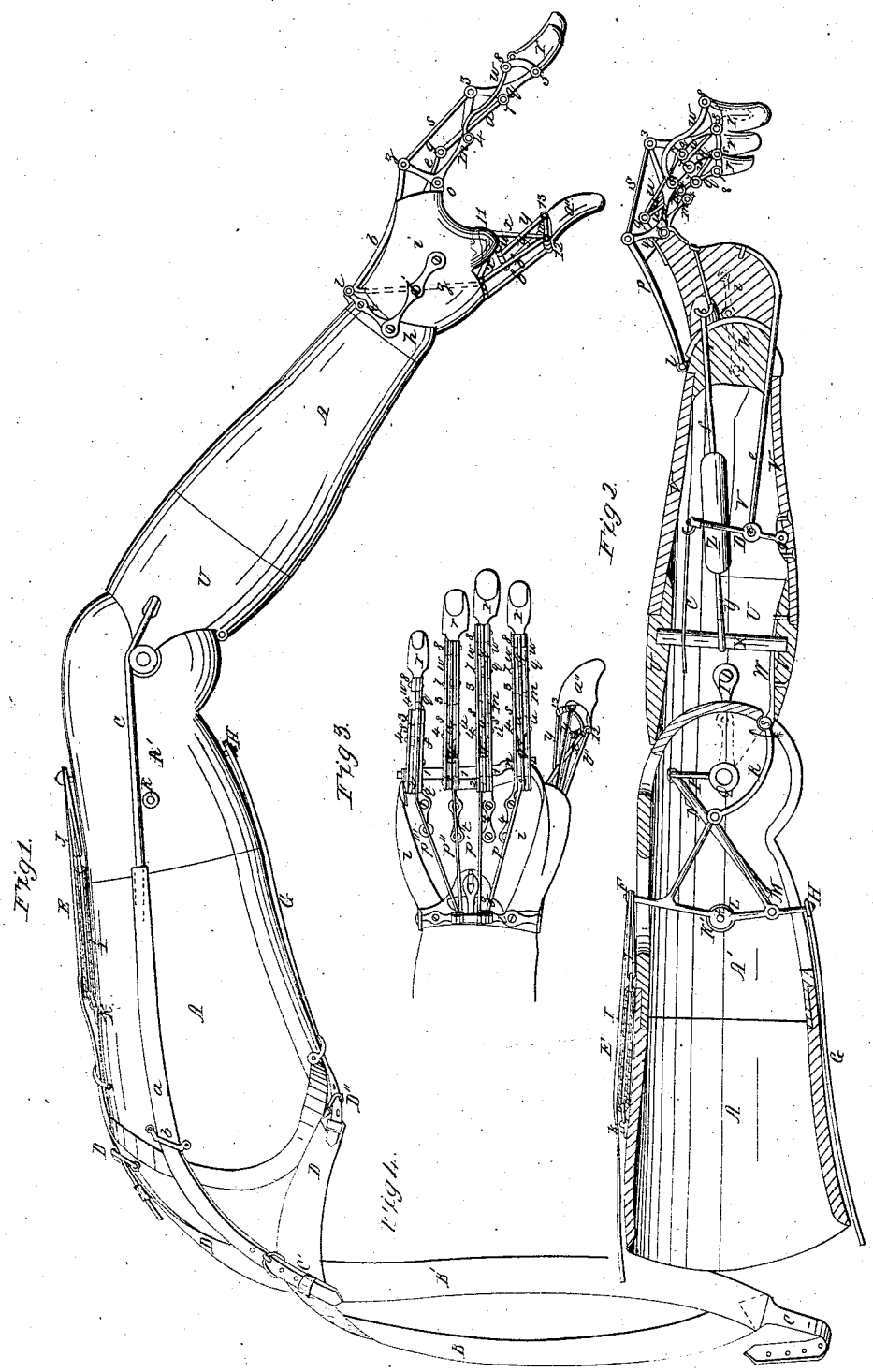
No. 48,659.

PATENTED JULY 11, 1865.

J. CONDELL.

ARTIFICIAL ARM.



UNITED STATES PATENT OFFICE.

JOHN CONDELL, OF MORRISTOWN, NEW YORK.

IMPROVEMENT IN ARTIFICIAL ARMS.

Specification forming part of Letters Patent No. **48,659**, dated July 11, 1865.

To all whom it may concern:

Be it known that I, JOHN CONDELL, of Morristown, in the county of St. Lawrence and State of New York, have made certain new and useful Improvements in Artificial Arms; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, which are made part of this specification, and in which—

Figure 1 represents the arm with the appendage by which it is supported in position. Fig. 2 is a section of the same. Fig. 3 is a view of the back of the hand. Fig. 4 represents the band appendage which supports the arm.

Similar letters of reference indicate corresponding parts in the several figures.

My arm is adapted to be used in cases of amputation of the upper arm—that is to say, where the operation is performed between the shoulder and elbow, and it is intended to give the wearer the command of the elbow-joint by flexion and extension, and also to command the motion of the hand, these operations being performed independently of the assistance of the opposite arm or exterior objects.

My improvements consist, first, in the appendage by which the arm is supported without interference with the action of the thorax, and which affords practically rigid points, in connection with which the vibration or rotation or combined motions of the stump are caused to produce the requisite motions of the elbow and hand; second, in the method of producing the flexor and extensor motions of the forearm; third, in the combination of springs and levers by which the said flexor and extensor motions are induced, modified, and controlled; fourth, in the construction of the elbow-joint; fifth, in the radial or rotary movement of the lower end of the forearm; sixth, in the method of producing the motions of the metacarpus; seventh, in the phalangeal articulations and action.

To enable others skilled in the art to which my invention appertains to fully understand and use the same, I will proceed to describe its construction and operation.

A is the socket or upper portion of the arm, being attached to the other portion or frame A′, to which the lower arm is pivoted.

The supporting appendage or band, Fig. 4, by which the artificial arm is supported, consists of two belts, B B′, of webbing or other suitable material, which are united at the end and terminate in a strap, C, which is under the axilla of the natural arm of the patient; thence passing in front of and behind the shoulder respectively, they cross on the back at C′, and by their continuations D D and buckles D′ D″, which latter are on the front and rear of the shoulder, are attached to the straps E and G, respectively, by which the arm is suspended.

The forearm is pivoted to the upper arm by a bolt, Q, which passes through the frame A′ of the latter and through two side bars or metallic connections, T, which are riveted to the former. The bolt is rigidly secured to the bars T, so that it rotates with the flexing and extension of the elbow-joint and upon it is a radial arm, P, the purpose of which will be presently described.

K′ is a pillar which extends across inside the frame A′ of the arm and is secured by a bolt, K, which is parallel to the hollow bolt Q which forms the axis of articulation of the elbow. Upon this pillar K′ and vibrating at right angles to the axis of the same is a frame, L, which is connected at the points F H, with the flexor and extensor straps E G, which, as has been said, are connected to the back-straps at D′ D″.

Screwed or riveted to the frame U of the lower arm is a plate, W, to which an arc-shaped connecting-rod, R, is pivoted at S, and the rod R is at its other end pivoted at O to the apex of the triangular frame L. By the motions of this frame communicated through the rod R to the forearm, the flexion and extension of the latter is directly effected. I wish to remark here, however, that in addition to the forces which act directly upon the frame L—namely, the straps E and G and the springs E and N—the motion of the stump will have the effect of communicating an impetus to the forearm in the direction in which it is moved, and also that when the arm is placed in certain positions its gravitation will cause it to vibrate upon the elbow-joint in either direction, according as the axial point Q is inclined in one direction or the other. The flexor-spring I is attached at *k* to the socket A, and by a link and strap, J, to the end F of the frame L. The extensor-spring N is attached at M to a hook on the frame L, and at its other end to the arm P, which projects radially from the axial elbow-bolt Q. These springs are proportioned to their respective duties, but the

main agent in producing the flexion and extension of the forearm are the straps E G, which being secured at D′ D″ to points which are practically rigid, are caused by the forward and backward motions of the stump to become tightened or slackened. The forward motion of the stump tightens the strap E, rocking the frame L, and causing the point S to move inwardly in the direction of the arrow, the motion being assisted by the contractile power of the spring I, and being in opposition to the spring N which is elongated by the rotation of the arm P around the elbow articulation, which describes a longer arc than the comparatively slow moving point M. The extension of the arm is directly due, independent of mere impetus derived from an outward motion of the arm to the tightening of the strap G as the stump is moved backwardly, and this motion is assisted by the contractile power of the spring N exerted on the arm P of the axial bolt Q, and it is in opposition to the power of the spring I.

The object of the arrangement of the definitive and elastic forces is to bring a nicely-adjusted and certain but gently-acting pressure to bear in the required direction, so that the motion may be attained without jerking or unnatural movement, but smoothly and noiselessly, in imitation of the living member.

The metacarpus is hinged to the wrist by means of the plates *j*, one on each side, which are pivoted to the plate which embraces the back of the wrist. Upon this pivoted point the metacarpus rocks forward under the impulse of a cord, *e*, connected by a vibrating lever, *d*, which rocks upon a plate, *g*, under the tension of a cord, *c′*, and strap *a*, the latter connected to the crossing-place C′ of the bands B D B′ D′. The required tension upon the said series of strap and cords to produce the forward motion of the metacarpus is effected by a forward and rotary movement of the stump which strains the strap *a*, rigidly attached at C′ over the point of the shoulder. This motion is in opposition to the spring Z and its tendons Y *f*, which connect a pillar, X, in the frame U of the forearm with the metacarpus, back of or above its center of vibration, so as to cause it to incline backward when at rest. Thus the forward motion of the metacarpus, which, as will be presently shown, opens the hand, is effected by a definite pull upon the cords, while the backward motion of the metacarpus, closing the hand, is effected by the constant-spring Z and its tendons, and is constituted the normal position of the hand.

The rotary motion in imitation of the relative movement of the radius and ulna on each other, of the forearm is effected by means of the other hand and not by the stump or its attachments. The portion V, which forms the connecting or middle portion of the forearm, is susceptible of rotation upon the frame U, but is firmly attached to the wrist-piece *h*, which rotates with it. The presentation of the hand is effected by this partial rotation.

It is now in order to describe the motions of the fingers, and a description of one will substantially apply to each of the others, as they only differ in the matter of proportion. This difference arises from two circumstances: One is their difference in point of length, and the other that in following the natural motion of the phalanges it becomes necessary to increase in speed from the fore to the little finger, as the latter in closing, under ordinary circumstances, is more bent than the ring-finger, that one more than the middle finger, and the forefinger the least of all.

m is a frame which is pivoted at four points, 1 2 3 4. At the point 1 it is pivoted to the metacarpus *i* by a rod, *n*, which passes through it and the eye *o*, which latter is attached to the metacarpus. Upon this point the frame *m* vibrates as the hand opens and closes. The point 2 on the frame is connected by a rod, *p*, with the wrist-plate *l*, where it is pivoted in common with the similar rods *p′ p″ p‴* from the other fingers. To point 3 on the said frame is pivoted a second frame, *q*, which is pivoted at 5 to the terminal section, *r*, of the finger.

Beyond the metacarpus the phalangeal frame may be said to be the pieces *m* and *q;* but for the purpose of staying these and communicating motion to them four rods are used, besides the rod *p*, which passes up the back of the hand from the wrist-plate to the point 2, which represents the first knuckle at the connection of the phalange with the metacarpus. The first of these rods is *s*, which connects the points 2 and 3 from the knuckle to the first joint of the finger. The principal use of this is to strengthen, as the definitive motion of the frame *m* does not depend upon it, though it becomes nearly in line with *p* when the hand is expanded, and forms a good outer surface to keep the buckskin covering of the hand from getting among the levers. The second of these rods, *t*, is riveted to the metacarpus, and is a fixed point relatively to that, but partakes of its vibratory movements when the latter is acted upon by the cords *f e*, respectively, to close and to open the hand. One end of the rod *u* is pivoted to the end of rod *t* at *g*, and the other end is pivoted to the point 7 on the piece *q*, its effect being, as the hand closes, to draw the said point inward, vibrating the piece *q* upon the point 3 of the frame *m*. One other rod remains to be described, and that is marked *w*. It extends from the point 4 of the frame *m* to the point 8, which is at the upper part of the terminal section of the finger.

The open and the closed positions of the fingers are shown in the respective sections, **Figs.** 1 and 2.

In the operation of opening the hand the metacarpus is drawn forward by the cord *e* and its connections, when the rod *p*, detaining the point 2 of the frame, vibrates the latter backwardly. The action of the metacarpus throws the point 9 forward and projects the rod *u*, which throws outwardly the frame *q*. The terminal section *r* is vibrated outwardly by the rod *w*,

which is pivoted to it at 8 and to the frame *m* at 4.

The closing of the hand is caused, as has been said, by the constant spring Z and its tendons, and the actions on the metacarpus and fingers is substantially the reverse of the opening motion.

To preserve a graceful motion of the fingers the rate of their motion increases from the forefinger to the little finger, so that when closed the little finger shall be most bent and the others proportionably. This is accomplished by modifying the length of the moving parts.

Some of the plates and rods, such as the plate *q* and the rods *s*, *u*, and *w*, are duplicated, as will be seen more especially in the upper view of the hand, Fig. 3. This is to insure steadiness and strength. I may duplicate other parts than those mentioned, or may make changes in these. In speaking of these rods, I have mentioned them in the singular number for brevity and for clearness, as too rigid perspicacity would create confusion.

The action of the thumb is due to the same power which actuates the fingers—namely, the motion of the metacarpus as it is vibrated inwardly or outwardly by the cords *e* or *f*, respectively, as has been described. There are two definite pivoted points, 10 11, at the base of the thumb, and they are connected, by the frame *x* and the rod *y*, with the pivoted points 12 13 on the base of the terminal section of the thumb *a''*. The frame *x* is prolonged at an angle, where it connects by a rod, *z*, with the wrist-plate L, which is attached to the forearm. The rod *b''* acts as a stay, and also maintains the proper contour of the part. The opening of the thumb is effected by the forward motion of the metacarpus, which pulls upon the rod *z*, which withdraws the short arm of the frame *x*, rocking the said frame on its pivoted point 11, drawing back the second phalange of the thumb, while the rod *y* rocks backwardly and rotates the terminal section of the thumb outwardly.

In cases of disarticulation at the elbow it becomes necessary to abandon the whole interior of the socket to the use of the stump, and, as an artificial elbow-joint is still required, the arrangement of rocking plates and connections must be located outside. Presuming that a short addition to the length of the humerus might not be objectionable, the axial-bolt may still be placed in the end of the socket, close to the end of the stump, and the arm P on the bolt may be reached by an orifice in the socket.

I do not think it necessary to define the exact modification that would be rendered desirable under possible circumstances, but shall rest my claims to a set of devices irrespective of exterior or interior location.

Having thus described my invention, what I claim therein as new, and desire to secure by Letters Patent, is—

1. The appendage, Fig. 4, which is adapted to maintain its place by means of its axiliary attachment, so as to afford two definite and practically rigid points, D′ D″, to which the flexor and extensor straps or cords are to be attached, so as to produce those motions by the forward and backward movements of the stump.

2. The cord *a c e*, or its equivalent, with or without the intervening lever *d*, and attached substantially as described, by which the forward motion of the metacarpus is obtained.

3. Attaching the flexor and extensor cords or straps to points on the front and rear of the shoulder-joint, so as to be brought into action by the forward and rearward motions of the stump.

4. The combination of the flexor and extensor straps with the rocking frame L or its equivalent, which connects by link or otherwise with the forearm.

5. The flexor-spring I, attached to the socket and to the rocking frame L, or its equivalent.

6. The combination of the spring N with the arm P, on the axial bolt, and the rocking frame L.

7. The spring Z, with its tendons Y F, or their equivalent, and extending from a point in the forearm to a point back of the center of vibration of the metacarpus, substantially as described.

8. Articulating the metacarpus to the end of the forearm by a pivotal point or points, so as to be moved in either direction by appropriate springs or cords which are attached to the metacarpus at points on opposite sides of the axis of vibration.

9. Constructing the forearm, as described, with a sleeve portion, V, which is capable of rotation so as to change the presentation of the hand.

10. Operating the fingers or thumb by the motion, however induced, of the metacarpus.

11. Pivoting the frame-piece *m* of the fingers to a point on the metacarpus, and the rods, which, under the motion of the metacarpus, primarily induce the deflection of the fingers to a point on the forearm.

12. Pivoting the second joint of the frame-pan *q* to a point of the frame-piece *m*, and the rod which gives the additional deflection due to the second joint to a point attached to or connected with the metacarpus.

13. Giving the additional deflection due to the terminal section or first joint of each finger by a rod attached to it and to a point on the frame-piece *m*.

14. Governing the motion of the thumb by a rod attached to the end of the forearm, which, under the vibration of the metacarpus, influences the frame-piece *x* and gives the deflection due to the second joint of the thumb.

15. Giving the deflection due to the first joint of the thumb by means of the rod *y*, which performs that office as the frame-piece *x* is vibrated by the rod Z when the metacarpus is moved.

Witnesses: JOHN CONDELL.
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