

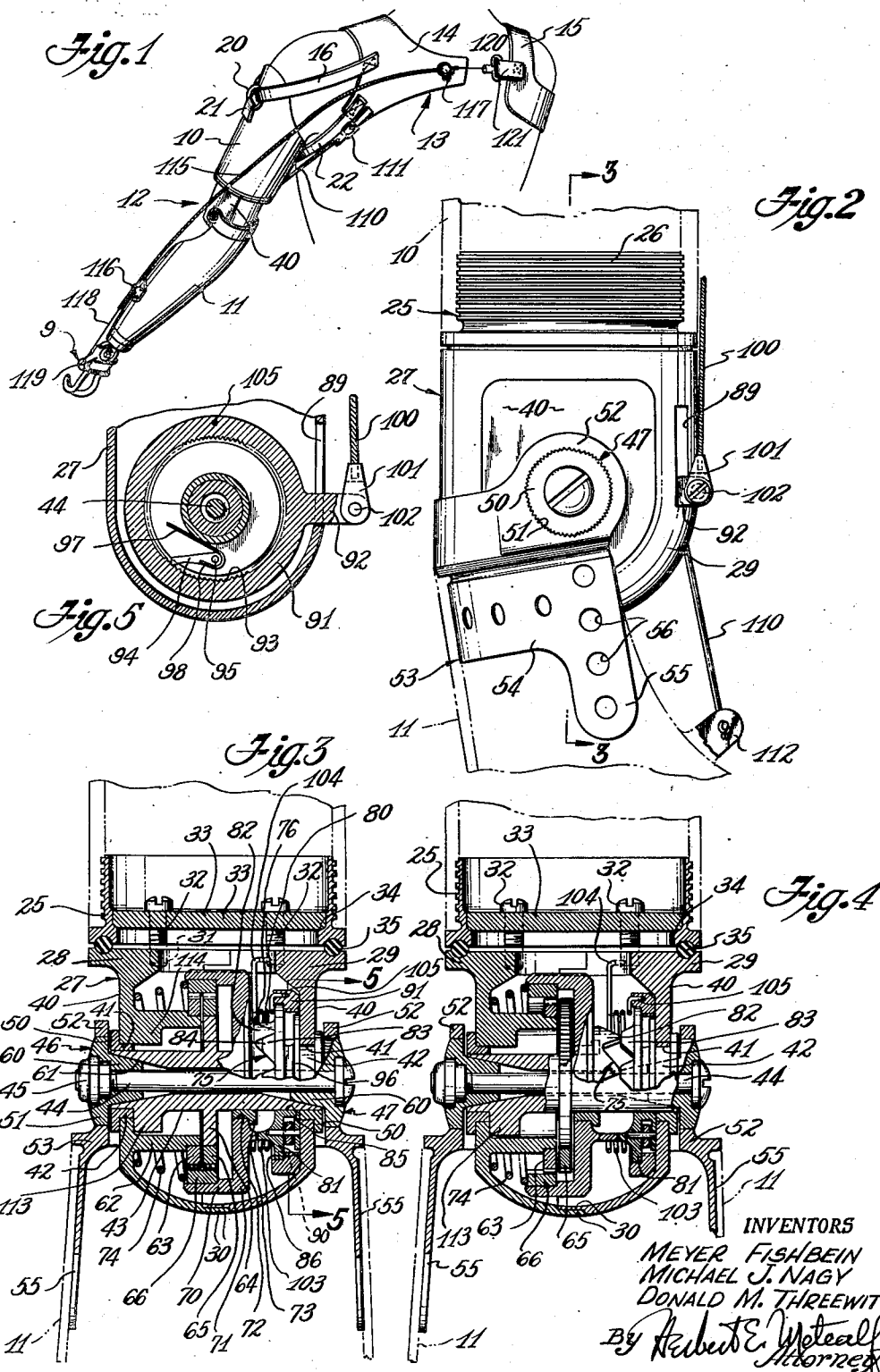
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ARTIFICIAL ARM

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ARTIFICIAL ARM

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1

The present invention relates generally to prosthetic devices, and is more specifically concerned with artificial arms for use in above-the-elbow amputations. The primary object of the invention is to provide a new and improved elbow joint with a locking device therefor, whereby the forearm can be locked with respect to the upper arm in any one of a large number of closely spaced angular positions within the range of its movement.

Another object of the invention is to provide an elbow locking device which is adapted to be locked and unlocked by successive downward and forward shrugs of the shoulder, thereby eliminating the operating button provided for that purpose in certain prior artificial arms. The objection to such operating buttons is that they must be pressed or tapped against the body or some other object in order to lock or unlock the elbow, which is sometimes difficult or inconvenient to do when the arm is in certain positions. Further, the act of pressing the button to actuate the lock, and the audible tap which usually accompanies it, draws attention to the wearer's physical handicap and is a source of embarrassment. With the present invention it is possible, by an almost imperceptible shrug of the shoulder, to operate the lock with the arm in practically any position, and the wearer is thus enabled to perform feats which would otherwise be impossible to accomplish.

Another object of the invention is to provide an elbow joint having a positive locking device, and also embodying friction clutch means permitting the forearm to slip under overload stresses or shock loads so as to protect the locking mechanism against damage and prevent injury to the wearer.

Still a further object of the invention is the provision of an elbow joint which is attached to the upper arm or stump socket by a frictionally resisted swivel connection so that the hinge axis can be turned to give any desired plane of movement to the forearm.

The foregoing and other objects and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description of the preferred embodiment thereof, reference being had to the accompanying drawings, in which:

2

Figure 1 is a perspective view, taken from behind and to one side, of the artificial arm of the invention, showing the manner in which it is worn and the harness for actuating the several mechanisms thereof;

Figure 2 is an enlarged side elevational view of a portion of the same;

Figure 3 is a sectional view taken along the line 3—3 of Figure 2, showing the locking device in its locked condition;

Figure 4 is another view of the same, showing the device unlocked;

Figure 5 is a sectional view taken along the line 5—5 in Figure 3;

Figure 6 is an exploded view of the elbow assembly; and

Figure 7 is a perspective view of the invention from the front.

In the drawings, the artificial arm comprises an upper arm or stump socket 10 and a forearm shell 11 having a hook 9 mounted on the lower end thereof. The forearm shell 11 is connected to the stump socket 10 by the elbow mechanism of the invention, which is designated in its entirety by reference numeral 12.

Both the stump socket 10 and forearm shell 11 are preferably formed of plastic-impregnated fabric such as knit cotton stockinet which is drawn over forms and cured in an oven, giving a rigid, lightweight shell of considerable strength and rigidity. In the case of the stump socket 10, the upper end of the form is made from a cast taken of the stump so as to obtain an accurately formed impression of the stump and thereby insure a comfortable fit. The stump socket 10 is held in place on the stump by means of a harness 13 comprising a pair of shoulder members 14 and 15 which are connected across the chest by a strap 17. A strap loop 16 is connected at its ends to the shoulder member 14 and passes through a ring 20 which is attached by a strap 21 to the stump socket 10 on the outside thereof. A second strap 22 is also secured at its ends to the shoulder member 14 and passes through another ring (not shown) on the inside of the stump socket 10. The two straps 16 and 22 slide freely through their respective rings on the stump socket and hold the latter in place on the stump while at the same time permitting the shoulder

3

to be shrugged either forwardly or rearwardly without restraint from the harness.

In the description which follows of the elbow 12, it is suggested that Figures 3 and 4 be referred to for the manner in which the several parts are assembled together and cooperate to perform their respective functions, while the exploded view of Figure 6 will be found helpful in following the description of the configuration of the separate parts.

The elbow 12 comprises a turntable member 25 having a serrated, annular flange 26 which is embedded in the bottom end of the stump socket shell 10; being assembled with the latter at the time the stockinet material is formed over the mold and cured in the oven. Attached to the turntable 25 is a housing 27 which is divided on its median plane into two halves 28 and 29 having cooperating annular flanges 39 on their abutting edges which are telescopically fitted together to form an interlocked assembly. The base portions of the housing sections 28, 29 are each provided with a pair of tapped holes 31 which receive fillister head screws 32 that are nassed through four holes in a circular plate 33 disposed within the turntable 25. The plate 33 is preferably made of laminated phenolic sheet and is seated on an internal annular shoulder 34 formed on the inside of the turntable. The adjoining end surfaces of the turntable 25 and housing 27 are provided with cylindrical grooves to receive an O-ring 35 of neoprene or other rubber-like material which provides a frictional medium between the two members. When the screws 32 are tightened up, the housing 27 is clamped to the turntable 25 with sufficient resistance against turning, by virtue of the O-ring 35, to withstand ordinary loads. However, if it is desired to turn the elbow so as to give a different plane of movement for the forearm, the housing 27 can be turned in the turntable 25 by either pressing the end of the forearm against a stationary object, or twisting the housing with the other hand.

The opposite sides of the housing 27 are provided with parallel, flat surfaces 40 which are apertured at 41 to receive shouldered bearing members 42. Extending through the housing 27 and journaled in the bearing members 42 is a shaft 43 having a central bore to receive a bolt 44. The head of the bolt 44 and the nut 45 threaded onto the other end thereof are seated in counterbored recesses formed in the outside surfaces of plugs 46 and 47 which are disposed in opposite ends of the shaft 43, said plugs being provided with serrated radial flanges 50 which are seated in companionately serrated holes 51 in side arm portions 52 of a saddle 53. The saddle 53 has a semi-cylindrical body 54 with downwardly projecting arm portions 55 on opposite sides thereof, said body and arm portions being disposed on the inside of the forearm shell 11 and bonded thereto by the plastic material when the shell is formed on the cast and cured in the oven. Holes 56 are provided in the body and arm portions of the saddle to obtain a good bond between the saddle and the forearm shell.

The plugs 46, 47 are each provided with inwardly directed, tapered hubs 60 which are seated within tapered end portions 61 in the central bore of the shaft 43. The tapered hubs of the plugs 56, 57 provide a frictional cone clutch connection between the saddle 53 and the shaft 43 so that when the latter is locked to the upper

4

arm by the positive locking device, to be described presently, and the forearm shell is subjected to overload or shock stresses, this friction clutch connection will permit slippage of the elbow joint and thereby prevent damage to the mechanism or injury to the wearer.

Formed integrally with the left hand half 28 of the housing 27 and projecting inwardly therefrom is a cylindrical hub 62, the inner end of which terminates just short of the center of the housing and is shouldered to receive an external ring gear 63 which is pressed into place. The shaft 43 has a radial flange 64 provided thereon which is disposed closely adjacent the end of the cylindrical projection 62, and pressed onto the periphery of the flange is an external ring gear 65. The ring gears 63 and 65 are substantially identical in shape and size, having the same pitch diameter and the same number of teeth. Meshing with the gears 63, 65 and slidable axially with respect thereto is an internal ring gear 66, the width of which is equal to the combined width of gears 63, 65. Ring gear 66 is pressed into an annular recess 67 in the flange portion 70 of a cup-shaped housing 71. The bottom of the housing 71 is drilled centrally to form a hole 72, and pressed into this hole is a shouldered bushing 73 which is journaled on and slidable axially with respect to the shaft 43. The housing 71 and associated ring gear 66 are urged toward the right to the position shown in Figure 3 by a conic spiral spring 74 which seats at one end against the inside surface of the left hand housing half 28, and at the other end against the side of the ring gear 66.

The two external ring gears 63 and 65, and the internal ring gear 66 cooperate to function as splined or dog-toothed locking members having a large number of closely spaced splines or teeth, so that the forearm is enabled to be locked with respect to the upper arm in any one of a large number of closely spaced angular positions instead of the three or four positions which have heretofore been provided. The shaft 43, which is connected to the forearm, is adapted to be locked to the housing 27 on the upper arm by moving the internal gear 66 so that its teeth mesh with the teeth of both of the gears 63, 65, as shown in Figure 3. In this position, the rotatable gear 65 is locked to the stationary gear 63. The device is unlocked by moving the internal ring gear 66 axially with the housing 71 to the position shown in Figure 4, wherein the ring gear 65 on the shaft 43 is disengaged and thus freed to rotate with respect to its companionate gear 63.

Movement of the housing 71 and gear 66 between locked and unlocked positions is effected by means of a cam arrangement, designated in its entirety by the reference numeral 75, and comprising an annular flange 76 projecting axially from the right hand side of the housing 71 which is engaged by an oppositely extending annular flange 80 provided on a cam member 81. The flanges 76 and 80 are formed with mating saw-toothed cam portions 82 and 83 which cooperate so that when the member 81 is rotated with respect to housing 71, the latter is cammed to the left against the pressure of the spring 74. The crests of the cam teeth 83 are cut off flat to form plateaus 84 upon which the relatively pointed crests of cam teeth 82 bear when the device is in the unlocked condition shown in Figure 4.

The cam member 81 has a central aperture 85 through which the shaft 43 is passed, and is

provided with a radial flange 86 which is seated for free rotation within an annular recess 90 formed in a ring 91. An operating lever 92 projects outwardly from one side of the ring 91 and extends through a slot 89 in the housing section 29. The ring member 91 has a serrated or toothed inner surface 93 that is adapted to be engaged by the free end of a pawl 94 pivoted on a pin 95 which is secured in the cam member 81. The pawl 94 is disposed between the radial flange 86 and another flange 96 on the member 81, which abuts against the inside surface of the flat portion 40 of the right hand housing section 29, the free end of the pawl being urged downwardly into engagement with the toothed surface 93, by a U-shaped leaf spring 97 (Figure 5). One end of the spring 97 is engaged in a notch 98 in the pawl, and the other end bears against the hub of the cam member 81. The pawl 94 engages the teeth 93 and causes the ring member 91 to drive the cam member 81 when turned in a counterclockwise direction. Clockwise rotation of the ring member 91, however, causes the pawl to ratchet freely over the serrations or teeth 93 without transmitting any driving force to the cam member 81. Thus, it will be seen that counterclockwise rotation of the ring member 91 with respect to the housing 71 has the effect of camming the locking device to the unlocked position shown in Figure 4.

The ring member 91 is adapted to be rocked through a limited angular distance by means of a wire or cord 100 having a fitting 101 attached to its end which is connected by a pin 102 to the operating lever 92. The cord 100 passes upwardly along the stump socket 10 through a guide loop 99 on the latter and is attached at its upper end by a strap 106 to the front of the harness shoulder member 14 adjacent the collar bone of the wearer. A downward, forward shrug of the left shoulder (in the case of a left arm amputation, as shown) causes the distance between the upper and lower points of attachment of the strap 106 to lengthen, and produces a pull on the cord 100 which causes the ring member 91 to be rocked upwardly in a counterclockwise direction through sufficient angular distance to raise the cam teeth 82 to the flat tops 84 of cam teeth 83.

When the pull on the cord 100 is relaxed, the ring member 91 is returned to its original position by a coiled torsion spring 103 which surrounds the flanges 76, 80 and is anchored at one end 104 to the housing 27 and secured at the other end 105 in a hole drilled into the ring member 91. The spring 103 exerts a clockwise rotational pull on the member 91 which tends to rotate the latter until stopped by engagement of the lever arm 92 with the bottom end of the slot 89 in the housing 27.

To release the locking device, the shoulder is given another shrug, which pulls upwardly on the cord 100, rocking the cam member 81 sufficiently to move the cam teeth 82 past the ends of the flat plateaus 84 in cam teeth 83. The housing member 71 is then pushed to the right by spring 74, and the cam teeth 82 drop down into full contact with cam teeth 93, shifting the ring gear 66 back into engagement with both gears 63 and 65 to lock the elbow, as in Figure 3. When the cord 100 is released after this second shrug, the ring member 91 is again returned by spring 103 to its original position, with the lever 92 in the bottom of the slot 89.

The forearm is adapted to be raised with respect to the upper arm by means of an elbow lift

control cord 110, one end of which is connected by a strap 111 to the back side of the harness shoulder member 14 at the lower outside corner thereof, and the other end of which is passed through a hole in a lift lever 112 fixed to and projecting forwardly from the forearm shell 11 a short distance below the elbow. The end of the cord 110 is knotted on the other side of the lever arm 112, and the cord is of such length that when the arm is hanging freely at the side of the wearer, the forearm is straightened out. To raise the forearm, the stump socket 10 is swung forwardly, which has the effect of increasing the length between the points of attachment at the ends of the cord 110. The resulting pull on the cord 110, acting on the lever arm 112, causes the forearm to raise to the desired position. If the elbow joint is locked, it is necessary, of course, to unlock the same before the forearm can be raised, and this is done by shrugging the shoulder downwardly and forwardly, as described earlier. A second shrug of the shoulder causes the elbow joint to lock again.

The forearm shell 11 is prevented from swinging rearwardly past its extended position by means of a radially extending limit stop lug 113 which is formed integrally with the shaft 43 adjacent the left hand end thereof. The lug 113 engages one end of a shoulder or boss 114 formed on the inside surface of the cylindrical projection 62 when the arm is straightended out, and prevents further rearward movement of the forearm.

Control of the hook 9 is obtained by means of a Bowden cable comprising a stainless steel flexible conduit 115 which is secured at one end to the forearm shell 11 by an anchor connection 116, and at the other end to the harness shoulder portion 14 on the back side thereof by another anchor connection 117. A wire 118 extends through the conduit 115 and is slidable therein, one end of the wire being fastened to the operating lever 119 of the hook, and the other end of the wire having a fitting 120 attached thereto which is connected by a strap 121 to the back side of the harness shoulder portion 15. Thus, in the case of a left hand artificial arm, as shown in Figure 1, the hook 9 would be opened by a forward shrug of the right shoulder.

Among the advantageous features of the invention is the fact that the elbow can be locked or unlocked by successive shrugs of the shoulder instead of requiring the wearer to tap or press an operating button against the side of his body or against some other object, which is sometimes difficult or inconvenient to do when the arm is raised in certain positions.

Another advantage of the invention is that the large number of teeth on the gears 63, 65, 66 permit the elbow to be locked in a large number of angular positions instead of the three or four provided for in prior devices.

Still a further advantage of the invention is that the swivel connection between the housing 27 and turntable 25 permits the elbow joint to be turned with respect to the stump socket 10 so as to give any desired plane of movement for the forearm shell 11.

While we have shown and described in considerable detail what we consider to be the preferred form of our invention, it is to be understood that such details are merely illustrative and are not to be taken as restrictive on the broad scope of the invention as defined in the claims appended hereto.

We claim:

1. In an artificial arm having a stump socket and a forearm shell, an elbow joint comprising a housing fixed to said stump socket, a shaft fixed to said forearm shell and journaled in said housing, a member fixedly mounted on said housing concentric with the axis of said shaft and having a plurality of angularly spaced teeth projecting therefrom, another member fixed to said shaft coaxial with and adjacent to said first-named member and having a plurality of angularly spaced teeth projecting therefrom, a locking element movable axially between a locked position in engagement with the teeth of both of said members and an unlocked position in engagement with the teeth of only one of said members, a plurality of angularly spaced, equidistant cam teeth projecting axially from said locking element in a circle concentric with the axis of said shaft, a rotatable cam member coaxial with said shaft and having a companionate circle of axially projecting cam teeth engageable with the cam teeth on said locking element to move the latter alternately from one to the other of said locked and unlocked positions when the cam member is rotated a predetermined angular distance in one direction, and means for rotating said cam member through said predetermined angular distance.

2. In an artificial arm having a stump socket and a forearm shell, an elbow joint comprising a housing fixed to said stump socket, a shaft fixed to said forearm shell and journaled in said housing, a member fixedly mounted on said housing concentric with the axis of said shaft and having a plurality of angularly spaced teeth projecting therefrom, another member fixed to said shaft coaxial with and adjacent to said first-named member and having a plurality of angularly spaced teeth projecting therefrom, a locking element movable axially between a locked position in engagement with the teeth of both of said members and an unlocked position in engagement with the teeth of only one of said members, a spring urging said locking element toward said locked position, an annular flange projecting axially from said locking element and having saw-toothed cam portions, a rotatable cam member arranged coaxial with said locking element and having an annular flange provided with cam portions cooperating with said first-named cam portions to shift said locking element from said locked position to said unlocked position against the pressure of said spring, the crests of said second-named cam portions being cut off to form plateaus upon which the crests of said first-named cam portions are adapted to bear to hold said locking element in said unlocked position, and means for successively rotating said cam member through limited angular distances whereby said locking element may be cammed over to said unlocked position or, alternatively, released so that said spring is enabled to return the locking element to said locked position.

3. In an artificial arm having a stump socket and a forearm shell, an elbow joint comprising a housing fixed to said stump socket, a shaft fixed to said forearm shell and journaled in said housing, a member fixedly mounted on said housing concentric with the axis of said shaft and having a plurality of angularly spaced teeth projecting therefrom, another member fixed to said shaft coaxial with and adjacent to said first-named member and having a plurality of angu-

larly spaced teeth projecting therefrom, a locking element movable axially between a locked position in engagement with the teeth of both of said members, and an unlocked position in engagement with the teeth of only one of said members, a spring urging said locking element toward said locked position, cam portions projecting axially from said locking element, a rotatable cam member arranged coaxially with said locking element and having cam portions cooperating with said first-named cam portions to shift said locking element from said locked position to said unlocked position against the pressure of said spring, an operating lever rotatable with respect to said cam member, means providing a driving connection between said operating lever and said cam member in one direction of rotation, a harness adapted to be secured on the shoulders of the wearer, and a cord connecting said operating lever to said harness whereby said cam member can be rotated through limited angular distances by successive shrugs of the shoulder to move said locking element alternately between locked and unlocked positions.

4. In an artificial arm having a stump socket and a forearm shell, an elbow joint comprising a housing fixed to said stump socket, a shaft journaled in said housing, positive locking means for locking said shaft to said housing in any one of several angularly spaced positions, and frictional clutch means connecting said shaft to said forearm shell, whereby said elbow joint is permitted to slip when over-loaded so as to protect said positive locking means against damage and prevent injury to the wearer.

5. In an artificial arm having a stump socket and a forearm shell, an elbow joint comprising a housing fixed to said stump socket, a tubular shaft journaled in said housing, positive locking means for locking said shaft to said housing in any one of several angularly spaced positions, a saddle fixedly mounted on said forearm shell, a pair of opposed plugs secured to said saddle at opposite sides thereof, said plugs having tapered hub portions which are received within correspondingly tapered socket end portions in said shaft, a bolt passing through the center of said shaft and engaging said plugs to draw them tightly into their respective sockets, said plugs providing a frictional cone clutch connection between said shaft and said saddle whereby the elbow joint is permitted to slip when overloaded so as to protect said positive locking means against damage and prevent injury to the wearer.

6. In an artificial arm having a stump socket and a forearm shell, an elbow joint comprising a housing fixed to said stump socket, a shaft fixed to said forearm shell and journaled in said housing, a member fixedly mounted on said housing concentric with the axis of said shaft and having a plurality of angularly spaced teeth projecting therefrom, another member fixed to said shaft coaxial with and adjacent to said first-named member and having a plurality of angularly spaced teeth projecting therefrom, a locking element movable axially between a locked position in engagement with the teeth of both of said members and an unlocked position in engagement with the teeth of only one of said members, a spring urging said locking element toward said locked position, a plurality of angularly spaced, equidistant cam teeth projecting axially from said locking element in a circle concentric with the axis of said shaft, a rotatable cam member coaxial with said shaft and having

a companionate circle of cam teeth engageable with said first-named cam teeth, said cam member being operable to move said locking element from said locked position to said unlocked position against the pressure of said spring, and means for successively rotating said cam member through limited angular distances whereby said locking element may be cammed over to said unlocked position or, alternatively, released so that said spring is enabled to return the locking element to said locked position.

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