April 21, 1964 J. C. HASPERT 3,129,777

REPLACEABLE NOZZLE HAVING COMPLETELY SHROUDED RETAINER

Filed Aug. 7, 1962 4 Sheets-Sheet 1

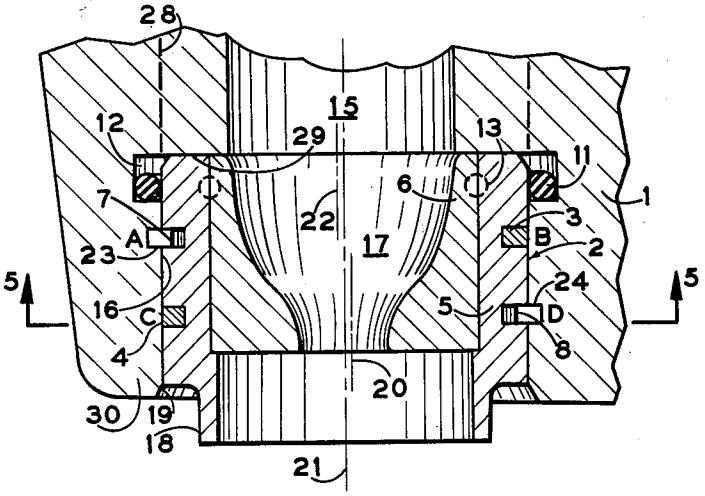


FIGURE 3

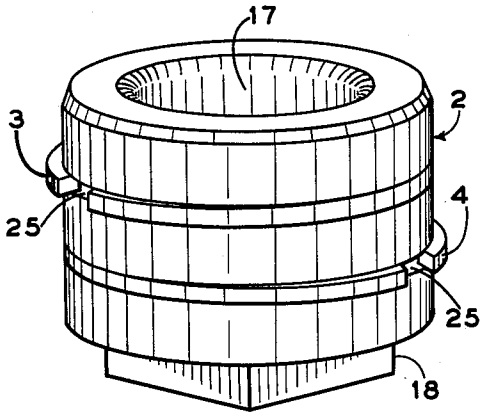


FIGURE 2

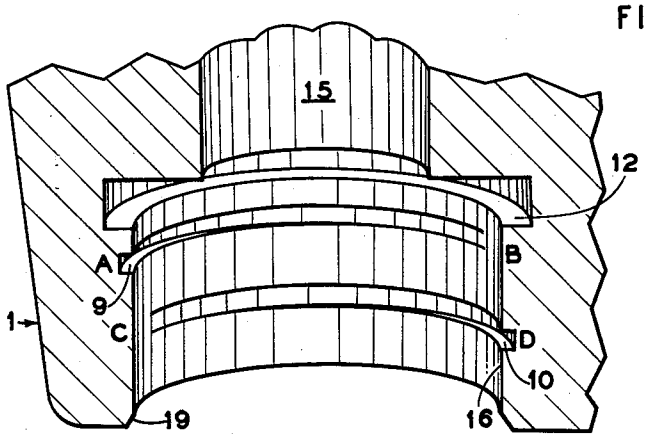


FIGURE 1

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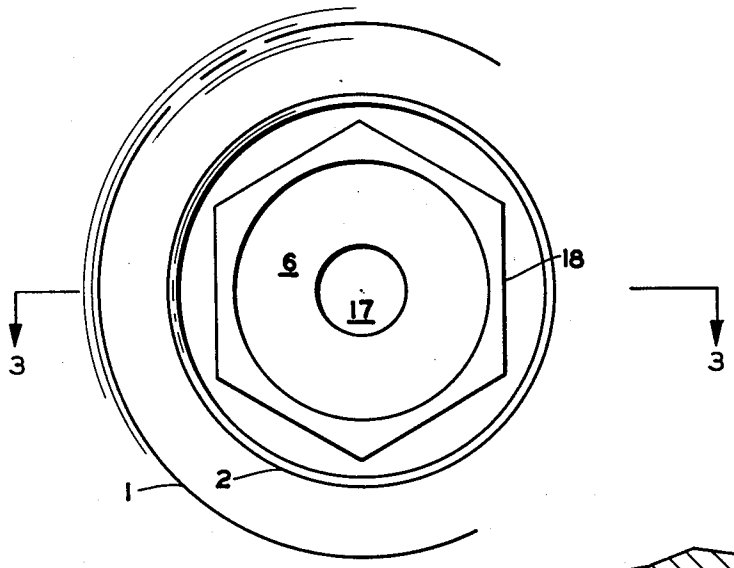


FIGURE 4

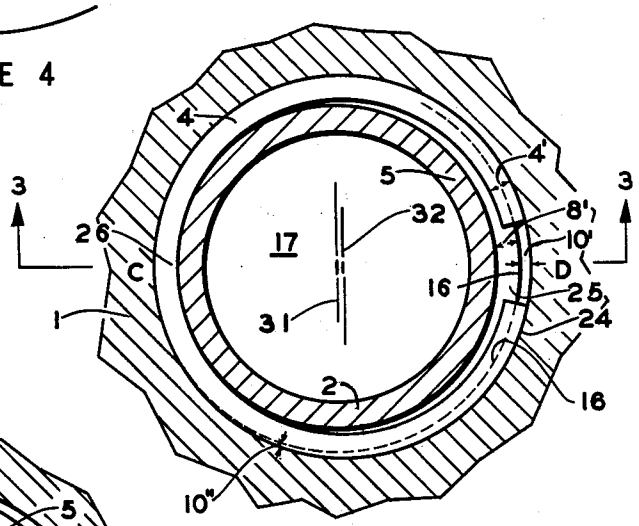


FIGURE 5

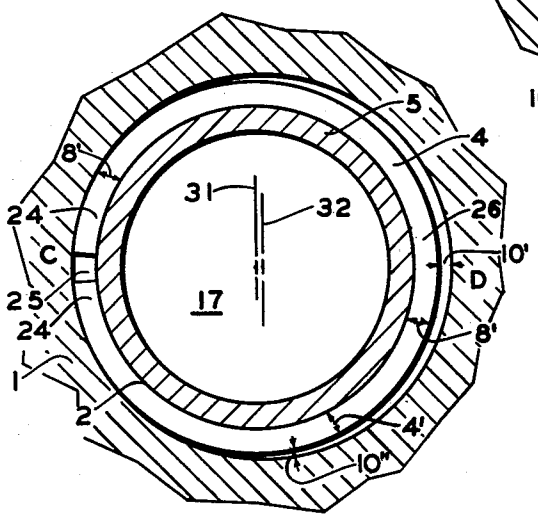


FIGURE 6

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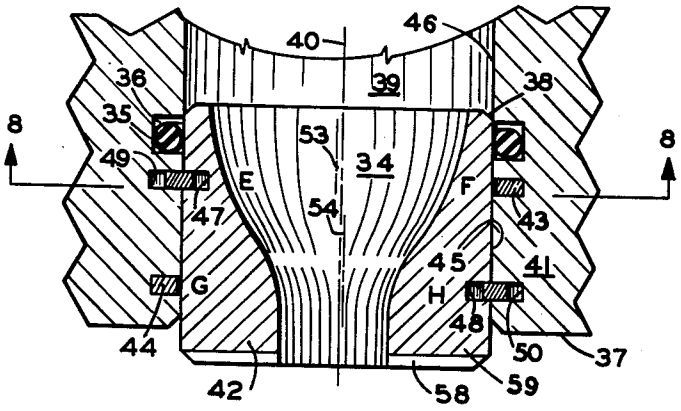


FIGURE 7

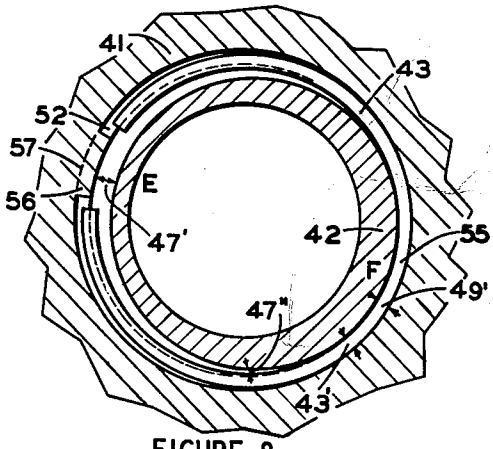


FIGURE 8

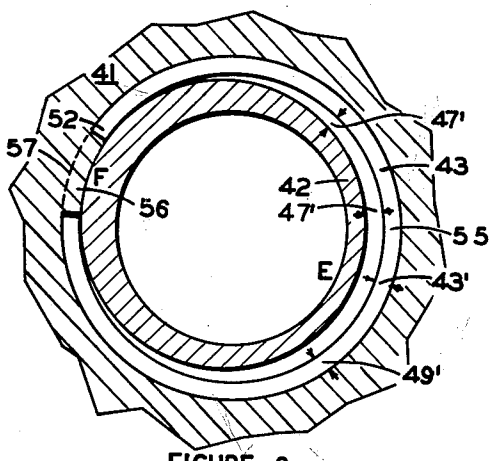


FIGURE 9

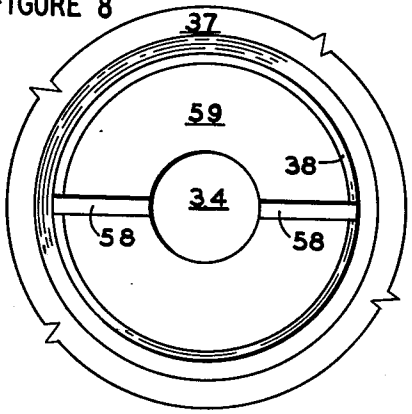


FIGURE 10

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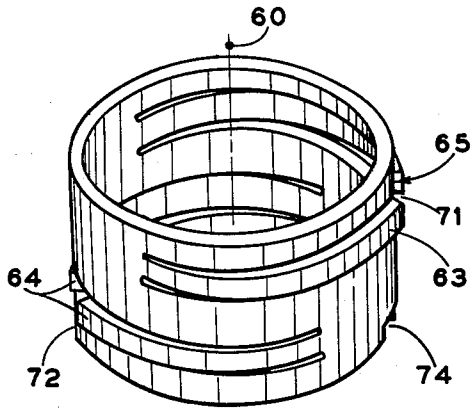


FIGURE 11

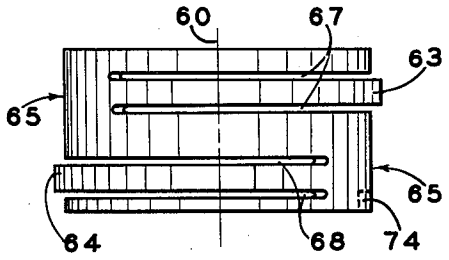


FIGURE 12

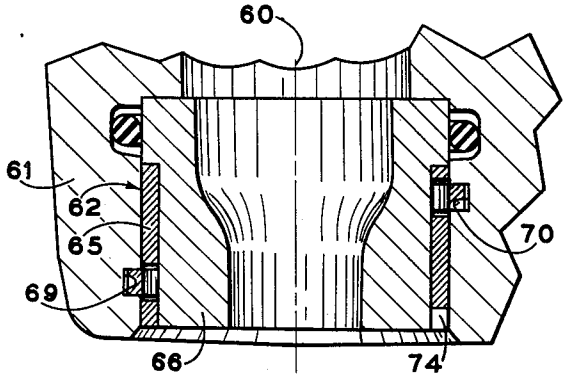


FIGURE 13

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3,129,777

REPLACEABLE NOZZLE HAVING COMPLETELY SHROUDED RETAINER

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Filed Aug. 7, 1962, Ser. No. 215,315
22 Claims. (Cl. 175—340)

The present invention relates to nozzles used for the delivery of fluids, a particular application being the jet nozzles used in rock bits to deliver flushing fluid between the cutters to clean the bottom of a borehole and carry off rock cuttings to the surface. It also has applications to mud guns and other surface equipment wherein it is desirable to replace nozzles from time to time to substitute a nozzle of a different orifice size, replace a worn or broken nozzle or similar reason.

Prior art structures including replaceable nozzles are shown in Payne, U.S. Pat. 2,855,182, and in the application of Kistler, S.N. 702,060, filed December 11, 1957, now abandoned (or Mandrell, U.S. Patent 3,115,200) especially as applied to rock bits, and the structures of the present invention as so applied are intended for use in like environments. While each of Payne and Kistler describe structures which are known to work well in service, each has limitations and disadvantages which the present invention purposes to obviate or ameliorate. Thus the Payne nozzle (FIGS. 1–3) has a plain cylindrical outer surface seated in a counterbore in the dicharge end of a flushing passageway, and is held in place against downward movement by a split snap ring or spring extending into a circumferential groove in the counterbore and underlying the bottom of the nozzle. The spring-like snap ring retainer is exposed to erosion through contact with the turbulent flushing fluid and the cuttings entrained therewith and instances have been noted of nozzle losses brought about by a combination of erosion of the snap ring and pressure exerted downwardly on the weakened ring by the flushing fluid.

The Kistler structure departed from Payne by providing a similar circumferential groove in the nozzle which registers with the groove in the flushing passageway so that a split snap ring extends partially into both grooves to secure the assembly against relative axial movement in either direction, thus eliminating the need for a counterbore. Since the registering grooves are necessarily disposed above the bottom of the nozzle and the portion of the bit containing the fluid passageway, the snap ring retainer is largely protected from the erosive action of the flushing fluid. However, the Kistler nozzle can not be withdrawn without providing an axial access pocket in either the nozzle or the boss, depending on whether the grooves and snap ring were designed for contraction of the snap ring entirely into the nozzle groove or expansion wholly into the flushing passageway groove. In addition, it is necessary with the Kistler structure to provide eyelets or similar structure at the portions of the snap ring adjacent the split therein to be engaged by a tool inserted through the axial access pocket to compress or expand the snap ring so that the nozzle may be withdrawn.

While the Kistler structure has met with outstanding engineering and commercial success, isolated instances of failure may be noted. These appear to be caused in part by the fact that the structure is not designed to avoid rotation of the nozzle or rotation of the snap ring or both, as the matching circumferential grooves are of uniform depth and are coaxial with the flushing passageway (as is also true of the single groove of Payne), and in part by the fact that some access of the flushing fluid to the snap ring is possible through the axial access pocket.

In the first instance, the snap ring is frequently found so positioned that the eyelets or the like are not available for engagement by the tool and the nozzle cannot be withdrawn, particularly so because no means are provided or are readily available for rotating it. In the second instance, the snap ring may be eroded to eliminate such ends and the whole ring may be eroded through gradual rotation and exposure to the area above the axial access pocket as to seriously weaken the entire snap ring, which seems to be the only logical explanation of isolated nozzle losses.

While such nozzle losses may be isolated, they are not without important consequences to those involved, particularly when drilling holes many thousands of feet below the ground surface. The loss of a nozzle means a sudden increase in orifice diameter from, e.g., 5/16" diameter to 1" diameter or more. Such a sudden increase means the loss of substantially all pressure drop across the bit and a low velocity mud stream on bottom. This in turn may imply conditions such that the cuttings can not be asported to the surface and the mud pump can not be adjusted to accomplish this result. In such exent, the only alternative is the time-consuming "round trip," pulling the bit to the surface to replace the lost nozzle and running the refurbished bit to bottom again. As this may take a full eight hours or more before drilling can be resumed, it can be readily appreciated that those concerned with operation of the drill rig and employment of its operating personnel in an economical manner have considerable cause to be disturbed about an occasional lost nozzle.

The present invention departs from the prior art by starting with the postulate that the snap ring retainer or spring must be completely shrouded, i.e., by eliminating any axial access pocket as in Kistler. In addition, it seeks to provide a structure in which there is little or no tendency for either the nozzle or the snap ring or both to rotate with respect to the wall of the fluid passageway under operating conditions. Idealization of both of these desirata will obviously eliminate most of the known and suspected causes of nozzle failure.

These objectives are achieved in the present invention primarily by providing one or more pairs of registering grooves in nozzle and boss as in Kistler but differing therefrom in that in at least one of the members (nozzle and boss) the groove is not concentric with the fluid passageway but is eccentric thereto so that it has a maximum depth at one circumferential position and a minimum depth at another. If, for example, the eccentric groove is in the nozzle boss (or other flushing passageway wall), it will have a maximum depth at one position and will run out or disappear at the diametrically opposite position. The snap ring retainer is mounted in the uniform depth groove in the nozzle so that it will be compressed radially, under the influence of an inward radial force, to lie wholly within the nozzle groove. A small portion of the ring opposite the split therein is secured to the nozzle and lies wholly within the concentric groove of the nozzle. With such construction, it is possible to engage and disengage the retainer for axial movement or locking against such movement simply by rotating the nozzle, and there is no need for an axial access pocket to the retainer. When the nozzle is so radially oriented that the split ends of the snap ring are aligned with the maximum depth portion of the boss groove, the ring assumes its relaxed position partially engaging both such boss groove portion and the corresponding portion of the nozzle groove to lock the nozzle in the boss. At the same time, the portion of the snap ring 180° away is secured wholly within the nozzle groove and abuts the zero depth portion of the boss groove.

When it is desired to remove the nozzle, it is engaged

by a rotatable tool and turned 180°. This brings the free ends of the snap ring adjacent the zero depth portion of the boss groove and forces them wholly within the nozzle groove. Since the opposite side of the retainer, which now is aligned with the maximum depth portion of the boss groove, is secured to restrain it from movement out of the nozzle groove, the entire retainer lies within the nozzle groove and can not hinder axial movement of the nozzle relative to the boss.

The preferred form of the invention utilizes two such snap ring retainers and sets of registering grooves, axially separated and spaced 180° apart circumferentially. While one such assembly will retain the nozzle in the boss, the fact that over approximately half its circumference the snap ring serves no locking function increases the likelihood of cocking. The use of a second snap ring, identical with the first but disposed so that it locks the nozzle to the boss over the circumferential portion not locked by the first ring, supplements the first assembly and avoids such cocking. A half turn of the nozzle to the unlocked position simultaneously compresses both the first and second rings to permit axial movement. However, one ring is adequate for some assemblies and more may be used for assemblies with long axial dimensions. The grooves and split retaining rings (or annular springs) may be disposed with their interlocking free ends at various circumferential positions with respect to each other.

To better enable those skilled in the art to comprehend the present invention, a drawing of several sheets and figures is attached hereto and is incorporated herein by reference. In the drawing:

FIGURE 1 is a perspective view of a portion of a nozzle boss or tube to illustrate the eccentric grooves therein according to the preferred embodiment of the present invention,

FIGURE 2 is a perspective view of a nozzle designed to be inserted in the boss of FIGURE 1, complete with snap rings,

FIGURE 3 is a diametral vertical sectional view of the assembly of the nozzle and boss of FIGURES 1 and 2, as on lines 3—3 of FIGURE 4, complete with O-ring and with nozzle and boss interlocked by the retaining rings,

FIGURE 4 is a bottom plan view of the assembly of FIGURE 3,

FIGURE 5 is a horizontal section on lines 5—5 of FIGURE 3,

FIGURE 6 is identical with FIGURE 5 except that the nozzle and retaining rings have been rotated 180 degrees to show the open or unlocked position of the nozzle and retaining rings with respect to the retaining ring grooves,

FIGURE 7 is a vertical diametral section of an alternate embodiment in which the retaining ring grooves in the nozzle are eccentric to the nozzle axis while the grooves in the boss are concentric, the retaining rings in such embodiment being retained in the boss rather than rotating with the nozzle,

FIGURE 8 is a horizontal section on lines 8—8 of FIGURE 7,

FIGURE 9 is a horizontal section similar to that of FIGURE 8 except that the nozzle has been rotated 180°,

FIGURE 10 is a bottom plan view of the embodiment of FIGURE 7,

FIGURE 11 is a perspective view of an alternate nozzle jacket, one in which the snap rings are integral parts of such nozzle jacket,

FIGURE 12 is an elevation of the nozzle jacket of FIGURE 11, and

FIGURE 13 is a vertical diametral section of a nozzle and boss assembly including the nozzle jacket of FIGURE 11.

In FIGURES 1–6 the preferred embodiment is shown as comprising a nozzle boss **1** defining a fluid passageway **15** therethrough, a nozzle **2**, a pair of retaining rings **3** and **4**, and a conventional O-ring **11**. As used herein, the term "boss" or "nozzle boss" is intended in a general sense to signify a member or a portion of a member having a fluid passageway therethrough and having sufficient section above the discharge end to accommodate a counterbore, retaining ring grooves, O-ring grooves, or combinations thereof. While the term has acquired such significance in the rock bit art, it is recognized that in other arts to which the invention is applicable equivalent terms are "tube" or simply "nozzle holder."

In the FIGURES 1–6 embodiment, nozzle **2** is depicted as comprising an outer member or jacket **5** and an inner member **6** which is either press fitted into the jacket in such manner as to permit field replacement with the aid of a small press, or is slidably mounted and sealed with an O-ring **13** indicated in phantom in FIGURE 3. (Note that inner member **6** and jacket **5** need not necessarily be relatively rotatable.) This two-piece structure has the advantage that the inner member **6** may be made of a relatively abrasion resistant material such as tungsten carbide with a minimum of machining, while jacket **5** may be made of a relatively soft, easily machinable material such as mild steel. There is also the incidental advantage of a lower capital investment in the rather expensive tungsten carbide than in a one-piece tungsten carbide nozzle, especially in view of the inventory of nozzles of various orifice sizes which must be kept on hand to meet various drilling conditions. However, the one-piece construction is equally feasible and may be used in lieu of the two-piece structure illustrated, just as in the FIGURES 7–10 embodiment below.

As indicated in the figures, boss **1** has machined therein from counterbore wall **16** at the lower part of fluid passageway **15** a pair of axially spaced eccentric grooves **9** and **10**, the machining axes **20** and **22** of which are located so that upper groove **9** has a zero depth at point B and a maximum at point A, diametrically opposed to point B. Lower groove **10**, on the other hand, has a zero depth at point C, immediately below point A, and a maximum depth at point D, immediately below point B. FIGURE 1 also illustrates the groove **12** in the boss which receives O-ring **11**, although such groove and the O-ring therein form no part of the present invention and may alternately be disposed in a groove in the periphery of the nozzle or in matching grooves in both nozzle and boss.

FIGURE 2 illustrates the general appearance of nozzle **2** as separated from boss **1**, and shows that retaining rings **3** and **4** are retained in the nozzle grooves in their relaxed positions. The wrench-engageable lower end **18** of the nozzle also appears in this figure, and is more fully shown in the bottom view of FIGURE 4. While a hexagon-shaped boss is shown, it is apparent that any conventional machine screw head or bolt head can be used which permits the use of a discharge orifice therethrough.

The cooperative disposition of the various parts of the nozzle assembly are shown in FIGURES 3, 5 and 6. As therein indicated, the retaining ring grooves **7** and **8** in nozzle **2** are concentric with nozzle and bore axis **21**, in contradistinction to the eccentric grooves **9** and **10** in borewall **16**. FIGURES 3 and 5 show the retaining rings in locking position, wherein each of the free ends **23** of upper ring **3** lie partly in each of the axially aligned grooves **7** and **9** while the free ends **24** of lower ring **4** lie partly in each of the registering grooves **8** and **10**, diametrically opposite the engagement of the free ends of the upper ring. To clarify the interfit of the ring **4** with grooves **8** and **10**, certain dimension lines have been added to FIGURE 5 (and FIGURE 6) to indicate the radial extent of the various grooves and parts. Thus the dimension **10'** indicates the maximum radial extent of boss groove **10**, the dimension **10''** being added to indicate a typical reduced radial extent of the same groove. Reference character **8'** indicates the radial extent of concentric nozzle groove **8** and **4'** of retaining ring **4**. From these dimensions it is

apparent that groove 10 disappears or runs out at point C, 180° removed from point D of maximum groove depth.

In connection with FIGURES 5 and 6, it should be noted that inner member 6 of nozzle 2 has been omitted for the sake of simplicity. The shape of such inner member forms no part of the present invention, and it is sufficient to note that the passageway 17 is preferably convergent as shown in FIGURE 3 to effect a high velocity in the discharge stream. It should also be noted that the split ends 24 of the retaining ring require no eyelets. FIGURE 5 is a horizontal cross section of the assembly just below the lower retaining ring and grooves as shown in FIGURE 3. A similar section on the upper ring and grooves would be a mirror reflection in a vertical plane through nozzle center line 21, or may be thought of as the view obtaining when the drawing sheet is rotated 180° (i.e., upside down). The same is true of FIGURE 6 following.

In FIGURE 6 the assembly of FIGURE 5 is repeated with the nozzle rotated a half-turn in either direction from its FIGURE 5 position. The assembly is such that the retaining rings rotate with the nozzle, the split or gap 25 between free ends 24 being reduced as boss groove 10 runs out and cams the free ends 24 radially inwardly until the ring lies wholly within nozzle groove 8. In this final position there is no part of ring 4 lying within boss groove 10, and the nozzle-and-rings assembly may be moved axially.

To obtain such common rotation of retaining rings 3 and 4 with nozzle 2, it is necessary to secure each ring to the nozzle at its closed end 26, i.e., the portion diametrically opposite the split or free ends. Such connection may take various forms, e.g., crimping or peening the ring and nozzle together, a pin or key inserted in appropriate openings, silver soldering, brazing, etc. Preferably the circumferential extent of the area secured is minimized in the interest of affording maximum ffexibility to the retaining rings.

Variations in the preferred embodiment of FIGURES 1–6 which may be noted include a larger fluid passageway above counterbore 16 (indicated by phantom borewall 23) the shoulder 29 defined by such openings actually being unnecessary in most instances. This shoulder only prevents the backwashing of the nozzle 2, ordinarily avoided because the flushing flow acts downwardly on the nozzle, and is completely unnecessary with a one-piece nozzle or a two-piece nozzle in which inner member 6 is force fitted within jacket 5, as with such assemblies nozzle 2 must move as a whole and such movement in either direction is prevented by the engagement of the retaining rings in the aligned grooves. It may also be noted that the nozzle is extendable below the bottom 30 of boss 1, that lower end 18 of the nozzle may have the simple termination of the nozzle of FIGURE 10 or the jacket of FIGURE 11, or may be rotated without a special termination, as discussed below. In assembling or disassembling nozzle 2 and boss 1, upper retaining ring 3 may snap into lower boss groove 10 with free ends 23 in the maximum depth portion of groove 10, in which event it is only necessary to rotate the nozzle a half-turn to continue the axial movement. This feature provides an incidental advantage in that it serves as a second interlock if the nozzle should inadvertently become unlocked from the double ring engagement of FIGURE 3.

A convenient feature indicated in FIGURE 3 is the chamfer 19 at the lower end of counterbore 16; this inclined surface is useful in compressing the retaining rings 3 and 4 when inserting the nozzle-and-rings assembly in the boss, but hand tools may also be used therefor.

Turning to the alternate embodiment of FIGURES 7–10, FIGURE 7 indicates in vertical section through assembly axis 40 a one-piece nozzle 42 having a pair of axially spaced grooves 47 and 48 in its outer cylindrical surface 45 which are eccentric to axis 40. As in the preferred embodiment, such grooves are concentric about machining axes 53 and 54 so that in the FIGURE 7 position upper groove 47 has a maximum depth at point E and a zero depth at the diametrically opposite point F, while lower groove 48 has a maximum depth at point H, immediately below point F, and zero depth at point G, just below point E.

In this embodiment, the roles of the two major members are reversed, boss 41 having substantially uniform depth grooves 49 and 50 therein which are concentric about axis 40 and serve to keep retaining rings 43 and 44 loosely retained when the nozzle 42 is withdrawn completely. In the position of the nozzle indicated in FIGURES 7 and 8, upper ring 43 partially fills both of the aligned grooves 47 and 49 to lock the nozzle to the boss, lower ring 44 at the same time partially filling aligned grooves 50 and 48 to serve as an additional lock and cooperating with the upper ring to prevent cocking. The rings in such positions are relaxed and occupy the same positions relative to the boss that they occupy when the nozzle is removed. As in the preferred embodiment, the position of lower ring 44 and registering grooves 48 and 50 for the FIGURE 7 disposition is that seen by inverting FIGURE 8. As in the earlier described embodiment, prime numerals have been used in FIGURES 8 and 9 to indicate the radial extents of grooves and retaining ring.

FIGURE 9 indicates the relative position and condition of retaining ring 43 when nozzle 42 has been rotated 180° from its FIGURE 8 position. As the zero depth portion of nozzle groove 47 at point F of the nozzle approaches the gap or split 52 between the free ends 51 of retaining ring 43, such free ends are cammed into boss groove 49. At the same time the closed end 55 of ring 43, diametrically opposite split 52, cannot move into the deep part of nozzle groove 47 because such a movement would require a movement of the ring as a whole. Linear movement is not possible because there is no room for such, and rotational movement is prevented by the lug 56 in groove 49. Of course, rotation of ring 43 may also be prevented by the expedients used in the embodiment of FIGURES 1–6—pinning, peening, silver soldering, brazing, or combinations thereof of closed end 55—in which event groove 53 may be made continuous, as indicated by phantom line 57 in FIGURES 8 and 9.

When nozzle 42 has been rotated to the FIGURE 9 position, lower ring 44 occupies the position indicated by inverting FIGURE 9 and both rings 43 and 44 lie only in the boss grooves 49 and 50. The nozzle may be moved down axially until lower ring 44 snaps into upper nozzle groove 47, whereupon the nozzle is again rotated 180°, back to its FIGURE 8 position, to permit the final disengagement step.

FIGURE 10, a bottom view of the FIGURE 7 assembly, indicates spanner slots 58 in the bottom 59 of nozzle 42 which are employed in rotating the nozzle during assembly and disassembly. Of course, the means illustrated in FIGURE 4 above or FIGURE 11 below may also be used.

In connection with this embodiment, it should be noted that borewall 46 defining fluid passageway 39 may be uniform in diameter, no counterbore being necessary to restrain the nozzle against upward movement. Attention is also directed to the chamfered upper edge 38 of the nozzle, which serves to expand retaining rings 43 and 44 gradually as the nozzle is inserted in the boss and thus prevent the rings from blocking such assembly.

This feature and the reversal of the grooves constitute the only major distinctions between the embodiment of FIGURES 1–6 and the embodiment of FIGURES 7–10. Otherwise the latter may use the two-piece nozzle of the earlier described embodiment, the counterbore thereof, etc. The fluid passageway 34 through nozzle 42 is preferably contoured in the same manner, and the lower end 59 of the nozzle may either be extended as shown or terminated flush with or above lower end 37 of the boss. An

O-ring 35 may be used either in a boss groove 36, a nozzle groove, or both.

The embodiment of FIGURES 11–13 represents something of a comprise between the two-piece, relatively thickly jacketed nozzle of the first embodiment and the one-piece nozzle of the second embodiment, which is preferably composed of an abrasion resistant material. As indicated in FIGURES 11–13, nozzle 62 is of two parts, an outer jacket or sleeve 65 and an inner member 66. Jacket 65 is relatively thin-walled and is composed of a resilient material such as spring steel, a suitable thickness thereof being 1/32–1/16 inch. There are no grooves as such in this nozzle, nor are there any completely discrete retaining rings. In place of retaining rings this assembly uses tabs 63 and 64 cut from the nozzle jacket by transverse saw cuts 67 and 68 and longitudinal cuts 71 and 72 about midway between the transverse cuts, and partially springing such tabs so that they have the relaxed positions indicated in the drawing. Saw cuts 67 and 68 extend less than fully circumferentially and serve the added function of providing clearance between the tabs and the balance of jacket 65 to prevent any malfunction by binding at the edges when the tabs are compressed back into their original positions. The nozzle grooves of the earlier embodiments are replaced here by the spaces left in the wall of the jacket when tabs 63 and 64 are sprung outwardly. Of course, in this embodiment there must be an eccentric groove in boss 61 for each tab, the drawing showing an upper eccentric groove 70 for upper tab 63 and a lower eccentric groove 69 for lower tab 64. As in the other embodiments, the tabs are spaced axially to register simultaneously with the boss grooves, and are disposed circumferentially so that the split end of each is approximately a half-turn from the split end of the other, thereby permitting simultaneous engagement with the boss grooves and simultaneous disengagement when the nozzle assembly is rotated 180° from the position shown in FIGURE 13. Leakage is prevented by a conventional O-ring as illustrated.

This embodiment is also illustrated with a small slot 74 in jacket 65 which serves the dual function of providing an index indicating the closed end position of lower tab 64 (and the open position of upper tab 63) and a means for inserting a spanner tool for rotating the nozzle. Such a tool has a projecting portion fitting into the nozzle orifice and a lug which engages the jacket portions defining slot 74, both being mounted on a transverse handle through which the necessary torque may be applied. Of course, a second slot diametrically opposite slot 74 could be added to permit use of a spanner tool having a second projection engaging the second slot where the axial length of nozzle jacket 65 below tab 64 provides sufficient section for such slot.

Preferably, inner portion 66 of nozzle 62 is not brazed or soldered to jacket 65, but is force fitted therein, the shouldered fits indicated in FIGURE 13 preventing movement of inner member 66 in either direction.

In addition to the means for retaining the nozzle described in connection with the various embodiments of the invention above, various tools requiring no special lower end on the nozzle may be employed. Such a tool is inserted in open condition through the nozzle orifice and is thereafter closed so that it can not be withdrawn. The outside of the tool head grips the converging inner wall of the nozzle and the operator applies pressure to move the nozzle axially of the boss, either manually or with the aid of a jack or press built into the tool. While such tools are desired primarily to exert an axial force, it is apparent that they may also be used to rotate a nozzle. See, for instance, the nozzle pullers disclosed by Newman in U.S. Patent 2,947,074. With such tools the nozzle termination may be entirely conventional.

In each of the above described embodiments it is desirable to have an index mark on each boss and nozzle, e.g., directly below the closed end of the lowermost groove of each member. Such index marks are highly useful, during assembly and disassembly operations, in aligning the nozzle so that the ring will lie only in the member having the concentric groove.

Broadly, the present invention is a novel means for assembling a cylindrical nozzle in a cylindrical recess in a holder having a fluid passageway therethrough with which a fluid passageway through the nozzle is coaxial, the clearance between the facing cylindrical surfaces of such members being just sufficient to permit axial and rotary movements during assembly and disassembly without appreciable wobbling and being provided with means for preventing fluid leakage through such clearance. The novel means of this invention comprise one and preferably at least two pairs of registering circumferential grooves in such facing surfaces and an expandable-contractable split retaining ring in each such pair of grooves, one member of each such pair being concentric with the cylindrical surfaces and the other member being eccentric thereto so that it has a zero depth at one small portion of the circumference of such surfaces and a maximum depth at a circumferential position approximately 180° from its zero depth. A split end retaining ring or spring (snap ring) fits into such pair of grooves so that it remains fixed, circumferentially and axially, with respect to the member having the concentric groove but is relatively movable in both dimensions with respect to the member having the eccentric groove. The portions of such ring adjacent the split (free ends) are expandable or contractable from their relaxed positions, during assembly and disassembly, so that in one circumferential position of the nozzle relative to the boss they partially fill both the concentric and eccentric members of the pair of grooves, in particular the maximum depth portion of the eccentric member. When the nozzle is rotated a half-turn, the free ends of the ring are forced wholly into the concentric groove so that the entire ring lies in such groove and the nozzle may be moved axially of the boss. Preferably two such pairs of grooves and two such retaining rings are employed, although any number may be employed. When two are used, they are preferably disposed with the maximum depth portions of the eccentric grooves 180° apart, but any circumferential spacing is workable which provides for simultaneous movement of both rings wholly into the concentric grooves as the nozzle is rotated into a particular position. It is also possible to provide the eccentric member of one pair of grooves in the nozzle while the eccentric member of a second pair of grooves is disposed in the boss. The preferred condition of the rings in locking position is such that they are relaxed, as any tendency of the rings to rotate under the influence of a flowing fluid, impacts and the like will require radial compression of the rings. During moments between the action of such forces, the rings will tend to slip back to their relaxed positions. In the opposite arrangement, where the rings unlock the nozzle from the boss in their relaxed positions, any beginning of rotation would tend to continue until the assembly is unlocked. It may also be noted that in all embodiments described there are modifications of the exact manner in which the retaining rings may project into the deep portions of the eccentric grooves in addition to the particular locking interfits shown in the drawing. Thus the ring portions immediately adjacent the split in any ring may lie wholly within the eccentric groove, more distant portions of the ring crossing over to the concentric groove in the other member so that there is always some circumferential portion of the ring lying partly in each of the registering grooves. Thus the expression "the ends of said ring adjacent the split therein lying partially in each of the registering grooves" is intended in a broad sense to cover such assemblies as well as those in which the very ends of the ring at the split lie partially in both the eccentric and the concentric members of the pair of grooves.

What is claimed is:

1. A nozzle assembly including a boss member having a flushing passageway therethrough at least the lower end of which is cylindrical surface, a nozzle member having a flushing passageway therethrough and a cylindrical outer surface slidable in said lower end and facing said boss cylindrical surface with sufficient clearance to permit axial and radial movements of the nozzle without appreciable wobbling, means for sealing against the flow of fluids through said clearance, said nozzle and boss members having at least one pair of registering circumferential grooves therein from said cylindrical surfaces, one of which is concentric with the axis of such surfaces and the other is eccentric to such axis, said eccentric groove having a zero depth at one circumferential portion and a maximum depth portion approximately 180° from its zero depth portion, and a contractable-expandable split retaining ring disposed in each said pair of grooves to remain axially and circumferentially fixed with respect to the member having the concentric groove therein and movable in both dimensions with respect to the other member during assembly and disassembly, the ends of said ring adjacent the split therein lying partially in each said registering groove to lock the nozzle and boss together and being movable radially upon rotating said nozzle approximately 180° relative to said boss so that such portions and the ring as a whole lies wholly in said concentric groove, thereby permitting an axial movement of said nozzle.

2. The nozzle assembly of claim 1 in which the lower end of said nozzle is especially adapted for engagement by a tool for rotating said nozzle during assembly and disassembly operations.

3. The nozzle assembly of claim 1 in which said boss contains at least one said eccentric groove.

4. The nozzle assembly of claim 3 in which said boss contains two said eccentric grooves, axially spaced and circumferentially disposed with their maximum depth portions approximately 180° apart.

5. The nozzle assembly of claim 4 in which said nozzle has an outer jacket of relatively easily machinable composition defining said cylindrical surface and concentric grooves and an inner member of abrasion-resistant composition defining said flushing passageway, said inner member being force fitted in said jacket.

6. The nozzle assembly of claim 4 in which said nozzle has an outer jacket of relatively easily machinable composition defining said cylindrical surface and concentric grooves and an inner member of abrasion-resistant composition defining said flushing passageway, said inner member being slidable upwardly within said jacket, said jacket including a shoulder portion to prevent downward movement of said inner member, said assembly including sealing means to prevent leakage between said inner member and jacket and shoulder means on said boss to prevent upward movement of said inner member with respect to said boss.

7. The nozzle assembly of claim 1 in which said nozzle includes at least one said eccentric groove and the upper end of said nozzle is chamfered to expand said retaining ring as said nozzle is assembled to said boss.

8. The nozzle assembly of claim 7 in which the concentric groove in said boss has a lug therein adapted to fit between the free ends of said ring formed by the split therein to prevent rotation of said ring.

9. The nozzle assembly of claim 7 in which there are two said pairs of registering grooves the eccentric members of which are disposed in said nozzle, said grooves being axially spaced and having their minimum depth portions approximately 180 apart.

10. A nozzle mountable in a boss having a flushing fluid passageway therethrough at least the lower end of which is in the form of a cylindrical surface and is provided with at least one retaining ring groove therein concentric with such cylindrical surface, such nozzle having a cylindrical outer surface of substantially the same diameter as said boss cylindrical surface but slidable axially and rotatable therein without appreciable wobbling, said nozzle having a retaining ring groove therein eccentric to its cylindrical surface so that it has a zero depth at one circumferential portion and a maximum depth portion at a circumferential position approximately 180° from its zero depth portion, said eccentric groove being capable of receiving portions of a split retaining ring adapted to engage the groove in said boss, said nozzle being capable of assembly to said boss together with means for sealing against fluid flow between said cylindrical surfaces and a retaining ring in said boss groove in non-rotatable relationship with respect to said boss so that at one rotary position of said nozzle with respect to said boss portions of said ring adjacent the split therein lie partially in the maximum depth portion of said eccentric groove and in a second such position, approximately 180° from the first, said ring lies wholly in said boss groove.

11. A nozzle adapted for sealable mounting in a boss having a flushing passageway therethrough at least the lower end of which is a cylindrical surface having at least one circumferential groove therein, said nozzle having a flushing passageway therethrough and an outer cylindrical surface adapted to face such boss cylindrical surface with only sufficient clearance to permit relative axial and rotary movement without appreciable wobbling, said nozzle surface having a circumferential groove therein for each said boss groove and adapted to register therewith to form a pair of ring receiving grooves one of which is concentric with said cylindrical surface and the other of which is eccentric thereto, said concentric groove being adapted to receive all portions of a split retaining ring under the influence of a radial force and to partially receive the free ends adjacent the split in said ring in their relaxed condition, said retaining ring being otherwise disposable in said concentric groove in non-rotatable relationship therewith, said eccentric groove having a zero depth portion and a maximum depth portion approximately a half-turn from said zero depth portion adapted to receive said free ends of said retaining ring at one rotary position of said nozzle with respect to said boss to lock said nozzle to said boss, said zero depth portion of said eccentric groove being adapted to force said retaining ring wholly into said concentric groove as said nozzle is rotated into a second position approximately a half-turn from the first, thereby unlocking the nozzle from the boss.

12. The nozzle of claim 11 which contains at least two said eccentric grooves adapted to register with corresponding concentric grooves in said boss.

13. The nozzle of claim 11 in which contains at least two said concentric grooves adapted to register with corresponding eccentric grooves in said boss.

14. The nozzle of claim 13 together with at least two said retaining rings disposed in said concentric grooves, each said ring having a closed end opposite the split thereing secured to said nozzle and lying wholly within said concentric groove, said two retaining rings being disposed with their respective closed ends approximately 180° apart.

15. A nozzle assembly including a boss member having a flushing passageway therethrough at least the lower end of which is a cylindrical surface, a nozzle member having a flushing passageway therethrough and a cylindrical outer surface slidable in said lower end and facing said boss cylindrical surface with sufficient clearance to permit axial and radial movements of the nozzle without appreciable wobbling, means for sealing against the flow of fluids through said clearance, said nozzle and boss members having at least one pair of registering circumferential grooves therein from said cylindrical surfaces, one of which is concentric with the axis of such surfaces and extends at least partially around said member and the other is eccentric to such axis, said eccentric groove having a zero depth at one circumferential portion and a

maximum depth portion approximately 180 degrees from its zero depth portion, and a contractable-expandable split retaining ring disposed in each said pair of grooves to remain axially and circumferentially fixed with respect to the member having the concentric groove therein and movable in both dimensions with respect to the other member during assembly and disassembly, the ends of said ring adjacent the split therein lying partially in each said registering groove to lock the nozzle and boss together and being movable radially upon rotating said nozzle approximately 180 degrees relative to said boss so that such portions and the ring as a whole lies wholly in said concentric groove, thereby permitting an axial movement of said nozzle, the concentric groove of each said pair of registering grooves beginning at a first point in the surface of the member where said ends adjacent the split in the retaining ring are to be accommodated and extending around the major portion of said surface in both directions at least to a pair of points each adjacent but circumferentially spaced from a second point 180 degrees away from said first point, said retaining ring similarly extending circumferentially in both directions from the split therein at least to said pair of points and being integrally secured between each of said pair of points and said second point to form a one piece retaining ring which is circumferentially complete except for the split therein.

16. The nozzle assembly of claim 15 in which said nozzle has an outer jacket of light gauge, relatively resilient material and an inner member of relatively erosion-resistant material, in which the concentric groove of said at least one pair of registering grooves is disposed in said nozzle, and in which said retaining ring is integral with the jacket of said nozzle as tabs defining by a pair of transverse slits in said jacket less than over the full circumference of said jacket and longitudinal slit at about the midpoint of said transverse slits and springing said tabs so that they assume relaxed positions with the free ends adjacent said longitudinal slit projecting beyond the outer periphery of said jacket.

17. The nozzle assembly of claim 16 in which there are two said pairs of rings integral with said jacket, said rings having their free ends approximately 180° apart.

18. The nozzle assembly of claim 17 in which there is at least one longitudinal slot in the lower end of said jacket adapted to receive a tool for rotating said nozzle during assembly and disassembly operations.

19. A nozzle adapted for sealable mounting in a boss having a flushing passageway therethrough at least the lower end of which is a cylindrical surface having at least one circumferential groove therein, said nozzle having a flushing passageway therethrough and an outer cylindrical surface adapted to face such boss cylindrical surface with only sufficient clearance to permit relative axial and rotary movement without appreciable wobbling, said nozzle surface having a circumferential groove therein for each said boss groove and adapted to register therewith to form a pair of ring receiving grooves one of which is concentric with said cylindrical surface and extends partially therearound, and the other of which is eccentric thereto, said concentric groove being adapted to receive all portions of a split retaining ring under the influence of a radial force and to partially receive the free ends adjacent the split in said ring in their relaxed condition, said retaining ring being otherwise disposable in said concentric groove in non-rotatable relationship therewith, said eccentric groove having a zero depth portion and a maximum depth portion approximately a half-turn from said zero depth portion adapted to receive said free ends of said retaining ring at one rotary position of said nozzle with respect to said boss to lock said nozzle to said boss, said zero depth portion of said eccentric groove being adapted to force said retaining ring wholly into said concentric groove as said nozzle is rotated into a second position approximately a half-turn from the first, thereby unlocking the nozzle from the boss, the concentric groove of each said pair of registering grooves beginning at a first point in the surface of the member where said ends adjacent the split in the retaining ring are to be accommodated and extending around the major portion of said surface in both directions at least to a pair of points each adjacent but circumferentially spaced from a second point 180 degrees away from said first point, said retaining ring similarly extending circumferentially in both directions from the split therein at least to said pair of points and being integrally secured between each of said pair of points and said second point to form a one piece retaining ring which is circumferentially complete except for the split therein.

20. The nozzle of claim 19 which comprises an inner member of relatively erosion-resistant material and an outer member or jacket of light gauge, each said concentric groove being in said jacket and relatively resilient material, said retaining ring being integral with said jacket in the form of a pair of tabs defined by transverse cuts in said jacket extending less than the full circumference thereof and a longitudinal cut at about the midpoint of said transverse cuts to define a split between said tabs, and further defined by a springing of said tabs to occupy relaxed positions projecting beyond the outer circumference of said jacket.

21. The nozzle of claim 20 in which there are at least two said pairs of tabs, said pairs being disposed with the splits therebetween circumferentially disposed at uniform intervals.

22. The nozzle of claim 21 in which there are two said pairs of tabs having the splits therebetween disposed approximately 180° apart.

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