the drill bit. Radial ports 33 extend laterally from the axial passage 32. These ports 33 are initially closed by frangible plugs 34 fitted in seats 35 at the outer ends of the ports. The plugs 34 are applied over the ports when the tool is to be inserted in the hole to prevent the plugging of the ports by dirt or debris, after which these plugs are readily removed by the force of the outward circulation of the fluid discharged through the ports.

The body 30 is provided with constricting means in the form of a disc 36 having a central port 37 therein, at a point beneath the lateral ports 33, so as to build up pressure sufficient for discharge through the radial ports 33 and also to discharge a jet of fluid downward through the drill bit. The constricting disc 36 is pivotally supported by a ring 38 screwed into the lower end of the axial passage 32 through the body 30. This tool is used in a manner similar to that described above.

By providing a constricted orifice at the lower end of the axial passage in the tool without complete closing thereof, provision is made for draining the fluid from the drill stem when the washing operation is completed. This permits the drill stem to be removed readily at the completion of the washing operation without the necessity for lifting the entire column of fluid and also without especially opening the drill stem for the discharge thereof.

This invention which directs a sufficient amount of fluid through the bit during the washing operation as well as laterally of the wash tool, not only prevents the formation of a bridge under the tool, but it washes down the bridge-forming material to the bottom of the hole. This permits the accumulated material and debris to be removed effectively from the bore hole, by reverse circulation. It makes possible the removal of a greater quantity of cavings from the wall of the well than would be possible if bridges were allowed to form at intervals under the bit as the latter is drawn up during the washing operation. It has been found that this invention reduces the time required for cleaning out a well by as much as twenty to twenty-five per cent. This is because the formation of a bridge under the bit of only six inches in thickness, prevents the washing of more than a twenty foot section of shot hole, before it is necessary to reverse the circulation and clean out this bridge. The bit and drill pipe could not be lowered back into the bottom of the shot hole until after the removal of the bridge, but by circulating the fluid downward through the bit, simultaneously with the lateral discharge, bridges can be prevented and the washing operation materially expedited.

I claim:

1. A well washing tool comprising a body hav-

ing a central opening therethrough and adapted for connection with the lower end portion of a string of pipe, and means mounted in the body in position for movement relative to the central opening for constricting said opening and causing discharge from the body in a jet lengthwise of the body.

2. A well washing tool comprising a body having a central opening therethrough and adapted for connection with the lower end portion of a string of pipe, said body having a lateral opening in position for communication with said central opening, and means mounted in the body in position for movement to a constricting position in the central opening below the lateral opening in response to downward fluid flow through said central opening and perforated for jet discharge of the fluid longitudinally of the central opening and for directing fluid through the lateral opening.

3. A well washing tool comprising a body having an axial opening therethrough and adapted for connection with a string of pipe, said body having a lateral opening in position for communication with said axial opening, and a constricting disc mounted in the body at one side of the axial opening below the lateral opening in position for movement to a constricting position in said axial opening in response to downward flow of washing fluid therethrough, said disc having a port therein communicating with the axial opening in said constricting position and directing a fluid jet discharge therefrom.

4. A well washing tool comprising a body having an axial opening therethrough and adapted for connection with a string of pipe, said body having a lateral opening in position for communication with said axial opening, and means for closing the outer end portion of the lateral opening and constructed for opening said lateral opening by pressure from within the axial opening.

5. A well washing tool comprising a body having an axial opening therethrough and adapted for connection with a string of pipe, said body having a lateral opening in position for communication with said axial opening, and a plug sealing the outer end of said lateral opening and so constructed and arranged for discharge therefrom by pressure from within the axial opening.

6. In well washing apparatus, the combination of a string of pipe having drilling means connected therewith, means for circulating fluid in opposite directions through said string of pipe, a body connected in said string of pipe and having a lateral discharge port therein, and means mounted in the body below said port for movement in response to downward fluid flow to a constricting position therein causing fluid discharge through the lateral port and said movable means being perforated for directing a fluid jet through the drilling means.

7. In well washing apparatus, the combination of a string of pipe having drilling means connected therewith, means for circulating fluid in opposite directions through said string of pipe, a body connected in said string of pipe and having a lateral discharge port therein, and a perforated disc pivotally mounted in the body in position for movement to a constricting position below the lateral port.

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