

April 5, 1960

D. J. GRADY

2,931,630

DRILL BIT

Filed Dec. 30, 1957

2 Sheets-Sheet 1

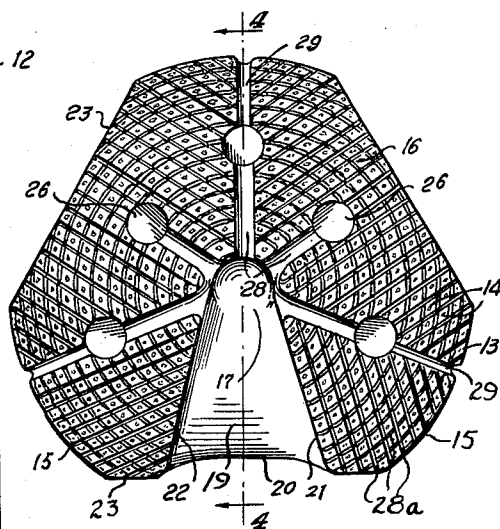
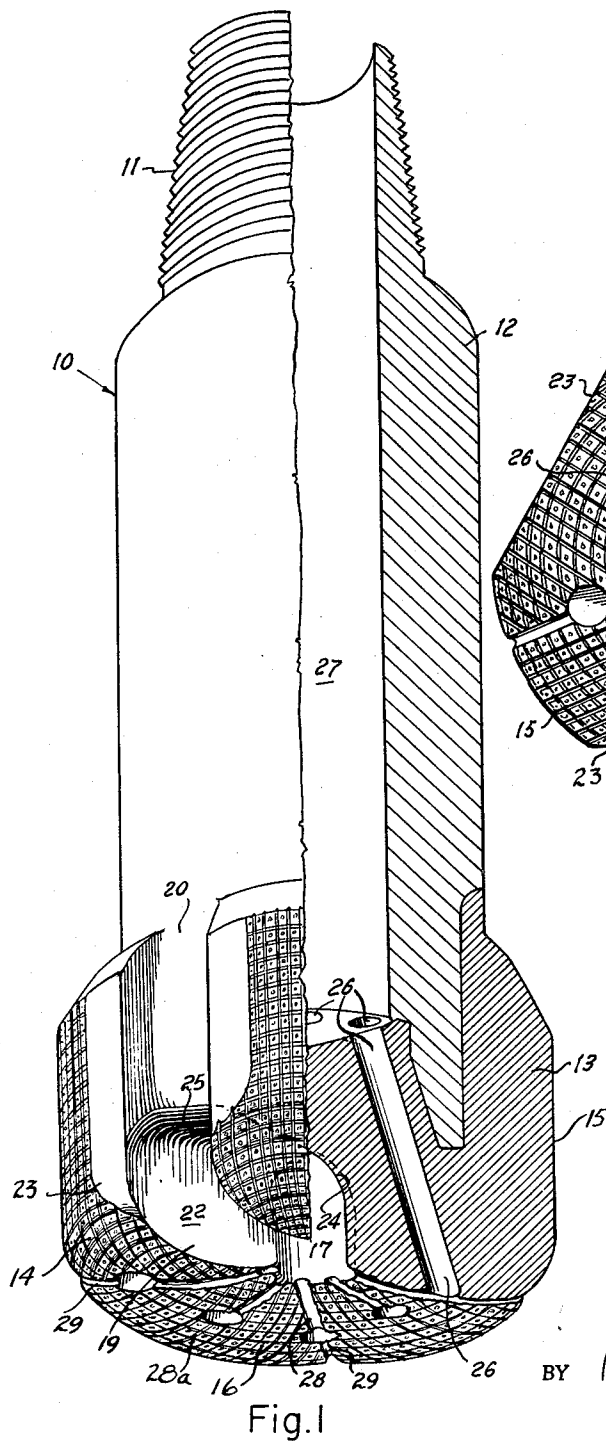


Fig. 2

BY

INVENTOR
Daniel J. Grady
*Browning, Simms, Hoyer
& Eichenrodt*

ATTORNEYS

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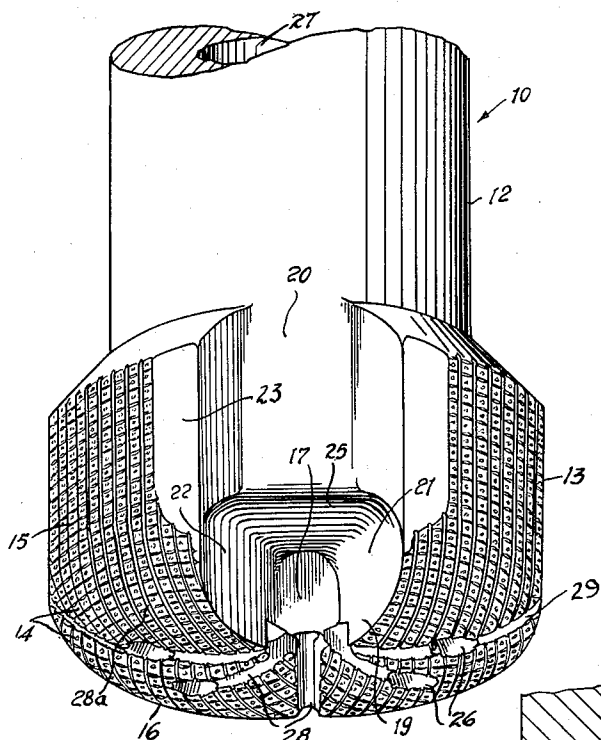


Fig. 3

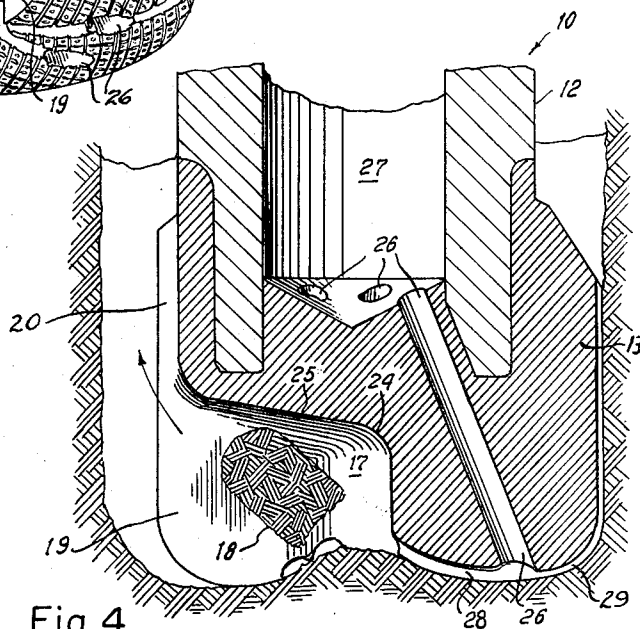


Fig. 4

INVENTOR

Daniel J. Grady

BY *Browning, Simms, Hyer*
+ *Eickhardt*

ATTORNEYS

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DRILL BIT

Daniel J. Grady, Shreveport, La., assignor to Hycalog, Inc., Shreveport, La., a corporation of Delaware

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10 Claims. (Cl. 255—61)

This invention relates to a drill bit of the type having diamonds or the like fixed thereto for cutting or abrading away an earthen formation. In one of its aspects, it relates to a bit of this type having an improved arrangement for removing formation at the center of the bore hole.

One of the principal problems encountered in the design of a diamond drill bit is the provision of an efficient cutting arrangement at the center of the bore hole. The diamonds positioned at or adjacent to the gage cutting surfaces of the bit travel at a relatively high lineal speed and hence their cutting action is relatively rapid. However, as the center of the bit is approached, the diamonds travel at slower and slower lineal speeds so that the cutting efficiency at, or close to, the center of rotation is considerably less than that at the periphery of the bit. Accordingly, the cutting efficiency at the center frequently establishes the penetration rate for the bit.

Several different approaches have been made in an attempt to increase the center drilling efficiency of this type of bit. One approach has been to increase the effective area of the cutting surface of the bit at its center by extending or recessing the center surface into conical shapes. The conical recess is more generally used because it is easier to flush drilling fluid over the surface of a recess from a central passageway in the bit. However, the use of such recesses has generated another problem. Thus, the cone of formation material in the recess frequently breaks off or fractures horizontally leaving a loose conical piece of formation in the cone recess. The broken off piece of formation turns or spins with the bit rather than being ground into pieces by the diamond cutting elements in the recess. This greatly reduces the penetration rate because the broken off piece of formation must be slowly worn away by the formation under it, or crushed by the bottom hole weight on the bit or released by raising the bit from the bottom of the hole. In formations where such fractures are common, it can be seen that the provision of the conical recess may reduce the efficiency of the bit rather than increase it.

A principal object of this invention is to provide a diamond type bit which in use deliberately forms a central core from the formation and then breaks off this core and flushes the same from the bit. Thus, the center of the hole being drilled is not actually cut away but rather is removed as a series of deliberately formed cores so that the penetration rate of the bit does not depend upon the efficiency of cutting at its central axis.

Another object is to provide such a bit wherein the pressure of the drilling mud or fluid is utilized to break off, or aid in breaking off, the central core of the formation after which such fluid flushes the broken off core from the bit.

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Another object is to provide such a bit with a flushing fluid arrangement wherein a major portion of the fluid tends to flow into the core receiving recess, but, as the core begins to form, it creates an obstruction in the path of the fluid causing a larger amount thereof to flush across the cutting face of the bit. When the core is broken off, this obstruction to flow is removed and a large volume of fluid flows into the recess so as to flush the core from the bit.

Another object is to provide a bit in which a central deliberately formed core is periodically broken off and flushed from the bit by drilling fluid and yet the entire bottom of the hole is subjected to a clean sweep of fluid with each revolution of the bit.

Other objects, advantages and features of this invention will be apparent to one skilled in the art upon consideration of the specification, claims and attached drawings, wherein:

Fig. 1 is an illustration, in perspective and partially in vertical section, of a drill bit constructed in accordance with the present invention;

Fig. 2 is a view of the lower end of the bit of Fig. 1;

Fig. 3 is an elevational view, in perspective, of the side of the bit viewed toward the groove or side door through which the broken-off cores are removed from the bit; and

Fig. 4 is a vertical section of the lower end of the bit taken on the line 4—4 of Fig. 2.

In accordance with this invention, a diamond bit is provided with a coaxial recess extending upwardly from its lower cutting surface or end so that as the drilling proceeds, a core will be formed in this recess. The bit is also provided with a passageway or groove extending from the recess so that as the core is broken off in the recess, it is flushed by the drilling fluid through the groove or passageway to the exterior of the bit and need not be ground into fine pieces as in a conventional bit. Since the central core is not cut away by the diamond cutting elements, the rate of penetration of the bit is made essentially independent of the efficiency of cutting at the center of the bit.

In accordance with another aspect of the invention, drilling fluid passageways and water courses are so arranged on the cutting face of the bit that upon breaking off a core, a relatively large amount of the fluid can flow into the core receiving recess to flush the broken-off core therefrom and yet while a successive core is being formed, only a small amount of fluid flows into the recess. Thus, water courses are arranged to extend across the face of the bit from inlet ports thereto to the recess. These courses supply fluid to flush out the broken-off cores and also cause a hydraulic pressure on the cores aiding in breaking them off. At least some of the courses can also extend outwardly from the inlet ports to the bit's periphery. The outwardly extending courses are made of smaller flow capacity than the inwardly extending courses. Accordingly, a major part of the fluid tends to flow toward the recess. However, as the core forms in the recess, it limits or obstructs flow through the courses into the recess so that more of the fluid is forced to flow outwardly through the smaller water courses and also to be distributed laterally of all of the courses across the entire face of the bit.

Referring now to Fig. 1, there is illustrated a preferred form of the diamond drill bit. It includes a bit body 10 having a connector, such as threaded pin 11, at its

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upper end for securing the bit to the lower end of a suitable drill string. The bit body comprises a stock or blank 12 and a lower matrix portion 13 fixed to the stock. Imbedded in the matrix are a plurality of diamonds 14 arranged to present cutting edges to the formation as the bit is rotated.

While the bit body as thus far described can be made in any desired manner, one preferred manner is to machine a graphite mold or, alternatively, to machine a metal die pattern which is then used to press a bit pattern in a graphite mold. Diamonds are then carefully set in the graphite mold and powdered metal is loaded into the mold. The metal blank or stock is then landed in the powdered metal and the entire assembly heated, sintered and bonded to form a unitary structure of the blank or stock, matrix and diamonds.

However constructed, the diamond bit will usually have a plurality of diamonds distributed about its periphery or gauge cutting portion 15 to cut gauge. Another portion of the diamonds is distributed on the lower face or endwise cutting portion of the bit, as at 16, to cut the bottom of the hole.

Extending upwardly from the lower face 16 of the bit and coaxial with the bit body is a core-receiving recess 17. As illustrated, the cutting diamonds are disposed on the bit body about this recess so that they cut an annular portion of the bore hole and permit a core 18 (shown broken off in Fig. 4) to form in recess 17. This core is periodically broken off, as illustrated in Fig. 4, and removed as such from the bit. For removal of the core, a passageway is provided extending from the recess 17 to the exterior of and above the bit. This passageway must, of course, be located within the regular contour developed by rotation of the endwise and gauge cutting portions so that the core may move therethrough to a point above the bit while the bit is in a hole which it has drilled. As illustrated, this passageway comprises a groove 19 extending substantially radially across the lower face of the bit from recess 17 to the periphery of the bit. As here shown, groove 19 has an upward extension 20 which extends above the gauge cutting surface so that the broken-off cores can move upwardly from groove 19 into the drill string-bore hole annulus above the bit from whence they can be carried by the drilling fluid to the surface of the earth.

To permit core removal, groove 19 has throughout its length a vertical cross-section or depth of a size at least as large as the horizontal cross-section of recess 17 and preferably such groove cross-section will be at least as large as the vertical cross-section of the recess. Preferably, the side walls 21 and 22 of groove 19 diverge outwardly from recess 17 to reduce the likelihood of the broken-off core becoming wedged in the groove.

As shown, groove 19 can be in register with one of flattened portions 23 so that extension 20 need not be as deep as groove 19. The only requirement is that it be deep enough to accommodate a core between the side wall of a hole cut by the bit and the bottom of the groove extension 20. Any cores tending to jam in the groove extension will contact the sides of the bore hole and be loosened so that they can be flushed upwardly.

Means are provided for periodically breaking off the core formed in recess 17. In the illustrated bit, such means can comprise a mechanical means or a hydraulic means or both exposed to the interior of the recess, capable of exerting a lateral force on the core. Thus, the upper end of the recess is curved, and preferably is arcuate as at 24, and constitutes such mechanical means so that as the core reaches and is engaged by such surface, it will be deflected laterally and broken off thereby as illustrated in Fig. 4. It will be noted that the upper wall 25 of groove 19 merges smoothly with surface 24 and preferably slopes upwardly and outwardly to provide a maximum clearance for removal of the core.

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Similarly, it is preferred that side walls 21 and 22 merge smoothly with the side walls of recess 17 and in a manner such that the juncture of these side walls with recess 17 occurs at a vertical diametral plane of the recess.

The lower end of the bit body is provided with a plurality of fluid ports or passageways 26 extending from a central bore 27 in the bit body. These ports 26 terminate at the lower end of the bit at points laterally spaced from recess 17 as is best shown in Fig. 2. At least some of the ports have water courses 28 in the form of channels or grooves extending inwardly therefrom to recess 17. At least some of these water courses terminate in the recess at points circumferentially spaced from the juncture of the groove 19 and the recess 17. In this manner, fluid flowing through these water courses tends to exert a hydraulic pressure laterally on the core to break it off or to aid in doing so. Thus these ports 26, bore 27 and water courses 28 constitute a hydraulic means for breaking off the core. It will be noted that water courses 28 terminate and join recess 17 at its lower end. Accordingly, as core 18 begins to form in the recess, it tends to obstruct flow from courses 28 and such flow is therefore forced to be distributed over the lower end of the bit and across the bottom of the bore hole. Such distribution can be aided by scores 28a indicated schematically in the various views.

At least some of ports 26 also communicate with the periphery of the bit by additional water courses 29 which extend outwardly from the ports and thence upwardly along the side of the bit. Courses 29 are made smaller in cross-section (i.e. flow capacity) than courses 28 so that the major part of the fluid tends to flow inwardly toward recess 17. This causes considerable hydraulic pressure to be exerted on the core and to rapidly flush it from the bit after it has broken off. On the other hand, while the core is still in place, flow into the recess is restricted and a large portion of the fluid flows across the face of the bit and also out through water courses 29 for distribution over the outer portion of the bottom and also over the gauge cutting surfaces of the bit.

While only one course 28 is aligned with groove 19 to exert the full force of fluid pressure against the core therein in the direction of groove 19, the force of the fluid from all of the courses coming into the recess sums to a large component in the direction to break off the core. The strength of the formation may be so low that the pressure of the drilling fluid will break the core before it contacts surface 24. However, regardless of what force is required to break off the core, the drilling fluid flushes it out of the bit.

It will be noted that the ports 26 can be spaced different distances from the center of the bit. As here illustrated, three of the ports are shown on one circle and two on another. This distribution of ports avoids a reduction of the number of cutting elements which would result if all the ports were on a single circle.

While reference has been made herein to "diamond" cutting elements, other hard cutting elements can be used. However, diamonds, due to their long life, are preferred. It will also be understood that the diamonds can be arranged in various patterns over the face of the bit and its gauge cutting surfaces. Further, the lower end and gauge cutting surfaces of the bit can take varied shapes and forms as long as the function of making an annular cut in the bore hole about recess 17 is retained.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims.

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As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A drill bit comprising a bit body having a bit head with an endwise cutting portion and a lateral gauge cutting portion, a substantially cylindrical recess extending upwardly into the lower end of the body to a point above said endwise cutting portion and disposed coaxially therewith to receive a core remaining at the center of the hole being drilled, a core passageway in the surface of the bit body extending from said recess to a point exteriorly of and above the bit head and having a cross-sectional dimension throughout its length at least as great as the horizontal cross-section of said recess so that a core formed in said recess and then broken off can pass through said passageway to a point above the bit, and means exposed to the interior of said recess above its lower end for applying a lateral force to an upstanding core in said recess to brake the same off.

2. A drill bit comprising a bit body having a bit head with an endwise cutting portion and a lateral gauge cutting portion, a recess having substantially non-converging walls extending upwardly into the lower end of the body to a point above said endwise cutting portion, said recess being disposed coaxially with said bit body to receive a core remaining at the center of the hole being drilled, a core passageway extending from said recess to a point exteriorly of and above the bit body and including a groove in the surface of the bit body extending laterally from said recess to a point exteriorly of the bit body above the gauge cutting surfaces thereof and having a transverse cross-sectional dimension throughout its length at least as great as the depth of said recess so that a core formed in said recess and then broken off can pass through said groove to a point above the bit, and means carried by the bit body and exposed to the interior of said recess for applying a lateral force to an upstanding core in said recess to break the same off and for flushing such broken off core laterally through the groove and then upwards from the bit.

3. A drill bit comprising a bit body having an endwise cutting portion and a lateral gauge cutting portion, a recess having substantially non-converging walls extending upwardly into the lower end of the bit body to a point above said endwise cutting portion to receive a core remaining at the center of the hole being drilled, said recess having a surface adjacent its upper end arranged to engage a core as it enters said recess in an axial direction and apply a lateral force to the core to deflect and break the same off, a core passageway in the surface of said endwise and gauge cutting portions of the bit body and extending laterally from said recess to the exterior of the bit body above the gauge cutting portion thereof and having a transverse cross-section throughout its length at least as large as that of said recess so that the core formed in the recess and broken off therein can pass through said passageway to the exterior of and above the bit, and means for supplying flushing fluid to said recess at a point spaced from the juncture of the passageway and recess.

4. A drill bit comprising a bit body having an endwise cutting portion and a lateral gauge cutting portion, a recess disposed coaxially with the bit body a groove extending from the top of said gauge cutting portion downwardly along the body and thence across its lower end and terminating in said recess, said recess having substantially non-converging walls extending upwardly into the bit body from its lower end so that a core can be formed in the recess by operation of the drill, the transverse cross section of the groove at all points outwardly of the recess taken with the space overlying the groove within the regular contour developed by the rotation of said endwise and gauge cutting portions being at least as

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large as the vertical cross-section of the recess so that a core formed in said recess may be flushed therethrough, and said bit body having a fluid passageway extending therethrough from its upper end and opening into said recess at a point spaced from the juncture of the groove and recess whereby flushing fluid can be directed against a core in the recess to move it through the groove.

5. A drill bit comprising a bit body having an endwise cutting portion and a lateral gauge cutting portion, a substantially cylindrical recess extending upwardly into the body from the lower end thereof to a point above said endwise cutting portion and disposed coaxially with the bit body, said recess terminating at its upper end in an inclined deflecting surface positioned to impinge against and break off a core formed in the recess, a groove across the lower end of the bit extending from the recess to the periphery thereof and thence upwardly, said groove having a depth throughout its length at least as great as the effective transverse dimension of the recess and having outwardly diverging side walls in its portion extending across the lower end of the bit body so that a core emerging from the recess is prevented from jamming in the groove, cutting elements mounted on the endwise cutting portion of the body to make an annular cut in the formation, and means for supplying drilling fluid to said recess.

6. A drill bit comprising a bit body having an endwise cutting portion and a lateral gauge cutting portion, a recess having substantially non-converging walls, extending coaxially of and upwardly into the bit body from the lower end thereof and terminating therein for receiving a core remaining at the center of the hole being drilled, a core passageway extending from said recess to the exterior of and above the bit and having a transverse cross-sectional dimension throughout its length at least as great as that of the recess so that a core formed in the recess can be flushed through the core passageway, said bit body having a fluid passageway extending from the upper end of the bit into said recess at the lower end thereof and at a point spaced from the juncture of the recess and passageway whereby a core being formed in said recess tends to limit flow through said fluid passageway until the core is broken off whereupon resulting increased flow into the fluid passageway flushes the broken-off core through the core passageway.

7. A drill bit comprising a body having a bit head with a lower end drilling face, a coaxial vertically extending substantially cylindrical core receiving recess extending upwardly into said body from its lower end, a core passageway in the surface of the bit body extending from said recess to the exterior of and above the bit head and having a transverse cross-section at least as large as that of said recess so that a core broken off in said recess can be flushed through the passageway to the exterior of the bit, said bit head having a drilling fluid supply port opening through said face at a position spaced laterally from said recess and also having a channel-like water course extending from said port across the lower end face of the bit head to said recess and terminating therein at a point circumferentially spaced from the juncture of the recess and passageway so that a core in said recess tends to limit flow of fluid from said water course into the recess to increase the hydraulic pressure applied to one side of a core in said recess.

8. The bit of claim 6 wherein said passageway comprises a port extending from the upper end of the bit and terminating at the lower end of the bit at a point laterally spaced from the recess and a channel-like water course in the lower end of the bit extending from the port to the lower end of the recess.

9. The bit of claim 8 wherein a second channel-like water course extends across the lower end of the bit from the port to the periphery of the bit, the second water course being of smaller cross section than that of the first-mentioned water course so that the major portion

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of the fluid tends to flow to said recess until limited by a core therein.

10. The bit of claim 7 wherein a second channel-like water course extends from said port across the end face of the bit outwardly to the bit's periphery, the second water course being of a smaller cross-section than the first-mentioned water course so that a major portion of the fluid from said port tends to flow to said recess until restricted by a core in the latter.

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References Cited in the file of this patent

UNITED STATES PATENTS

2,371,490	Williams	Mar. 13, 1945
2,493,178	Williams	Jan. 3, 1950
2,628,073	Kless	Feb. 10, 1953

FOREIGN PATENTS

131,386	Australia	Feb. 14, 1949
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