United States Patent

Fishbein

[15] **3,702,611**

[45] **Nov. 14, 1972**

[54] **SURGICAL EXPANSIVE REAMER FOR HIP SOCKET**

[72] Inventor: **Meyer Fishbein,** 12020 Saltair Place, Los Angeles, Calif. 90049

[22] Filed: **June 23, 1971**

[21] Appl. No.: **155,718**

[52] **U.S. Cl.** **128/305,** 82/1.2, 408/154, 408/157, 408/159

[51] **Int. Cl.**.....**A61b 17/32,** A61b 17/16, B23b 51/00

[58] **Field of Search** ..82/1.2; 128/305, 312; 408/154, 408/157, 158, 159

[56] **References Cited**

UNITED STATES PATENTS

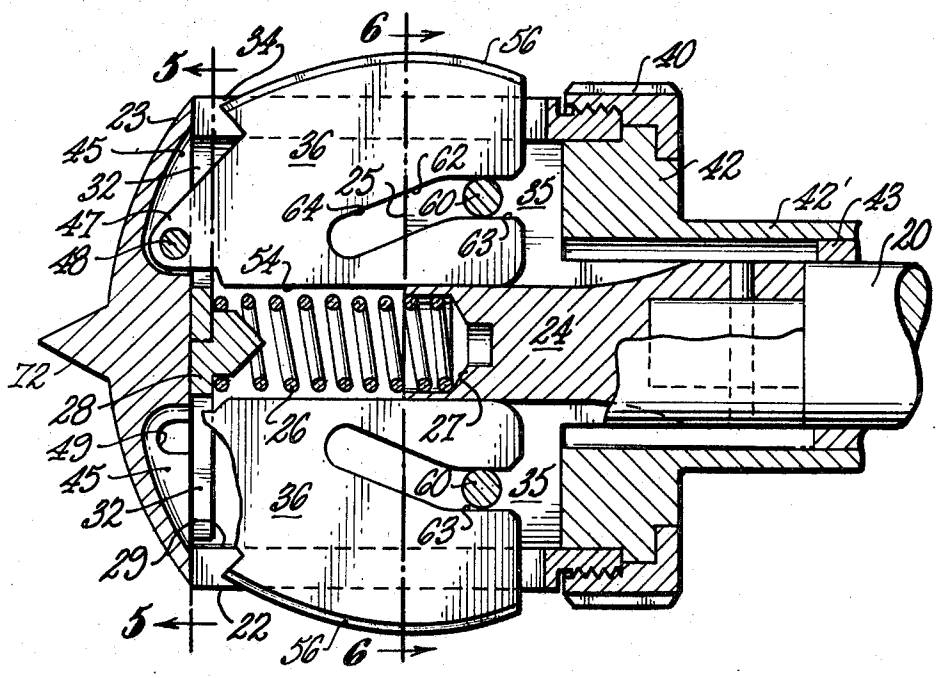
2,616,103	11/1952	Stecher	408/158 X
2,649,001	8/1953	Fennell	408/158
3,630,204	12/1971	Fishbein	128/305
2,694,321	11/1954	Riza	408/158

Primary Examiner—Channing L. Pace
Attorney—Forrest J. Lilly

[57] **ABSTRACT**

An expanding reamer is provided for surgical reaming of the acetabulum in hip surgery. The reamer includes a head with a convex end adapted to seat in a previously prepared concavity in the central part of the acetabulum. This head pivotally mounts a set of radially expansive blades. It is telescopically mounted on the end of a rotary drive shaft, and the drive shaft mounts a cam actuator which engages cam elements to expand the cutters progressively in response to axial thrust exerted on the drive shaft by the surgeon with the reamer head seated in the acetabulum. A spring is used to contract the cutters when the reaming operation is interrupted.

7 Claims, 13 Drawing Figures



PATENTED NOV 14 1972

3,702,611

SHEET 1 OF 2

FIG. 1.

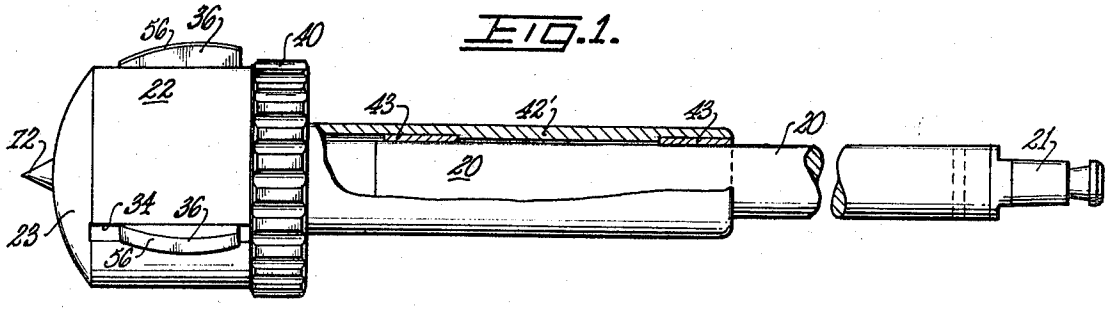


FIG. 2.

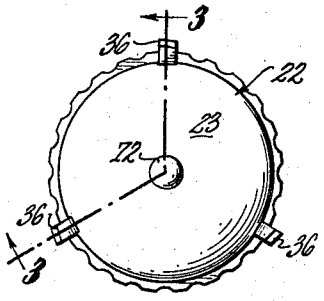


FIG. 3.

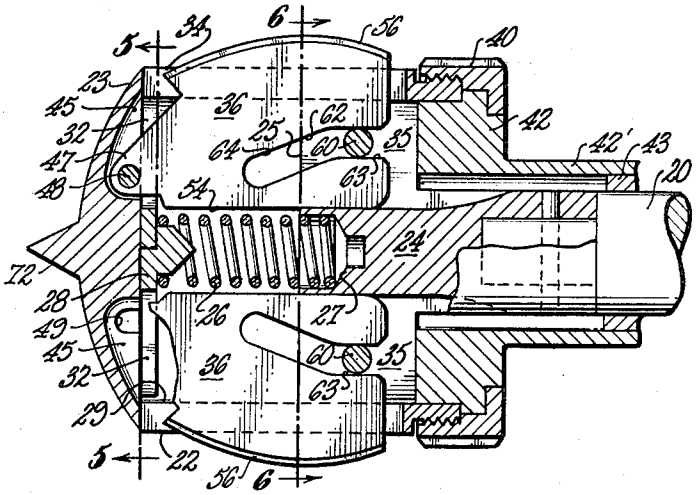


FIG. 4.

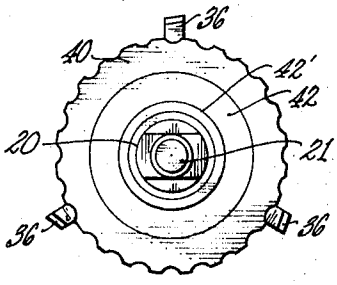


FIG. 3a.

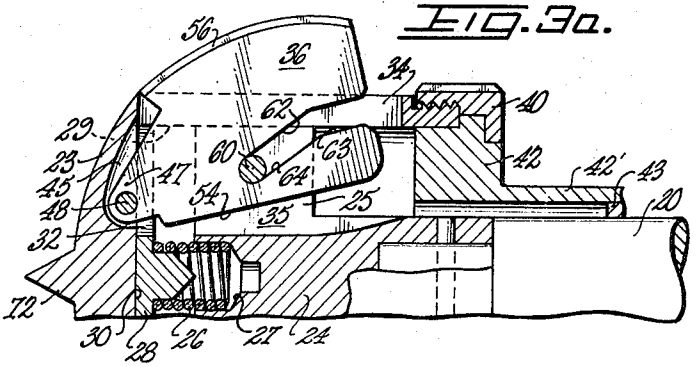


FIG. 5.

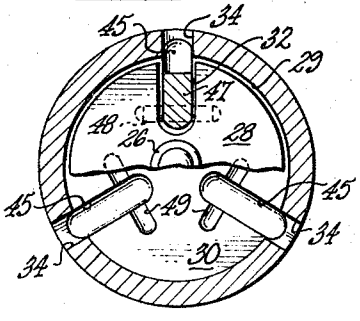
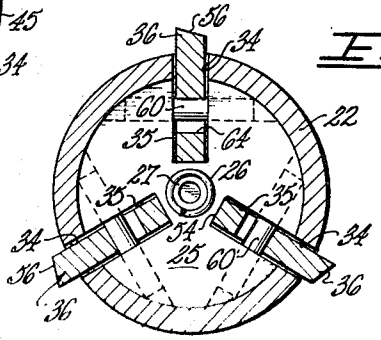


FIG. 6.



INVENTOR.
MEYER FISHBEIN
BY Marcel Hilly
ATTORNEY

FIG. 7.

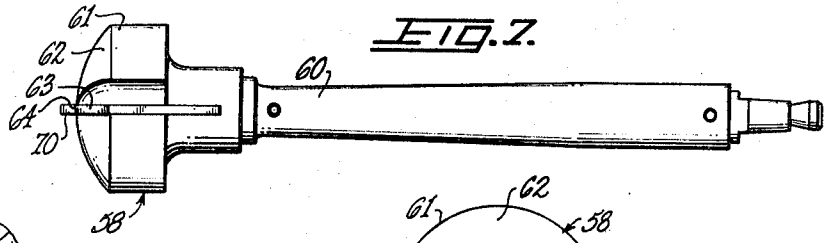


FIG. 9.

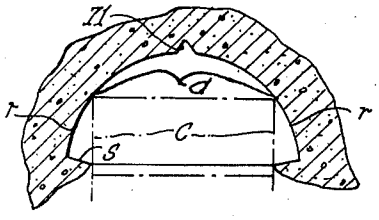


FIG. 8.

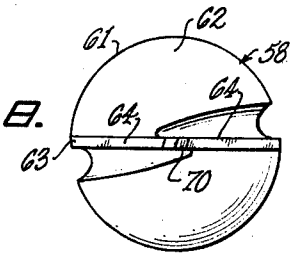


FIG. 10.

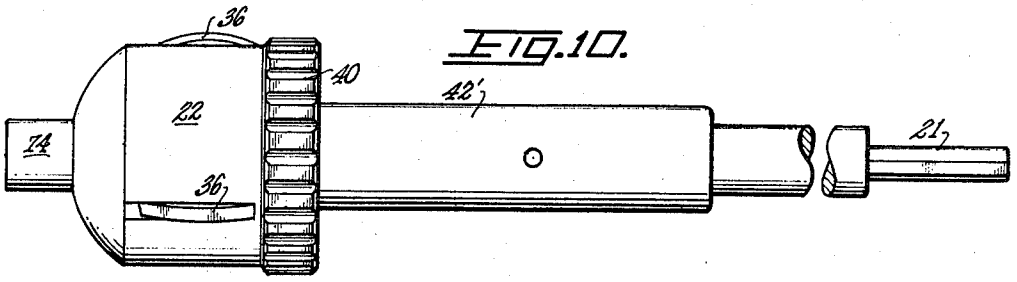


FIG. 11.

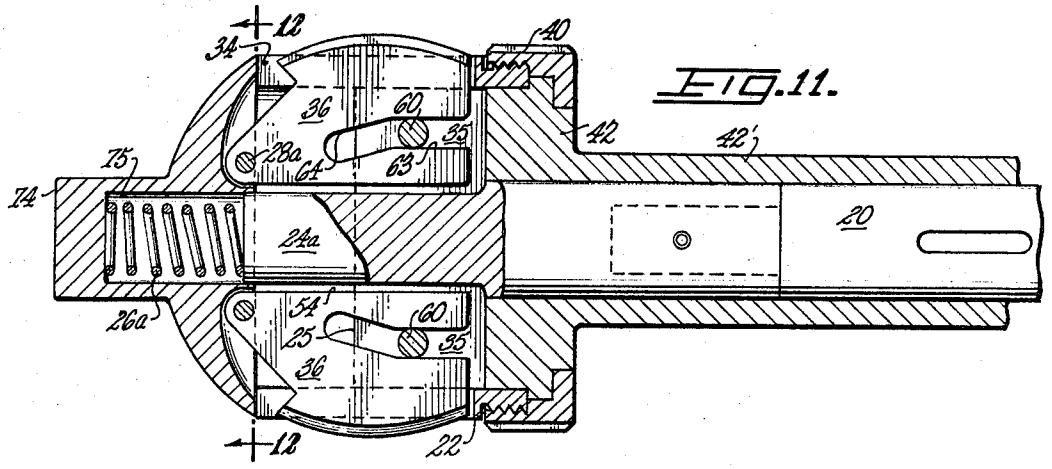
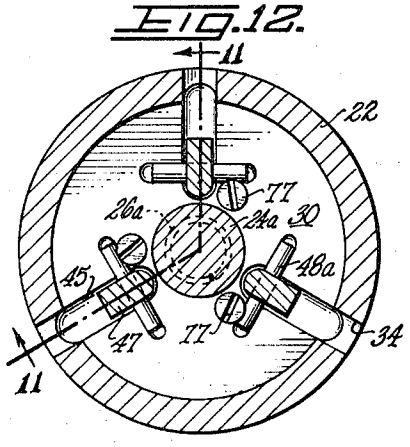


FIG. 12.



INVENTOR.
MEYER FISHBEIN
BY Forrest Kelly
ATTORNEY

SURGICAL EXPANSIVE REAMER FOR HIP SOCKET

FIELD OF THE INVENTION

This invention relates to expanding reamers employed in the preparation of an acetabulum to receive a cup or artificial socket used in "total-hip" reconstructive surgery.

BACKGROUND OF THE INVENTION

To explain the expression "total-hip" surgery, consider the condition wherein the hip socket or acetabulum and the femoral head are badly deteriorated due to arthritis. In elderly patients particularly, this diseased condition dictates the removal of the head (ball) of the femur and its replacement by a polished metal ball with shaft anchored in the intramedullary canal of the femur. To provide a proper bearing surface for the ball, one that will not limit the normal motion of the leg, it is necessary to reform the normal socket, or acetabulum, reaming away the diseased bone and cartilage to make a new structural base to receive a metallic or plastic artificial socket matched to the artificial femoral head. The artificial socket is affixed within the reformed acetabulum by means of an acrylic cement, or other suitable means.

In shaping the acetabulum to receive the artificial socket, the acetabulum is undercut so as to provide a peripheral shoulder against which the cement and artificial socket are seated and thus anchored to the bony structure of the acetabulum.

To accomplish an undercut of the acetabulum, there was developed a reamer whose cutting blades could be manually expanded incrementally. To perform this undercutting task, this reamer, with blades in a retracted position, is inserted into the acetabulum, its location in the acetabulum being predetermined by a hole bored in the center of the acetabulum. After inserting the expanding reamer into the acetabulum, a wheel crank which is connected to a cam is rotated to extend the blades into contact with the surface of the acetabulum. The expanding reamer is then rotated, making the first cut into the walls of the acetabulum bony structure. The cutting operation is stopped momentarily, and a second extension of the blades is made by an angular rotation of the wheel crank to force the blades into a second, deeper engagement with the acetabulum wall. The reamer is rotated again and the cut thus deepened. Such progressive incremental cuts are performed until the surgeon deems the size of the undercut sufficient to form a shelf in the acetabulum to which the cement matrix and artificial socket may be satisfactorily anchored.

The object of this invention is to produce an expanding reamer whose blade extension may be controlled while the reamer is rotating, without need to stop the cutting operation to progressively extend the blades as bony structure is removed. Further objects are to simplify current reamer designs so that unskilled persons can easily disassemble for cleaning and reassembly without the use of any tools, and to improve upon current expanding reamers, which are subject to blades becoming disengaged from their cam actuators, in a way that eliminates this danger completely.

BRIEF SUMMARY OF THE INVENTION

The invention provides a reamer head which is telescopically mounted on the end of a powered drive shaft. This head has a convex, semi-spherical end face of the same diameter and radius of curvature as a previously prepared concavity formed in the central region of the acetabulum; and the purpose, of course, is to extend or widen this previously prepared concavity, on the same spherical curve, using continuously progressively expanding reamer cutters, or under reamer cutters, so as to complete the new socket, but leaving an undercut shoulder around its periphery. The extremity of the drive shaft within the reamer head has a cam actuator which coacts with cam formations on the expansive cutters, which are pivotally mounted in or on the reamer head so as to expand in radial planes of the drive shaft axis. Thus, with the convex end of the reamer head seated in the acetabulum, as earlier described, axial thrust on the rotating drive shaft operates through the cam actuator and cam formations to expand the cutters continuously and progressively as the work proceeds. Maintenance of this axial force, and the outward extension of the cutters, keeps the cutters in direct contact with the wall of the acetabulum as it is cut away. At the point where the surgeon feels that the acetabulum wall has been fully prepared, the rotation is stopped and axial thrust removed. On removal of the axial thrust, a compression spring returns the cutters to their contracted static position, and also returns the drive shaft to its original extended position relative to the reamer head.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings, showing present illustrative embodiments of the invention:

FIG. 1, is a side elevation of a reamer in accordance with the invention, with parts broken away;

FIG. 2, is a front elevation of the reamer of FIG. 1;

FIG. 3, is a section taken on the broken line 3—3 of FIG. 2;

FIG. 3*a*, is a view showing a fragmentary portion of FIG. 3, but with the reamer cutters in expanded position;

FIG. 4, is a rear elevational view of the reamer of FIG. 1;

FIG. 5, is a section taken on line 5—5 of FIG. 3;

FIG. 6, is a section taken on line 6—6 of FIG. 3;

FIG. 7, is a side elevational view of a tool used in the initial preparation of the socket prior to use of the invention;

FIG. 8, is a front elevational view of the tool of FIG. 7;

FIG. 9, is a diagram illustrating the preparation of a hip socket which has been prepared with use first of the reamers of FIGS. 7–8, and next the reamers of the present invention;

FIG. 10, is a side elevational view of another embodiment of the invention;

FIG. 11, is a longitudinal sectional view of the embodiment of FIG. 10 being taken on the section line 11—11 of FIG. 12;

FIG. 12, is a section taken on line 12—12 of FIG. 11.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is first had to the embodiment of the invention shown in FIGS. 1–6. A shaft 20, adapted at one end, as at 21, for coupling to an electric drill motor, not shown, has telescopically mounted on its opposite end a hollow cylindrical reamer head 22 with a convex, forward, semispherical end 23. Pinned onto a reduced end portion of shaft 20 is an actuator comprising a stem 24 having a radially enlarged cylindrical head or piston 25 on which the head 22 is slidably mounted. A coil compression spring 26 seats in a socket 27 in the end of stem 24, and bears at its other end against a radially slotted disc 28 seated at the inner end of the bore 30 in hollow head 22, against the inside surface 30 of end wall 23.

The disc 28 has three radial slots 32, and aligned therewith are three longitudinal slots 34 in the cylindrical side wall of head 22, as well as three radial slots 35 in the piston 25. These sets of slots are spaced apart by 120° and afford accommodation for three radially expansive reamer blades or cutters 36.

The rearward end of the cylindrical side wall of head 22 is reduced and screw threaded to receive a lefthand threaded nut 40 which confines a disc 42 that shoulders against the end of the head 22, and forms a closure and abutment facing the piston 25 mounted on the end of shaft 20. Disc 42 mounts a hollow shaft 42′ containing bearing bushings 43 for the drive shaft 20.

The three cutters 36 are pivotally mounted inside the nose of the head 22, by arrangements best seen in FIGS. 3, 3*a*, and 5. These include three radially disposed slots 45 in the inner face of end wall 23, merging with the three slots 34 in the side wall of the head, as seen best in FIG. 5. These slots 45 receive the cutter tails 47 which are provided with cross-pivot pins 48 receivable in half-round grooves 49 sunk into the inner side of end wall 23, crosswise of but not as deep as the slots 45. The disc 28 held in place by the spring 26, engages and confines the pins 48, and thus holds them pivotally seated in the grooves 49 under spring compression.

FIG. 3 shows the cutters 36 pivoted inward to their normal contracted position, with their inner edges 54 parallel to and in engagement against the stem 24.

The spring 26 is at this time expanded, and the cutter head 22 longitudinally extended to its maximum relative to the shaft 20 on which it is telescopically mounted. The cutters 36 have convex, bevelled cutter edges 54 which in the limiting contracted position of FIG. 3, emerge only to a small degree, appropriate for the beginning of a reaming cut, outside the slots 35 in the head 22.

FIG. 3*a* shows the cutter head with cutters fully expanded. The contour of the convex end 23 of the cutter head is substantially spheric, and the convex cutter edges 54, when the cutters are expanded, are substantial continuations of this spheric or semi-spheric contour.

To progressively expand the cutters from the position of FIG. 3 to that of FIG. 3*a*, the following means have been provided: pins 60 are set into piston 25 transversely across slots 35, and these pins engage in cam slots 62 formed in the cutters 36. These slots open through the rearward ends of the cutters to enable assembly with the pins 60, and have initial portions 63 parallel to the axis of the shaft 20, and secondary camming portions 64 which converge toward said shaft. Accordingly, if head 23 is supported, and shaft 20 subjected to an axial force, to the left in the drawings, the shaft progressively compresses spring 26, and the pins 60, working in the angular portions 64 of the slots 62, cam the cutters outwardly about the pivots 48. Thus, assuming an electric drill motor, not shown, to be coupled to the shaft 20, the head of the reamer seated in a concave cavity already formed in the hip socket and the drill motor operated to rotate the shaft, forward pressure on the drill motor forces the shaft 20 forwardly, and the cutters are expanded in proportion to the pressure exerted until their limit of expansion is reached. By progressive application of pressure, the reamer cutters are progressively expanded, and the expansion can be continuous, and as rapid as is consistent with clean, stable cutting.

Reference is next directed to FIG. 9, showing the acetabulum of a hip, which has been initially prepared for use of the present reamer by use of a known cutter 58 shown in FIGS. 7 and 8. This tool has a shank 60 for rotation by a drill motor, and a head 61 having a convex face 62, with an arcuate cutter blade 63 mounted therein, conforming to but rising a short distance above the face 62, bevelled in back of sharpened cutter edges 64. This cutter is used first to form the central portion of the socket, along the arc *a* FIG. 9. The bone will remain at this stage outside the cylindrical outline indicated at *c*. The tool of the invention is then inserted and seated against the central portion of the spherical socket as thus partly prepared (along region *a*), and then operated as described just above. The cutters 36 will then progressively expand responsively to the axial force exerted by the surgeon on the drill motor, to make a final cut as out to the line *r*. The cuts are manipulated by the surgeon generally so that the cut at *r* leaves a shelf or shoulder at *s*. The artificial plastic socket is then cemented in place according to techniques now in use, making use of the shoulder *s* to assure good anchorage.

The cutter 58 in some case is formed with a center point 70 so as to form a conical center hole 71 in the socket, and in such case, the head of the reamer may, if desired, be formed with a center cone 72 for seating in this center hole, although this is not essential.

FIGS. 10 to 12 show a modification, having a number of parts corresponding generally and substantially exactly in function to components of the first described embodiment. These will be identified by like reference numerals but with the suffix *a* added in the embodiment of FIGS. 10–12. Redescription of these similar parts will not be required.

One difference to be pointed out in the embodiment of FIGS. 10–12 is the substitution for the center point of a cylindrical centering hub 74 which is adapted for insertion and free rotation in a hole previously drilled at the inner end of the acetabulum. The spring 26*a* seats in a socket 75 inside this hub and there is in this case no disc such as the disc 28 of FIGS. 1–6. The cross pins 28*a* are confined but loosely enough to permit pivoting by hold down screws 77.

The drawings and descriptions disclose two present preferred embodiments of the invention but it will be understood that these are for illustrative purposes only and that various changes in design, structure and arrangement may be made without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A rotary bone reamer for use in hip surgery, comprising:
- a drive shaft having a rearward end and forward end adapted for rotation from its rearward end by a driver;
- a cutter head slidably mounted on the forward end portion of said shaft for movement relative thereto between longitudinally extended and longitudinally contracted positions, said cutter head having a convex forward end wall adapted to seat in a previously prepared concavity in the acetabulum;
- a plurality of cutter blades pivotally mounted in said cutter head to swing in spaced radial planes through the longitudinal axis of said shaft between radially contracted and expanded positions;
- a compression spring acting between said shaft and said cutter head to yieldingly urge said shaft and cutter head toward a longitudinally extended position of said shaft relative to said head, and
- actuator means on the forward extremity of said shaft for operatively engaging said cutter blades to progressively expand them radially in response to movement of said shaft from said longitudinally extended position toward said longitudinally contracted position.

2. The subject matter of claim 1, wherein said actuator means includes camming means interacting said shaft and said cutters for radially expanding said cutters in response to relative movement of said shaft toward said cutter head.

3. The subject matter of claim 2, wherein said cutter blades have cam slots convergent toward the forward end of the cutter head, and
- cam actuating pins mounted on said shaft and extending transversely through said slots.

4. The subject matter of claim 1, wherein said cutter head comprises a hollow cylinder, including also:
- means detachably secured to the rearward end of said cutter head including a rear closure wall for said hollow head,
- a bearing sleeve for said shaft fixed to said closure wall and affording said slidable mounting of said head on said forward end portion of said shaft, and
- said forward extremity of said shaft having thereon an enlarged head normally yieldingly seated against the inner side of said closure wall by said compression spring.

5. The subject matter of claim 1, including camming means interacting between the forward end portion of said shaft and said cutters for radially expanding said cutters in response to relative displacement of said forward end portion of said shaft inwards into said cutter head.

6. The subject matter of claim 1, wherein said cutter head comprises a hollow cylinder, including also:
- means detachably secured to the rearward end of said cutter head including a rear closure wall for said hollow head,
- a bearing sleeve for said shaft fixed to said closure wall and affording said slidable mounting of said head on said forward end portion of said shaft,
- said head comprising a piston slidable longitudinally inside said hollow cylinder,
- radial slots in said piston receiving said expansive and contractive cutter blades,
- cam slots in said cutter blades convergent toward the forward end of the cutter head, and
- cam actuating pins mounted on said piston and extending transversely across said radial slots in said piston and through said cam slots in said cutter blades.

7. The subject matter of claim 1, including pivot pins on said cutter blades and half-rounded grooves sunk in the inner side of said forward end wall are used to pivotally mount said cutter blades, and
- a removable plate seated against said end wall and engaged by said spring serves to confine said pivot pins in said grooves under the pressure of said spring.

* * * * *