

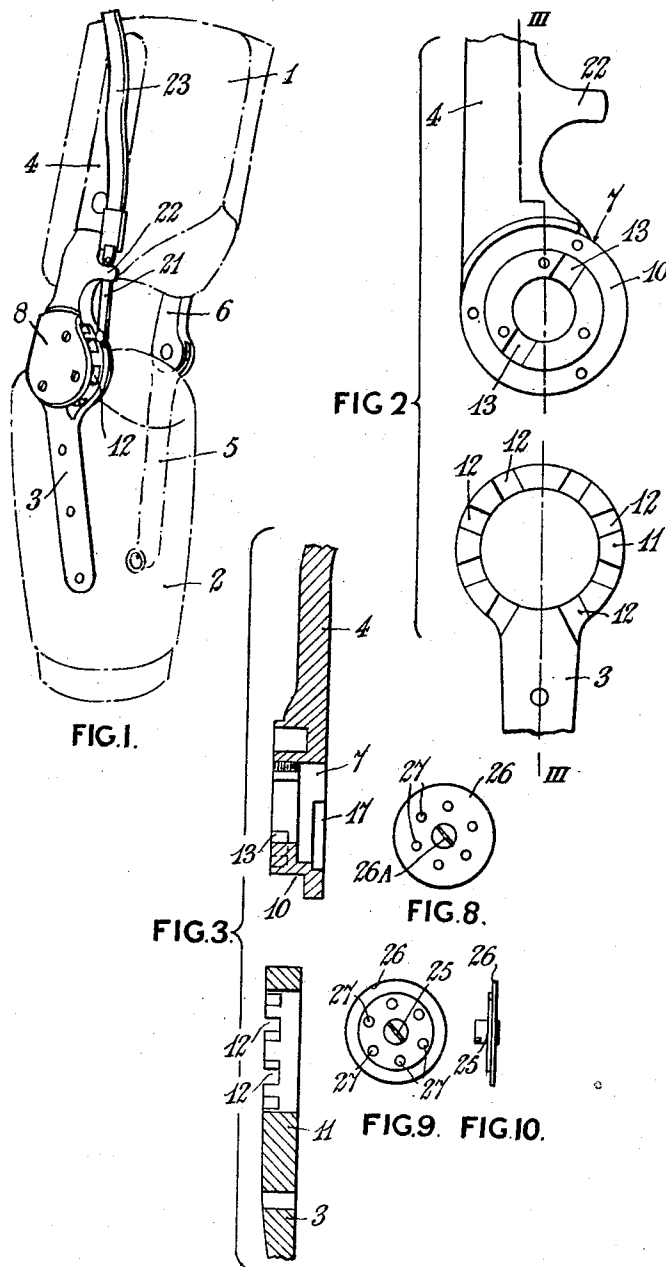
Nov. 20, 1956

C. P. STEEPER
ARTIFICIAL LIMBS

2,770,811

Filed April 29, 1952

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

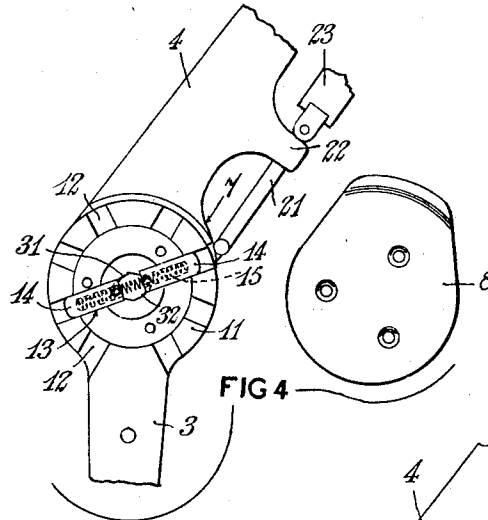


FIG. 4

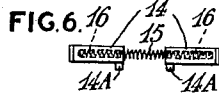


FIG. 6

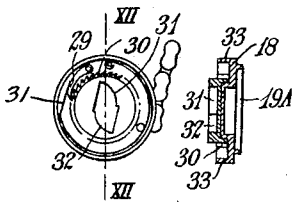


FIG. 12

FIG. 12

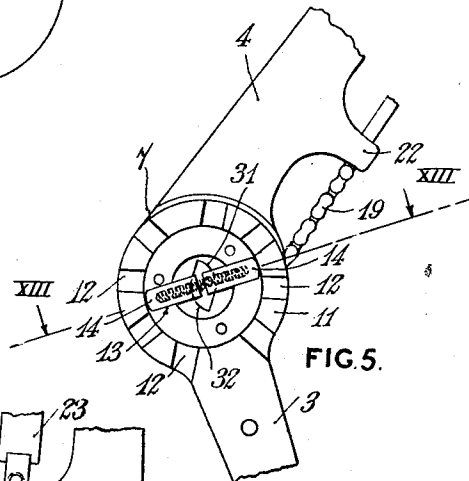


FIG. 5

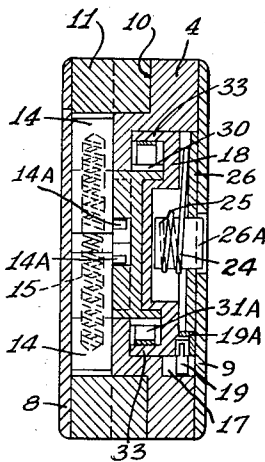


FIG. 13

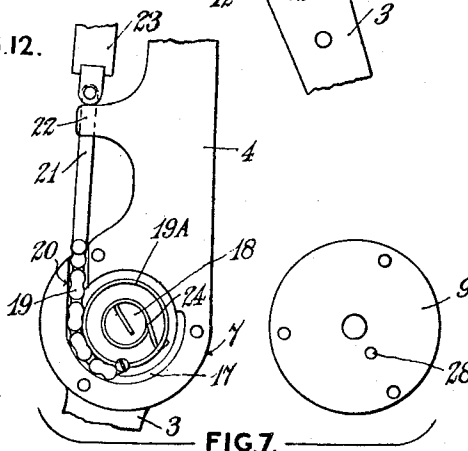


FIG. 7

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ARTIFICIAL LIMBS

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8 Claims. (Cl. 3—22)

This invention relates to artificial limbs and surgical appliances of the kind having upper and lower limb sections, such as upper arm and forearm, or thigh and shin, although in some cases either or both sections might be merely an attachment corset. In limbs or appliances of this kind the sections are connected by a joint or by a plurality of joints, usually two, which joints are axially aligned, and allow one section to be moved relatively to the other; each such joint includes two co-operating and relatively movable parts, each part being connected to or formed in, its respective section. Further in limbs or appliances of this kind such joint or at least one of such joints is controllable by the wearer, so that the joint may be locked in any one of several positions to prevent relative movement of the limb sections, or may be freed to allow relative movement of the sections.

Although the invention may be applied to artificial legs or surgical appliances, it is primarily intended for artificial arms.

In artificial arms having upper arm and forearm sections connected together by an elbow joint, there is usually provided mechanism by which the wearer may either cause the joint to be free, so that he may move the forearm relatively to the upper arm, or may cause it to be locked in a selected one of several positions, in which case the forearm is fixed in a particular attitude in relation to the upper arm. This kind of mechanism is usually governed by a pull cord, the forearm being movable by another pull cord arrangement.

The elbow joint usually consists of a shaft fixed to and extending across the lower end of the upper arm, the forearm having two spaced extensions each connected for pivotal movement adjacent an end of the shaft, although sometimes the forearm merely has a single central extension connected to the shaft. Between these pivoted connections, or around the central extension, forming the actual elbow joint, the control mechanism is associated with the shaft and the forearm. Such a normal elbow mechanism occupies most of the available space inside the elbow; it is usually quite complex and relatively heavy. It is an object of this invention to simplify the controllable elbow joint, to free the space, and to lessen weight and complexity, whilst at the same time giving a strong, reliable and easily controlled joint.

Freeing the space in the elbow has the important advantage that "through-elbow" amputations, or amputations immediately above the elbow, may be much more satisfactorily fitted with an artificial arm, since the artificial elbow may occupy the normal position, instead of needing to be distorted to accommodate the usual elbow mechanism and the stump. Further, surgical appliances may be fitted in an effective manner with pull cord operation of the lock.

Although it has been stated above that the invention deals mainly with artificial arms, it will be realised that the difficulties mentioned may also arise with the knee joint of an artificial leg, or in cases of surgical weakness

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at the knee or elbow which need the support of a surgical appliance.

According to this invention there is provided an artificial limb or surgical appliance of the kind referred to, wherein the joint controllable by the wearer includes co-operating and interfitting parts, one limb part comprising a bearing, for seating the second limb part, a housing, containing locking and freeing mechanism, and locking means, such as a pair of plungers, selectively engageable with recesses in the second limb part or retractible therefrom, the said mechanism being adapted to hold the locking means in either the engaged or the retracted position. The engaged or retracted positions are preferably selected automatically by alternate movements of a single action by the wearer.

One form of the invention will now be described in more detail as an example and with reference to the accompanying drawings in which:

Figure 1 is a perspective view showing the device as applied to an artificial arm;

Figure 2 is a composite front elevation showing the two main parts of the device separated;

Figure 3 is a section on the line III—III of Figure 2; Figure 4 is a front elevation similar to Figure 2 but showing the two main parts assembled and the interior mechanism in position. The front cover plate is shown removed;

Figure 5 is similar to Figure 4 but showing the two main parts in a slightly different position, with the plungers retracted;

Figure 6 is a side elevation of the plungers;

Figure 7 is a rear elevation of the two main parts assembled and the interior mechanism in position. The lower cover plate is shown removed and inverted;

Figure 8 is a top plan of the tension adjusting plate; Figure 9 is an underneath plan of Figure 8;

Figure 10 is a side elevation of Figure 9;

Figure 11 is a top plan of the cam and ratchet mechanism; and

Figure 12 is a section on the line XII—XII of Figure 11.

Figure 13 is a transverse section taken about on the line XIII—XIII of Figure 5 looking in the direction of the arrows.

Referring to Figure 1, the artificial arm has upper arm and forearm 1 and 2, which are connected together by two pairs of "steels" 3, 4 and 5, 6, one pair on each side. Each pair of "steels" consists of one strip of steel, 3 or 5, fixed for most of its length to the forearm 2 and projecting upwardly therefrom at one end, and another similar strip of steel 4 or 6 for the upper arm 1, but projecting downwardly therefrom. The projecting parts of each pair of steels are connected together, to form aligned pivotal joints at each side of the arm. The projecting parts of one pair of steels 3, 4 are enlarged to include a bearing surface and a housing for the operating mechanism. In this way the pair of steels and the elbow control mechanism may be made as a unit, quite separately from the arm, to which the unit may be applied by fixing the steels to the arm. Also if desired two units could be fixed to the arm, one on each side, with a single operating control. Normally however one controllable joint would be sufficient, with a plain joint on the other side. This is as shown in Figure 1.

The projecting end of the upper steel 4 is formed as, or provided with, an enlarged circular boss or housing 7, hollow and closed at each end by upper and lower cover plates 8 and 9. The axis of this housing is common with that of the elbow joint as a whole.

The housing 7 has an upper stepped-in portion 10 of reduced external diameter, which provides a bearing to receive an annular enlargement or ring 11 formed on,

or fixed to, the upwardly projecting end of the lower steel 3. The inner diameter of the ring 11 corresponds to the outer diameter of the stepped-in portion 10 of the housing. The outer diameter of the ring is the same as that of the housing. The ring is retained by the upper cover plate 8, which overlaps the circumference of the stepped-in portion 10. By this construction the lower steel 3 may be moved angularly relatively to the upper steel 4; in other words the forearm may be moved in relation to the upper arm.

The ring 11 has four pairs of radially extending recesses 12, the recesses of each pair being diametrically opposed, and the stepped-in portion has one pair of similarly arranged recesses 13. By rotating the ring, any one of the four pairs of recesses in the ring may be brought into correspondence with the pair in the housing. A plunger 14 is slidable in each recess 13 in the housing, so that there are two radially extending and radially oppositely movable plungers 14, and each is pressed outwardly by a common compression spring 15 between the inner ends of the plungers 14. Each end of the spring 15 fits into a recess 16 (see Figure 6) in the inner end of the adjacent plunger 14. In this way, when pairs of recesses correspond, and if the plungers are not held back in any way, they will slide in the housing recesses 13 and their outer ends will enter the ring recesses 12, preventing movement of the ring on the housing, and so locking the forearm. Since there are four pairs of recesses on the ring, the forearm may be locked in four positions.

More than four, or fewer, pairs of recesses could be used, to vary the number of positions.

As has been described, the plungers are situated in the upper, stepped-in portion 10. The inside of the larger lower portion 17 of the housing is shaped to seat a disc 18, rotatable in the housing and having attached to its lower side a small flat-sided roller chain 19, one end of which is anchored to the disc. This chain leaves the housing through a slot 20 and its other end is connected to a slide rod 21 which slides in a bracket 22 and is connected to the wearer's control cord 23. Between the slot and its anchorage the chain 19, lying between the lower surface of the disc 18 and the lower cover plate 9, passes round a part-circular guide 19A. By a pull on the chain the disc 18 is rotated against a helical compression spring 24, whose outer end is fixed to the disc 18 and whose inner end is retained by a slotted boss 25 projecting from the centre of a tension adjusting plate 26. When the chain is released the disc 18 is rotated in the other direction by the spring 24. Rotation of the housing is limited in either direction to 90° by the permitted movement of the slide rod 21, whose length must be calculated accordingly.

It will be seen from Figures 8, 9 and 10 that the tension adjusting plate 26 is a disc with spaced apertures 27 and with the integral slotted boss 25. It will be seen from Figure 7 that the inner side of the lower cover plate 9 has a very small circular projection 28. During assembly the tension adjusting plate 26 may be rotated by means of the head 26A to adjust the spring 24 to the required tension, after which the cover plate 9 is pressed home to seat the projection 28 in one of the apertures 27 and anchor the spring through the medium of the disc and boss 25.

Rotation of the disc 18 is used to operate a pawl 29 and ratchet 30, which in turn operate a pair of cams 31, 32, which either retract the plungers 14 or allow them to be pushed outwardly, for locking as previously described.

The upper surface of the disc 18 is formed with a peripheral upwardly directed flange 33 (see Figures 11 and 12) and carries a small pawl 29, rockable in a plane parallel to that of the disc and having its point inwardly directed for engagement with the teeth of the ratchet wheel 30. The pawl 29 is pivotally connected to the disc

18, and a light leaf spring 31A is arranged around the inside of the flange 33 to constrain the pawl to the ratchet wheel. The lower face of the ratchet wheel rests on the upper surface of the disc. When the disc is rotated in one direction by the chain, the pawl causes the wheel to rotate with the disc. When the disc rotates in the other direction under the influence of the helical spring, the wheel remains stationary and since the disc movement is limited to 90°, the wheel can be moved in approximately 90° steps in one direction only.

On top of the ratchet wheel there is formed integrally therewith a cam disc of sufficient depth to enable an elongated depression to be cut in its upper face. This depression has its opposite vertical sides or edges curved suitably to form the concave cams 31 and 32. The upper surface of the cam disc is located by contact with the inside of the stepped-in portion 10, and also the said upper surface is closely adjacent the lower surfaces of the plungers 14.

Near the inner end of each plunger 14, and projecting downwardly from its lower surface, is a short pin 14A. These pins engage in the elongated depression in the cam disc, each pin being in contact with one of the concave cams 31, 32, which are so shaped that rotation of the cam disc in the manner previously explained will draw the plungers radially inwardly or allow them to move radially outwardly.

The plungers 14 are held in the outer, forearm-locking position by their common compression spring 15, and they are held in the inner, or free position, by the cams 31, 32. In the latter state the cams hold the plungers so that their outer ends are clear of the inner surface of the ring 11, which can thus be moved freely. If the control cord 23 is operated to allow the plungers to move outwardly whilst they are not opposite a pair of recesses in the ring, then they will enter those recesses as soon as the forearm has been moved to bring the recesses into coincidence with the plungers.

Operation of an artificial arm fitted with the joint described is as follows.

With the forearm in the free state the plungers are held in their retracted position by the cams. If the wearer wishes to lock the forearm in one of its fixed positions, he moves the forearm approximately to the required position, according to the degree of bending of the arm he needs, and operates the control cord. This rotates the cam disc, so that the plunger pins 14A can ride along the cams 31, 32 under the influence of the spring 15. The plungers then enter the ring recesses at once, if they are coincident, or as soon as they are brought to coincident by further slight forearm movement. To move from one locked position to another, two successive pulls are made on the cord. The first retracts the plungers so that the forearm can be moved and the second puts the plungers ready for engaging the next pair of recesses in the ring. The cams are so shaped that, with practice, one shorter pull only is necessary to move from one locked position to another. This shorter pull moves the cam disc less than 90° but sufficient to disengage the plungers from any pair of recesses. The cord is then held at this position whilst the forearm is moved, and on release of the cord the pressure of the spring 15 rotates the cam disc to allow the plungers to return to the locking position.

The main feature of the invention is that the elbow joint mechanism is very compact in that it is contained in a housing which also forms the elbow joint bearing. In fact in a prototype joint constructed according to the example described, the outside diameter of the joint is less than 1¼ inches, whilst its depth is less than half an inch. It will therefore be realized that the invention can provide a very compact joint which does not intrude on the interior space of the arm. A similarly compact arrangement could be used for the knee joint of an artificial leg.

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What I claim is:

1. In an elbow joint of the class described, in combination, a pair of co-operating parts, one part consisting of a first steel, a housing formed at one end of said first steel, a bearing formed in said housing for rotatively supporting the second of said parts, releasable locking means in said housing including at least one locking plunger adapted to interengage recesses formed in said second part, instrumentalities extending from said housing for controlling said locking means, and said second part including a steel, an annulus formed with said steel including a bearing surface engaging the bearing of the housing aforesaid, and the recesses mentioned being formed in said housing, wherein the releasable lock means includes a cam comprising a cam disc mounted on a driving disc and movable relatively thereto, said cam disc including a ratchet wheel, and a pawl mounted on the driving disc and adapted to engage said ratchet wheel to effect rotation of said cam disc under the control of said controlling instrumentalities.

2. An artificial arm comprising, in combination, an upper arm, a forearm, coaxial joints connecting the said arms at the adjacent ends of the same, each joint comprising spaced pairs of steels, the steels of each pair attached to the respective arms at one end and having the opposite ends juxtaposed side by side, and pivotal connections between said juxtaposed ends, at least one of said pivotal connections comprising a housing with an external bearing surface at the pivotal end of one steel, in substantially the plane of the steel, and the other steel having a ring-like bearing surrounding said housing and substantially in the plane of the said other steel as well as the housing, locking means on said housing for locking engagement with the housing and movable radially of the housing and ring-like bearing, actuating mechanism in said housing operatively connected to said locking means, the said ring-like bearing having selective portions to be lockingly engaged by said locking means, and control means connected to said actuating mechanism and extending therefrom to a point exterior to the housing for ready operation thereof.

3. An artificial arm as claimed in claim 2 in which the locking means comprises oppositely movable locking parts on the housing, and the ring-like bearing has selective openings therein at spaced intervals to receive the locking parts for holding one arm in any one of selective positions respecting the other arm, the actuating mechanism also including a cam member movably mounted in the housing and connected to actuate the locking parts.

4. An artificial arm as claimed in claim 2, in which the locking means comprises oppositely movable locking parts on the housing, and the ring-like bearing has selective openings therein at spaced intervals to receive the locking parts for holding one arm in any one of selective positions respecting the other arm, the actuating mechanism also including a cam member movably mounted in the housing and connected to actuate the locking parts, and spring means coacting with and intermediate of the locking parts to cause same to be projected into locking engagement in selected openings of the ring-like bearing member.

5. An artificial arm as claimed in claim 2, in which the locking means comprises oppositely movable locking parts on the housing, and the ring-like bearing has selective openings therein at spaced intervals to receive the locking parts for holding one arm in any one of selective positions respecting the other arm, the actuating mechanism also including a cam member movably mounted in the housing and connected to actuate the locking parts, and spring means coacting with and intermediate of the locking parts to cause same to be projected into locking engagement in selected openings of the ring-like bearing member, a spring retracted actuating disc rotatable in the

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said housing and disposed parallel with the housing, means connecting the disc and said cam member, and the said control means being attached to the rotative disc for turning same.

6. An artificial arm as claimed in claim 2, in which the locking means comprises oppositely movable locking parts on the housing, and the ring-like bearing has selective openings therein at spaced intervals to receive the locking parts for holding one arm in any one of selective positions respecting the other arm, the actuating mechanism also including a cam member movably mounted in the housing and connected to actuate the locking parts, and spring means coacting with and intermediate of the locking parts to cause same to be projected into locking engagement in selected openings of the ring-like bearing member, a spring retracted actuating disc rotatable in the said housing and disposed parallel with the housing, means connecting the disc and said cam member, and the said control means being attached to the rotative disc for turning same, the connecting means between the actuating disc and cam member comprising ratchet teeth on the periphery of the cam member and a ratchet pawl carried by the rotative actuating disc and engaging the said teeth.

7. In an artificial arm construction, in combination, an upper arm, a forearm, and a joint connecting the said arms comprising a first steel attached at one end to the upper arm, a second steel attached at one end to the forearm, the opposite end of the first steel being formed with a housing in substantially the plane thereof provided with an external bearing, and the opposite end of the second steel being formed in the plane thereof with a ring-like bearing receiving the bearing portion of the said housing to establish a pivotal connection between the two steels, said ring-like bearing having selective openings at spaced intervals therein disposed radially of the housing, a locking member radially movable on the housing, spring means normally acting to project said locking member from the housing into one of the selective openings when in registry therewith, a rotative cam member in the said housing connected with the locking member to hold same retracted in the housing and permit said projecting thereof, an actuating rotative disc parallel to the cam member and in said housing, means connecting the disc and the cam member for turning the latter in one direction, and control means leading from a point external to the housing and connected to the actuating disc in the housing for operating the latter and the cam member associated therewith.

8. An artificial arm of the class described comprising an upper arm, a forearm, a joint connecting said upper arm and said forearm, and control means, said joint comprising first and second co-operating and interfitted parts, said first part comprising a housing formed exteriorly with a bearing surface for supporting said second part, said second part being engaged with said bearing surface, actuating mechanism mounted within and enclosed by said housing, locking means in said housing, said locking means being selectively engageable with said second part and retractable therefrom, said mechanism being adapted to hold said locking means in the engaged and retracted positions, and said control means extending from said housing and connected to the mechanism for operating said mechanism.

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