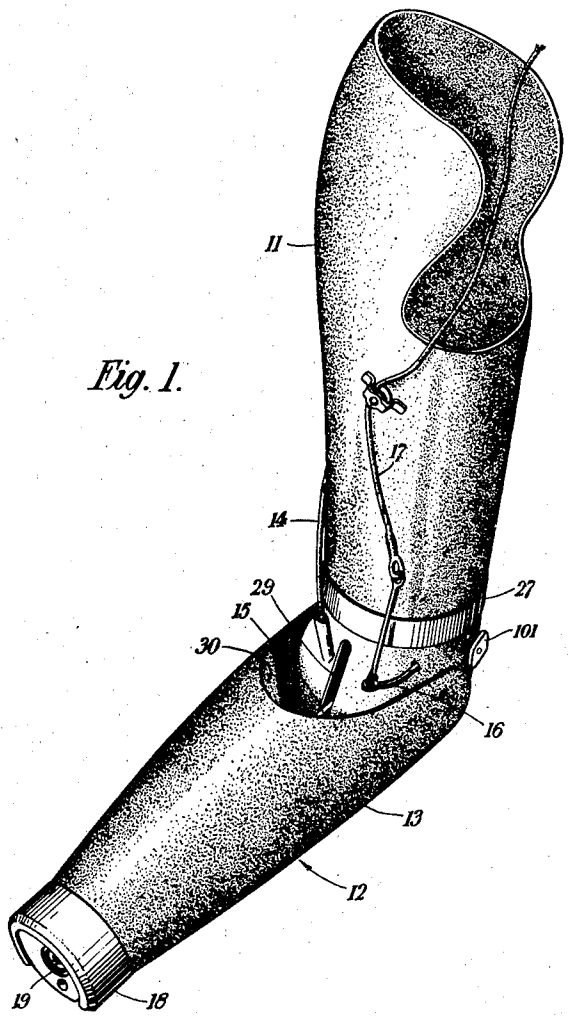
July 26, 1949. J. OTTERMAN 2,477,463

ARTIFICIAL ARM

Filed Feb. 7, 1946 5 Sheets-Sheet 1

Fig. 1.



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ARTIFICIAL ARM

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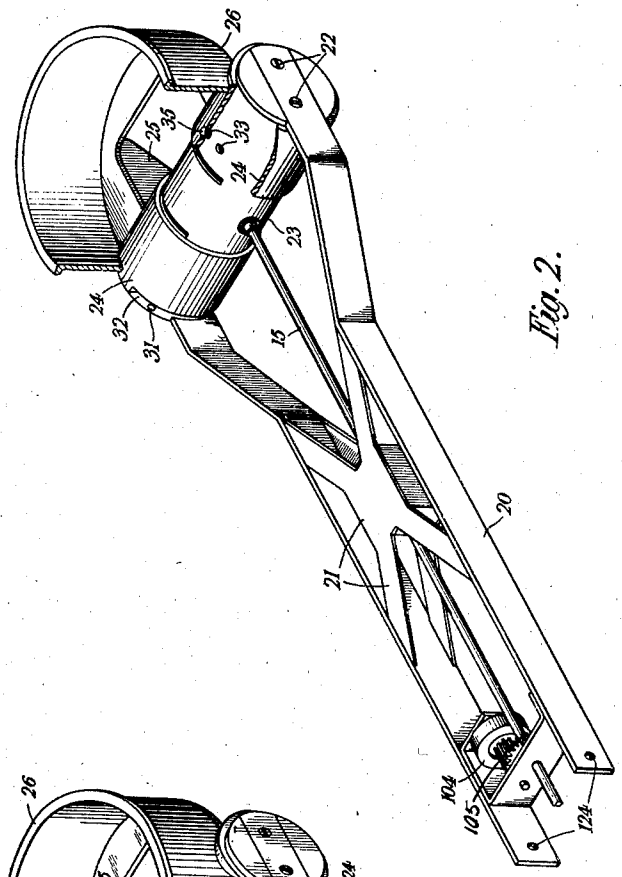

Fig. 2.

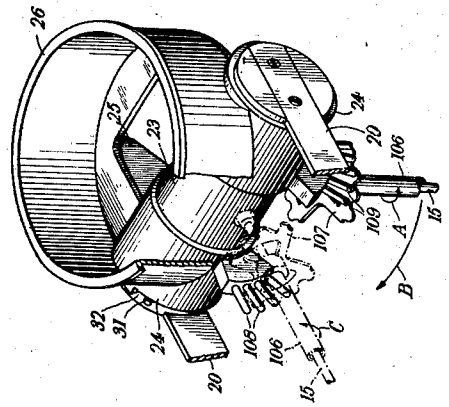

Fig. 10.

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ARTIFICIAL ARM

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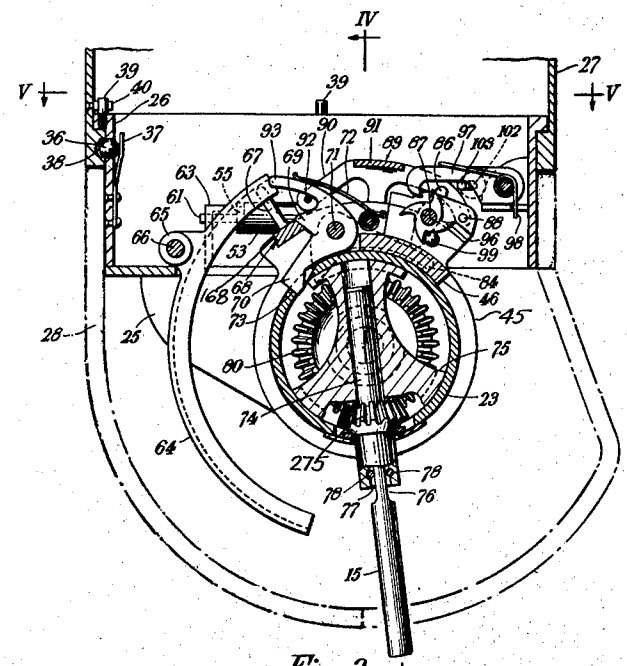

Fig. 3.

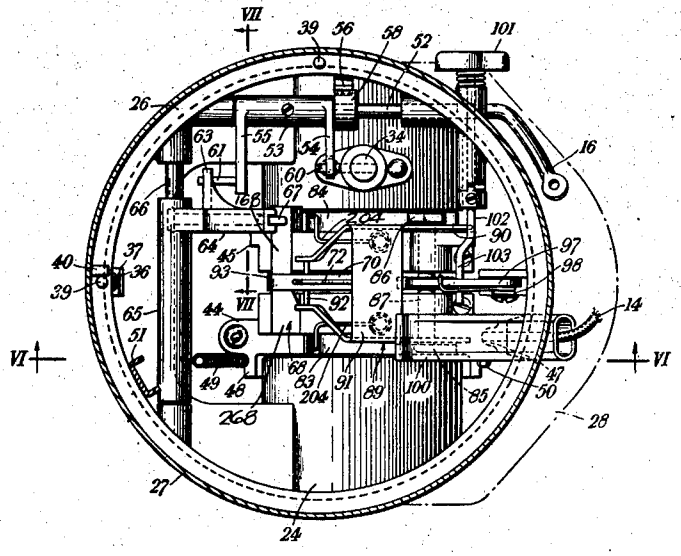

Fig. 5.

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ARTIFICIAL ARM

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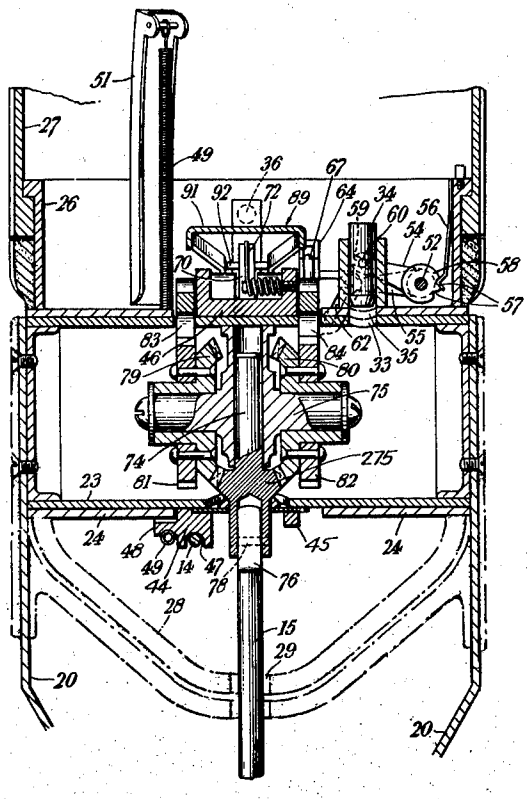

Fig. 4.

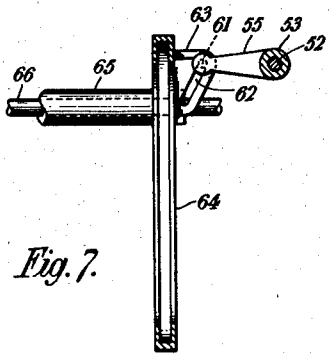

Fig. 7.

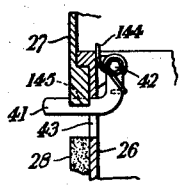

Fig. 9.

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ARTIFICIAL ARM

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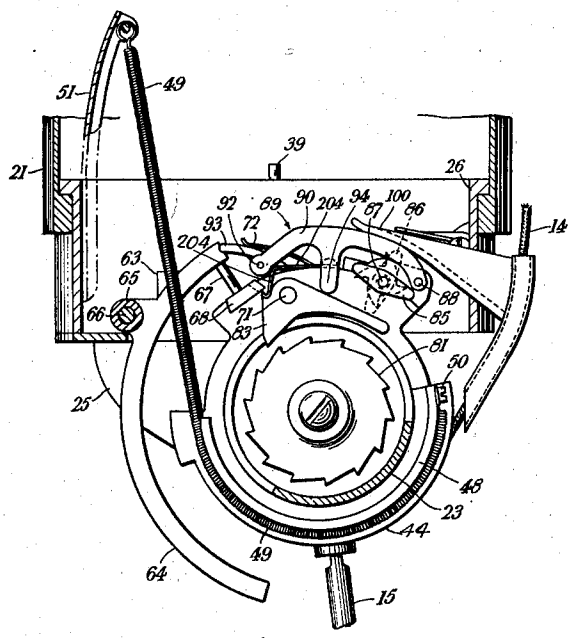

Fig. 6.

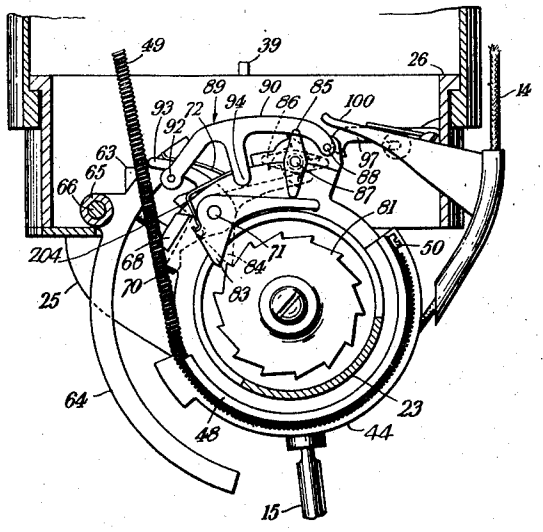

Fig. 8.

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Patented July 26, 1949 2,477,463

UNITED STATES PATENT OFFICE

2,477,463

ARTIFICIAL ARM

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Application February 7, 1946, Serial No. 646,133
In Great Britain September 28, 1945

20 Claims. (Cl. 3—12)

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This invention relates to artificial arms, for use in cases of amputation above the elbow, of the type comprising an elbow joint operable by a flexion cord, wire or the like to flex the arm. The flexion cord, as is well known, is actuated by shoulder movement, chest movement or pedal movement of the person fitted with the arm.

It has been proposed to fit such an arm with a hand and to utilise the traction of the flexion cord to work the hand, usually by pulling a pivoted thumb to open position in relation to fixed fingers against the action of a spring. In the case of this known construction, however, only that part of the traction of the flexion cord over and above that required to flex the arm was available to work the hand, the major part of the traction being utilised to flex the arm or, where the elbow joint has been locked in adjusted position, being expended in taking up lost motion. As the amount of movement which can be given to the flexion cord is at best small, the hand cannot be satisfactorily operated in this way.

The invention provides an artificial arm for use in cases of amputation above the elbow, and comprising an elbow joint for enabling the arm to be flexed, a driving member for imparting movement to a hand or other appliance, an operating member actuable by a flexible cord, and a selector mechanism for coupling the operating member at will either to the elbow joint or to the driving member, and thereby permitting of separate and independent operation of the elbow joint and of the driving member under the control of the flexion cord.

By employing a selector mechanism which can couple the operating member at will either to the elbow joint or to the driving member, the whole of the pull of the flexion cord is available for operating the selected member, i. e. either for flexing the arm or for working the hand or other appliance.

The arm according to the invention will normally comprise a forearm unit, to the wrist part of which will be fitted the hand or other appliance, e. g. a split hook or screw driver, to which the driving member will be coupled. The hand or other appliance is preferably detachable from the arm and coupled thereto by the mechanism described in my copending United States application Serial No. 662,650, filed April 16, 1946, now

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Patent No. 2,427,974. In some cases, however, it may be desirable to couple a screw driver or other appliance directly to the elbow joint, in which case the forearm unit may be dispensed with.

It is preferred to employ, as the driving member, one which receives a rotary movement when coupled by the selector mechanism to the operating member, and is automatically reversed after each operation. Such a reversible rotary driving member is particularly convenient, since it enables a hand of the construction described in E. W. Hobbs' United States application Serial No. 644,498, filed February 3, 1946, now Patent No. 2,464,577, to be utilised in conjunction with the arm the subject of the present invention. Preferably a manually operable means, e. g. a projecting push-button which can be operated by the other hand or by pressure of the arm against a table or other surface, is provided for disabling the reversing mechanism, so enabling the driving member to be continuously rotated in the same direction by repeated traction of the flexion cord. This is desirable when a screw driver appliance is fitted to the arm.

In a preferred form, the arm according to the invention comprises a bucket for attachment to the stump, a forearm unit, a tube carrying the forearm unit and mounted to rotate in relation to the bucket to enable the arm to be flexed, a rotary driving member projecting from the tube, gearing within the tube for rotating the driving member, an operating member actuable by a flexion cord, and a selector mechanism for coupling the operating member at will either to the tube or to the gearing, traction on the flexion cord serving to rotate either the tube or the driving member according to the setting of the selector mechanism. By connecting the rotary driving member to a hand or other appliance fitted to the wrist of the forearm unit, the entire pull of the traction cord can, when the selector mechanism is appropriately set, be utilised for operating the hand or appliance.

A specific form of artificial arm according to the invention will not be described in detail, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of the arm,

Fig. 2 is a perspective view of the forearm

supporting structure and part of the elbow mechanism,

Fig. 3 is a vertical section through the elbow mechanism drawn on an enlarged scale as compared with Figs. 1 and 2 and showing the parts in the position they occupy with the selector mechanism set for flexion of the arm and with the operating member in home position,

Fig. 4 is a section on the line IV—IV in Fig. 3,

Fig. 5 is a sectional plan view of the elbow mechanism, taken on the line V—V in Fig. 3,

Fig. 6 is a section on the line VI—VI in Fig. 5,

Fig. 7 is a section on the line VII—VII in Fig. 5,

Fig. 8 is a view similar to Fig. 6, but showing the parts in the position they occupy with the selector mechanism set for operation of the driving member and with the operating member moved somewhat away from home position,

Fig. 9 is a part sectional view showing an alternative form of latch for locking the forearm against rotary movement in relation to the upper arm, and

Fig. 10 is a diagrammatic perspective view of an alternative form of elbow mechanism which provides for pronation and supination of the hand as the arm is flexed.

Like reference characters denote like parts throughout the figures.

The arm (see Fig. 1) comprises a bucket 11, of leather, or other suitable material, to fit the stump, and a forearm unit 12 enclosed in a plastic sheath 13. A flexion cord 14, which is attached to the wearer's harness in the usual way, serves either to flex the forearm, or to effect rotary movement of a drive shaft 15 according to the setting of a selector mechanism controlled by a selector lever 16 operable by a snatch-pull cord 17. As will be readily understood the cord 17 is worked by the chest muscles to operate the selector lever 16, and the flexion cord 14 is worked by the back muscles to perform the operation selected by the lever 16.

The forearm carries a wrist fitting 18 of the construction described in copending United States application Serial No. 662,650 aforesaid, to which an artificial hand or other appliance can readily be fitted as described in said application, rotary movement being imparted to the hand or appliance from the shaft 15 to operate the same by a barrel 19 in the wrist fitting, which engages a driving member in the hand or appliance as described, in the case of a hand, in United States application Serial No. 644,498 aforesaid.

The skeleton structure of the forearm unit 12, enclosed within the plastic casing 13, is shown in Fig. 2. It consists of a pair of light metal side members 20 united by cross bracings 21 and secured at their upper ends by screws 22 to a cylinder 23 (see also Fig. 4). At their lower ends the members 20 are secured to the wrist fitting 18 (not shown in Fig. 2) by screws passed through holes 124 in the members 20.

The cylinder 23 is rotatable in trunnion bearings 24 fixed to, and supported by webs 25 from, a ring fitting 26 carried by the bucket (see also Fig. 3). The ring fitting 26 is outwardly flanged at its upper end and rotatable in relation to an inwardly flanged ring fitting 27 (Figs. 1 and 3) fixed to the lower end of the bucket 11. A plastic cap 28 is fixed to the lower end of the ring fitting 26 and serves as a housing for the elbow mechanism, being provided with a slot 29 (Fig. 1) through which the drive shaft 15 may pass.

It will be noted from Figs. 2 and 3 that the axis of the cylinder 23 is forwardly offset from the axis of the bucket and ring fitting 26, instead of intersecting the axis of the bucket as is normal practice. This has the advantage that the fore arm can be flexed through a larger angle in relation to the upper arm. It also permits of shaping of the plastic cap 28 with a forwardly bulged portion as shown in Figs. 1 and 3—the plastic sheathing being cut-away as indicated at 30 in Fig. 1 to enable it to move over said forwardly bulged portion as the arm is flexed. This shaping of the cap 28 is of advantage as reducing the tendency of the wearer's clothing to be caught between the forearm and upper arm, as compared with normal constructions in which the cap is hemispherical.

The flexion of the forearm is limited by a stud 31 (Fig. 2) on the cylinder 23 which projects upwardly into a slot 32 in the left hand trunnion 24, the ends of the slot 32 defining the limiting up and down position of the forearm in relation to the upper arm. The cylinder 23 is provided with a number of holes 33, two of which are seen in Fig. 2, which are engaged by a locking bolt 34 (Fig. 4) as later described to lock the forearm in adjusted position, a hole 35 being provided in the right hand trunnion 24 to allow the bolt 34 to move into locking position.

The forearm is rotatable about the axis of the upper arm by virtue of the rotatable mounting of the ring fitting 26 in the ring fitting 27, and is normally locked in adjusted position by engagement of a ball 36, pressed by a spring 37, in one of a series of recesses 38 in the member 27 as shown in Fig. 3. If the wearer wishes to alter the setting of fitting 26, and therefore of the forearm, in relation to fitting 27, he can do so by pushing on the forearm and moving it round to the desired position, whereupon the ball 36 will engage with another of the recesses 38 to relock the forearm. This rotational movement of the forearm is limited by upstanding studs 39 on the fitting 26 in cooperation with an inwardly projecting stud 40 on the fitting 27 (see Figs. 3 and 5).

Fig. 9 shows an alternative and more positive form of lock, which should preferably be used in conjunction with the ball lock shown in Fig. 3. This alternative lock comprises a latch 41, pivoted at 42 to the fitting 26 and projecting through a slot 43 in fitting 26. This latch is spring pressed by a spring 144 into engagement with a selected one of a number of slots 145 in fitting 27, and requires downward pressure on its projecting end to release the fitting 26 for rotation in relation to the fitting 27.

On the cylinder 23, and between the trunnions 24, is rotatably mounted a pulley member, comprising a pair of spaced rings 44, 45 (Figs. 3–6) united by a bridge piece 46. The ring 44 is formed with a pulley groove 47 (Fig. 4) for the flexion cord and also with an outstanding grooved flange 48 to accommodate the tension spring 49. This, as shown most clearly in Fig. 6, is fixed at one end by a screw 50 to the pulley member, and at the other to an upstanding bracket 51 fixed to the ring fitting 26. The spring 49 normally retains the pulley member in the home position shown in Figs. 3–6, but traction on the flexion cord 14 will be effective to move the pulley member anti-clockwise from this home position as seen in Fig. 6.

Rotary movement of the pulley member is effective, according to the setting of the selector lever 16, either to flex the arm or to impart rotary movement to the drive shaft 15 to cause the same to operate the hand or other appliance fitted to the wrist mechanism 18. The selector lever 16 (Fig. 5) is constituted by a cranked extension of

a shaft 52, to which is fixed a sleeve 53 carrying outstanding arms 54, 55. As shown in Fig. 4, a leaf spring 56 fixed to the ring fitting 26 cooperates with one or other of two notches 57 in a member 58 fixed to shaft 53 to hold the selector lever 16 in adjusted position. By a snatch pull on the cord 17 (Fig. 1) the lever 16 can be raised from the lowered position to rotate shaft 52 clockwise into the position shown in Fig. 4; while when the lever 16 is moved down again, the shaft 52 is rotated anti-clockwise until spring 56 engages with the lower of the two notches 57. The lever 16 can be returned to the down position by pressure on a table or any other convenient surface, or by means of the other hand.

When the lever 16 is in the up position, rotation of the pulley member is effective to flex the arm. The arm 54 has a slot 59 (Fig. 4) engaging a pin 60 on the bolt 34, and in the up position of lever 16 the arm 54 holds the bolt lifted, as shown in Fig. 4, to permit the cylinder 23 to rotate in the trunnions 24. The other arm 55 on the sleeve 53 carries a projecting pin 61 engaging a slot 62 (Fig. 7) in a bracket 63 secured to a part circular channel member 64 carried by a sleeve 65 slidably mounted on a rod 66. When the lever 16 is in the up position, the arm 55 holds the sleeve 65 in the bottom end position on rod 66 as seen in Fig. 5. Engaging the channel member 64 is a pin 67 on a cam slide 68 and in the position of the parts shown in Figs. 3–7 the cam slide 68 is maintained with its narrow portion 168 (Fig. 3) opposite an abutment 69 on a coupling pawl 70 (Fig. 3). The pawl 70 is pivoted on a pin 71 extending between rings 44, 45 of the pulley member and in this position of cam slide 68 a spring 72 urges the coupling pawl 70 into engagement with a notch 73 in the cylinder 23. As the bolt 34 is in the free position, traction on the flexion cord will therefore effect rotation of the cylinder 23, which is now coupled for rotation with the pulley member, and raise the forearm.

It will be understood that in Figs. 3–6 the forearm is shown in the down position, and the notch 73 is consequently in register with pawl 70 in the home position of the pulley member. Should the forearm be in an up position when the selector lever 16 is moved up to retract the bolt 34, the forearm will tend to drop due to its weight until the pawl 70 comes opposite the notch 73 to engage the latter and permit of controlled flexion of the arm by the flexion cord.

When the lever 16 is moved to the down position, the arm 54 will move the bolt 34 down to engage one of the holes 33 in the cylinder 23 to lock the forearm. If the bolt 34 is then not immediately opposite a holt 33, the forearm will fall slightly by gravity to allow the bolt to engage a hole almost immediately. Downward movement of lever 16 likewise displaces sleeve 65 to its up position on rod 66 (as seen in Fig. 5) thereby bringing the wide part 268 (Fig. 5) of cam slide 68 into contact with the abutment 69 on the pawl 70 to retract the latter from the notch 73. The pulley member is now free to rotate on the cylinder 23. Movement of the lever 16 to the down position also renders operative mechanism for rotating the drive shaft 15, which mechanism is rendered ineffective when the lever 16 is in up position as will be later described.

The drive shaft 15 is coupled to a shaft 74 journalled in a spider 75 fixed inside the cylinder 23 by the coupling shown in Fig. 3. This consists of a flat 76 on the end of the shaft 15, which engages between a pair of transverse pins 78 fitted in the hollow end 77 of the shaft 74. The lower end of the drive shaft 15 is connected, inside the wrist fitting 18 to the barrel 19 by a similar coupling. These couplings permit of effective transmission of the drive from the shaft 74 to the barrel 19, even though these may be brought out of alignment to some extent, e. g. as the result of bending of the forearm skeleton structure when carrying a heavy weight.

A bevel wheel 275 on shaft 74 meshes with a pair of bevel wheels 79, 80 supported by the spider 75 and carrying respectively ratchet wheels 81, 82. A pair of pawls 83, 84 are pivoted on the pin 71 carried by the pulley member and are constrained by light springs 204 to engage the ratchets 81, 82 respectively. Tappets 85, 86 on a shaft 87 mounted for rotation in the pulley member, however, cooperate with the tails of the pawls 83, 84 to ensure that only one of the pawls can engage its ratchet at any time, the tappets being differently offset in relation to the shaft 87 as shown.

When the lever 16 is in the up position to select flexion of the arm, both pawls 83, 84 are held inoperative, irrespective of the position of the shaft 87, by the following mechanism. Pivoted at 88 (see Fig. 6) to the pulley member is a rocker frame 89 consisting of two side members 90 joined by a bridge piece 91. A pin 92 joining the forward ends of the side members 90 engages beneath an extension 93 of the coupling pawl 70, and when the coupling pawl 70 is in engagement with the recess 73 in the cylinder 23, the rocker frame 89 is held by the spring 72, in the position shown in Figs. 3 and 6, in which fingers 94 on its side members cooperate with the tails of pawls 83, 84 to hold disengaged that one of the pawls which is not so held by its tappet, as shown in Fig. 6; the spring 72 being stronger than the pawl-engaging spring 204.

When, however, the coupling pawl 70 is moved to disengaged position by downward movement of the lever 16, the rocker frame 89 is moved clockwise about its pivot 88 from the position of Fig. 6 to that of Fig. 7, thus lifting the fingers 94 and allowing one of the pawls 83, 84 to engage its ratchet. This, assuming the selector lever 16 to be moved down when the pawls are in the position shown in Fig. 6, would be the pawl 83 whose tappet 85 is in horizontal position. The other pawl 84, despite upward movement of the cooperating finger 94, would be held disengaged by its tappet 86 which is in a vertical position.

When the lever 16 is in down position therefore, traction on the flexion cord will rotate one or other of the ratchets and thus cause rotation of the drive shaft 15 in a direction determined by which of the ratchets 81, 82 is coupled to the pulley member by its associated pawl.

Provision is made as follows for reversal of the pawl and ratchet engagement, and therefore of the direction of rotation of shaft 15, on successive operations of the flexion cord. This is required where opening or closing of the hand is determined by the direction of rotation of shaft 15 as described in United States application Serial No. 644,498 aforesaid. The shaft 87 carrying the tappets 85, 86 also carries a star wheel 96 cooperating with a change-over pawl 97 pressed towards it by a spring 98 (Fig. 3). On return movement of the pulley member clockwise to home position under the influence of spring 49, the star wheel 96 pushes the pawl 97 aside. At the beginning of the next traction stroke, however, the star wheel 96 will, as the pulley member begins

to turn anti-clockwise, engage the pawl 97 and be rotated by it through 90° to the position shown in Fig. 8, a spring-pressed ball 99, which projects between adjoining teeth of the star wheel, being pushed aside as the star wheel turns, but springing forward again between the teeth to ensure true rotation through 90° of the star wheel. This 90° rotation reverses the position of the tappets, as shown, and therefore the position of the pawls, so that the required reversal of the direction of rotation of shaft 15 is obtained.

Shortly before the pulley member reaches home position on clockwise movement thereof by the spring 49, a fixed cam 100 engages the rocker frame 89 to rock it clockwise into position to hold both pawls disengaged. This is to prevent further rotation of shaft 15 in the previously selected direction during the initial part of the next traction stroke and before the star wheel 96 has been able to reverse the tappets. Immediately after the star wheel has performed its 90° rotation the rocker frame 89 clears the cam 100 and the spring 72 returns it to the position shown in Fig. 8 in which the selected pawl is free to engage.

In some cases, as when the wearer is unable at one traction stroke to effect sufficient rotation of shaft 15 in the selected direction to open or close the hand, or desires to rotate a screw driver a number of times in the same direction, it is desirable to disable the tappet reversing mechanism. This can be effected by rotation of a knob 101 (see Figs. 1 and 5) fixed to a spindle 102 having a cranked extension 103. When the knob is turned clockwise as seen in Fig. 3 from the position shown, the extension 103 lifts the pawl 97 clear of the star wheel 96 and so disables the tappet reversing mechanism, until such time as the knob is restored to its original position.

Sometimes the wearer may be so injured that several part pulls on the flexion cord are needed fully to open or close the hand. In this case the traction on the cord will not be relieved sufficiently at the end of each pull to allow the reversing gear to come into operation, and the efforts of the wearer are assisted by a relatively massive momentum wheel 104 (Fig. 2) near the wrist fitting, coupled to the shaft 15 by gearing 105. This will act as a flywheel and maintain the shaft 15 in rotation during the intervals between the pulls on the flexion cord, thus smoothing the movement of the hand from a series of jerks to a continuous movement.

In conclusion, it may in some cases be desired to effect pronation and supination of the hand as the arm is flexed, i. e. to cause the hand to rotate relatively to the wrist fitting, so as to approach the thumb towards the body, as the forearm commences to move up from its lowermost position and thereafter to rotate in the reverse direction relatively to the wrist fitting as the forearm approaches the fully up position. Provision for this may be made as shown diagrammatically in Fig. 10.

In this case the forearm carries a rotatable sleeve 106 surrounding the shaft 15. Fixed to the upper end of the sleeve 106 is a mutilated gear 107 adapted to engage two series of pegs 108, 109 fixed to the trunnions 24. Starting from the down position of the forearm shown in full lines, the gear 107 first engages the pegs 109, thereby causing the sleeve to rotate in the direction of the arrow A, as the forearm carried by cylinder 23 swings up as shown by arrow B in relation to the fixed pegs. As the forearm continues to move up, the gear 107 will come out of mesh with the pegs 109 and engage the pegs 108. Continued upward movement of the forearm will then cause reverse rotation of the sleeve 106 in relation to shaft 15 as shown by the arrow C.

Rotary movement of sleeve 106 is arranged to effect rotary movement of the hand in relation to the wrist fitting as described in United States application Serial No. 662,650 aforesaid.

What I claim as my invention and desire to secure by Letters Patent is:

1. An artificial arm for use in cases of amputation above the elbow, and comprising a bucket for attachment to the stump, a forearm unit, a tube carrying the forearm unit and mounted to rotate in relation to the bucket to enable the arm to be flexed, a rotary driving member projecting from the tube and serving to impart operating movement to an appliance at the wrist of the forearm unit, gearing within the tube for rotating the driving member, a pulley mounted to rotate on the tube, a spring biasing the pulley to a home position, said pulley being rotatable from home position against said spring by traction on a flexion cord, and a selector mechanism for coupling the pulley at will either to the tube or to the gearing, whereby rotation of the pulley by the flexion cord will be effective, according to the setting of the selector mechanism, to rotate said tube or to operate said gearing to rotate said driving member, said selector mechanism including a lever and a pawl controlled thereby for coupling the pulley, in one position of the lever, to the tube to cause rotation thereof with the pulley in the direction to raise the forearm unit.

2. An artificial arm as claimed in claim 1, having a lock for locking the tube in various positions of adjustment thereof in relation to the bucket and a connection between the lever and the lock for releasing the lock on movement of the lever into position to couple the pulley to the tube and for re-engaging the lock on movement of the lever into position to couple the pulley to the rotary driving member.

3. In an artificial arm the combination of a tube supporting a forearm unit, bearings on an upper arm unit for supporting the tube, a rotary driving member extending forwardly from the tube along the forearm unit, gearing within the tube for rotating the driving member, said gearing comprising a pair of gear wheels, which are alternatively operable on the driving member to drive it in opposite directions, a pair of ratchets one for driving each gear wheel, an operating member actuable by a flexion cord and rotatably mounted on the tube, a spring for biasing the operating member to a home position, a pair of pawls carried by said operating member and one associated with each of the ratchets, a shaft rotatably mounted on the operating member, a pair of tappets carried by the shaft and serving to maintain one or other of the pawls disengaged from its ratchet according to the position of the shaft, a star wheel on the shaft, and a change-over pawl arranged to cooperate with the star wheel to reverse the position of the tappets and therefore the engagement of the pawls at each operation of the flexion cord.

4. Apparatus as claimed in claim 3, in which the change-over pawl is effective to rotate the star wheel as the operating member commences to move from its home position, and comprising a fixed cam operative to maintain both pawls

disengaged from their ratchets when the operating member is in the home position and until it has moved therefrom sufficiently for the star wheel to operate.

5. Apparatus as claimed in claim 3, comprising a selector member movable from a first to a second position, a lock for locking the tube against rotation in relation to its bearings, means for retaining the lock in locking position when the selector member is in its first position and for retracting the lock from locking position when the selector member is in its second position, a driving pawl controlled by the selector member and operable to couple the operating member to the tube to effect rotation thereof only when the selector member is in its second position, and means operated by the selector member when in its second position for holding both of the ratchet-engaging pawls disengaged from their ratchets.

6. Apparatus as claimed in claim 3, comprising a selector member movable from a first to a second position, a lock for locking the tube against rotation in relation to its bearings, means for retaining the lock in locking position when the selector member is in its first position and for retracting the lock from locking position when the selector member is in its second position, a driving pawl controlled by the selector member and operable to couple the operating member to the tube to effect rotation thereof only when the selector member is in its second position, and a rocking frame mounted on the operating member and cooperating with the ratchet engaging pawls and with the driving pawl, said rocking frame maintaining both ratchet engaging pawls disengaged when the driving pawl is in operative position but freeing the ratchet engaging pawls for engagement with their ratchets when the driving pawl is moved out of operative position.

7. Apparatus as claimed in claim 3, comprising a selector member movable from a first to a second position, a lock for locking the tube against rotation in relation to its bearings, means for retaining the lock in locking position when the selector member is in its first position and for retracting the lock from locking position when the selector member is in its second position, a driving pawl controlled by the selector member and operable to couple the operating member to the tube to effect rotation thereof only when the selector member is in its second position, a rocking frame mounted on the operating member and cooperating with the ratchet engaging pawls and with the driving pawl, said rocking frame maintaining both ratchet engaging pawls disengaged when the driving pawl is in operative position but freeing the ratchet engaging pawls for engagement with their ratchets when the driving pawl is moved out of operative position, and a fixed cam for cooperating with the rocking frame to cause it to maintain the ratchet engaging pawls disengaged when the operating member is in the home position.

8. In an artificial arm the combination of a tube supporting a forearm unit, bearings on the upper arm unit for supporting the tube, a rotary driving member extending forwardly from the tube along the forearm unit, said driving member serving, when rotated, to impart operating movement to an artificial hand, gearing within the tube for rotating the driving member, means for turning the tube in its bearings to flex the arm, a sleeve surrounding the driven member and rotatably supported by the forearm unit, a mutilated gear on said sleeve, and pegs on the bearings which serve to engage the gear, as the arm is flexed, to effect rotation of the tube first in one direction and then in the reverse direction and thereby to impart movements of pronation and supination to the hand.

9. An artificial arm for use in cases of amputation above the elbow and comprising a bucket for attachment to the stump, a forearm unit, a tube carrying the forearm unit and mounted to rotate in relation to the bucket to enable the arm to be flexed, a rotary driving member projecting from the tube, gearing within the tube for rotating the driving member, said gearing comprising a pair of gear wheels which are alternatively operable on the driving member to drive it in opposite directions, a rotary operating member actuable by a flexion cord, a selector mechanism for coupling the operating member at will either to the tube or to the gearing to enable traction on the flexion cord to rotate either the tube alone or the driving member alone according to the setting of the selector mechanism, a ratchet associated with each gear wheel, a pair of pawls carried by the operating member, one for cooperation with each ratchet, mechanism operable by the selector mechanism for moving the pawls into and out of operative relationship with the ratchets, means connecting the pawls for maintaining one of the pawls disengaged from its ratchet when the other is engaged, and a reversing mechanism which operates automatically to reverse the pawls and therefore the direction of rotation of the driving member between consecutive operations thereof.

10. An artificial arm for use in cases of amputation above the elbow, comprising a bucket for attachment to the stump, a forearm unit, a cylinder fixed to the upper end of the forearm unit, bearings carried by the bucket for supporting the cylinder, a ring fitting for supporting the bearings, a cooperating ring fitting on the bucket in relation to which the first mentioned ring fitting is mounted for rotation and means for latching the two ring fittings together in one of a plurality of positions of relative adjustment.

11. An artificial arm for use in cases of amputation above the elbow, comprising a bucket for attachment to the stump, a forearm unit, a cylinder fixed to the upper end of the forearm unit, bearings carried by the bucket for supporting the cylinder, a wrist fitting at the end of the forearm unit, means operable by a flexion cord for rotating the cylinder in its bearings to flex the arm, a rotary driving member projecting from the cylinder, means likewise operable by the flexion cord for rotating the driving member, a driven member in the wrist fitting, a drive shaft coupling the driving member and the driven member, said drive shaft having flattened ends engaging within hollow ends of said driving and driven members, a pair of transverse pins located in the hollow portion of the driving member and engaging the associated flat on the drive shaft between them to drive it, and a further pair of transverse pins located in the hollow portion of the driven member and engaging the associated flat on the drive shaft to impart rotary movement from said shaft to said driven member.

12. An artificial arm, for use in cases of amputation above the elbow, and comprising an elbow joint for enabling the arm to be flexed, a rotary driving member for imparting movement to a hand or other appliance, an operating member

actuable by a flexion cord, a first one way driving connection for imparting movement from said operating member to said elbow joint, a second one way driving connection for imparting movement from said operating member to said driving member, and a selector mechanism interlinking said one way driving connections so that but one of them at a time is effective, said selector mechanism being movable at will to alternative positions, in one of which the first one way driving connection is effective to enable traction on the flexion cord to operate the elbow joint and flex the arm and in the other of which the second one way driving connection is effective to enable traction on the flexion cord to rotate the driving member.

13. An artificial arm, for use in cases of amputation above the elbow, and comprising an elbow joint for enabling the arm to be flexed, a rotary driving member for imparting movement to a hand or other appliance, an operating member actuable in forward direction from a neutral position by a flexion cord, a spring for returning the operating member to neutral position on release of tension in the flexion cord, a first one way driving connection for transmitting forward movement from the operating member to the elbow joint, a second one way driving connection for imparting, on forward movement of the operating member, movement in either of two directions to the rotary driving member, a selector mechanism interlinking said one way driving connections so that but one of them at a time is effective, and a reversing mechanism, operative only when the selector mechanism is positioned to render said second one way driving connection effective for automatically reversing the direction of the rotation imparted to the driving member by successive forward movements of the operating member.

14. An artificial arm as claimed in claim 13, comprising manually operable means for rendering the reversing mechanism ineffective.

15. An artificial arm for use in cases of amputation above the elbow and comprising a bucket for attachment to the stump, a forearm unit, a tube carrying the forearm unit and mounted to rotate in relation to the bucket to enable the arm to be flexed, a rotary driving member projecting from the tube, gearing within the tube for rotating the driving member, an operating member actuable in forward direction from a neutral position by a flexion cord, a spring for returning the operating member to neutral position on release of tension in the flexion cord, a first one way driving connection for transmitting forward movement from the operating member to the tube, to enable the tube to be rotated by a pull on the flexion cord to flex the arm, a second one way driving connection for transmitting forward movement from the operating member to the gearing to enable the gearing to be operated by a pull on the flexion cord to rotate the driving member, and a selector mechanism interlinking said one way driving connections so that but one of them at a time is effective.

16. In an artificial arm, the combination of a tube supporting a forearm unit, bearings on an upper arm unit for supporting the tube, a rotary driving member extending forwardly from the tube along the forearm unit, forward and reverse gearing within the tube for rotating the driving member, an operating member operable in one direction by traction on a flexion cord to drive the gearing and therefore the driving member, a

spring for imparting return movement to the operating member on release of tension in the flexion cord, and an automatic reversing mechanism for reversing the gearing between successive operations of the operating member, to enable successive pulls on the flexion cord to rotate the driving member in opposite directions.

17. In an artificial arm, the combination of a tube supporting a forearm unit, bearings on an upper arm unit for supporting the tube, a rotary driving member extending forwardly from the tube along the forearm unit, a pair of ratchet wheels geared to the driving member and operable to rotate the driving member in opposite directions, an operating member rotatable in one direction by traction on a flexion cord, a spring for imparting return movement to the operating member on release of tension in the flexion cord, a pair of pawls carried by the operating member, each pawl being associated with one of the ratchets and being operative to turn its ratchet when the operating member is rotated by the flexion cord, and a manually operable member coacting with said pawls and movable into alternative positions to effect alternative disengagement of said pawls from their respective ratchets.

18. In an artificial arm, the combination of a tube supporting a forearm unit, bearings on an upper arm unit for supporting the tube, an operating member rotatable in one direction by traction on a flexion cord, a spring for imparting return movement to the operating member on release of tension in the flexion cord, and a pawl on the operating member for engaging a notch in said tube, said pawl being effective, on rotation of said operating member in response to traction on the flexion cord, to rotate the tube and therefore to flex the arm.

19. An artifical arm for use in cases of amputation above the elbow, and comprising an elbow joint for enabling the arm to be flexed, a rotary driving member for imparting movement to a hand or other appliance, an operating member actuable by a flexion cord, a selector mechanism for coupling the operating member at will either to the elbow joint or to the driving member, and thereby permitting of separate and independent operation, according to the position of the selector mechanism, either of the elbow joint or of the driving member under the control of the flexion cord, a locking member for locking the elbow joint to prevent flexing of the arm, and means linking the selector mechanism to the locking member and serving to render the locking member ineffective, on movement of the selector mechanism into position to couple the operating member to the elbow joint and to restore the locking member to effective position on movement of the selector mechanism into position to couple the operating member to the driving member.

20. An artificial arm for use in cases of amputation above the elbow, and comprising an elbow joint for enabling the arm to be flexed, a driving member for imparting movement to a hand or other appliance, an operating member actuable by a flexion cord, a first driving connection for imparting movement from the operating member to the elbow joint, a second driving connection for imparting movement from the operating member to the driving member, and a selector mechanism interlinking said driving connections so that but one of them at a time is effective, said selector mechanism being movable at will between alternative positions, in

one of which the first driving connection is effective and in the other of which the second driving connection is effective.

JOYCE OTTERMAN.

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