2 Sheets. Sheet 1.

J. H. Koeller,

Artificial Arm.

No. 43,590. Patented July 19, 1864.

Fig: 3.

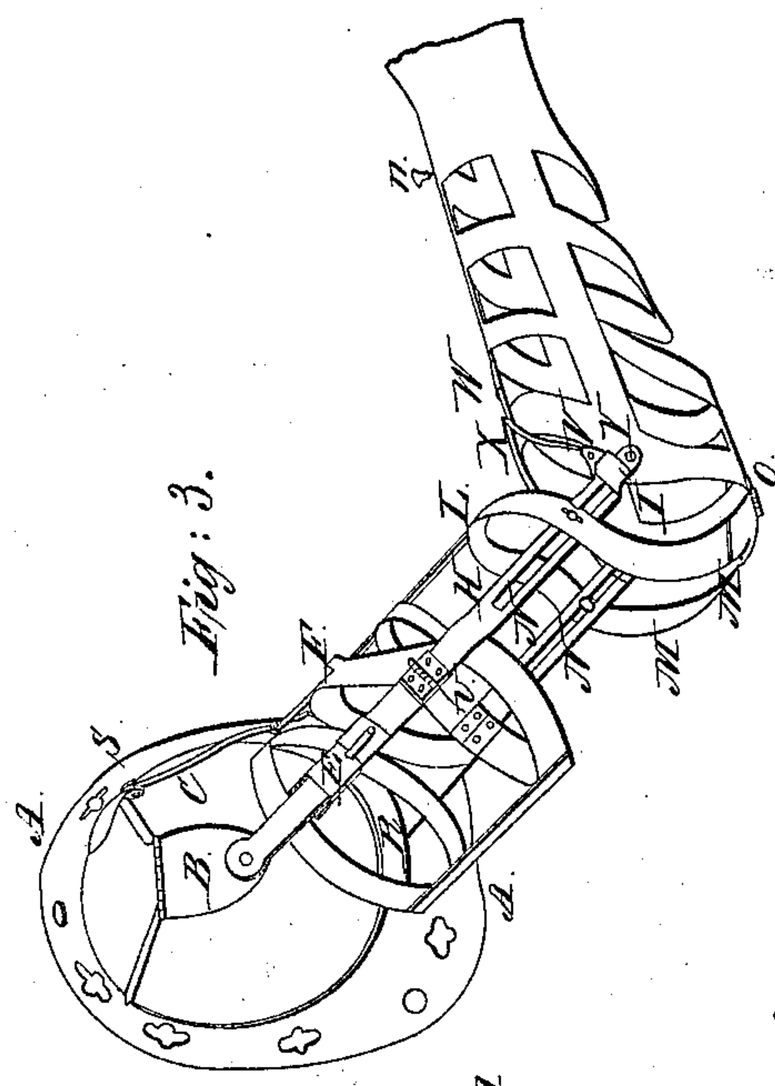


Fig: 4.

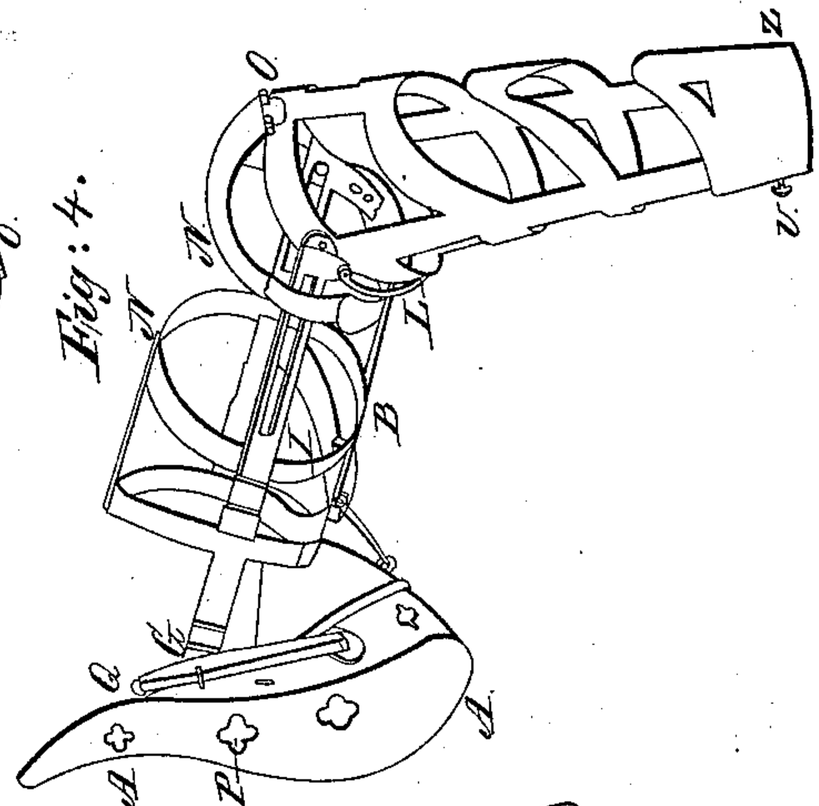


Fig: 2.

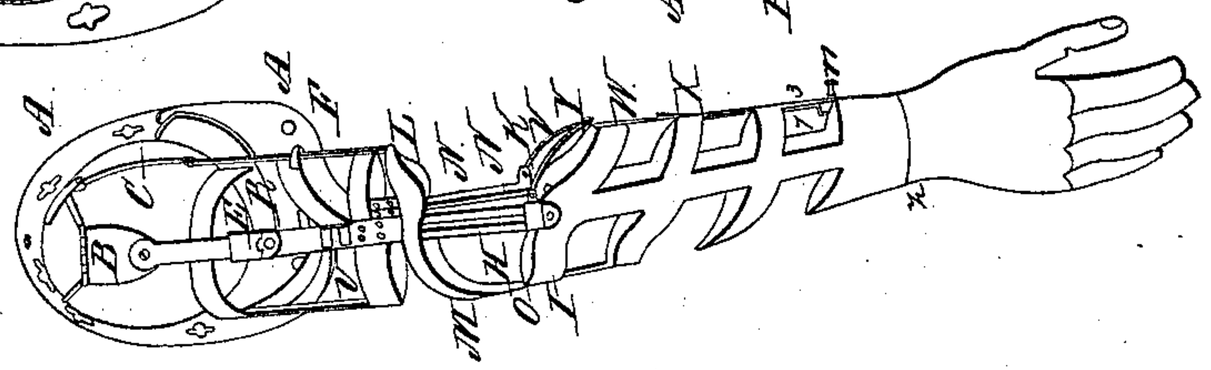
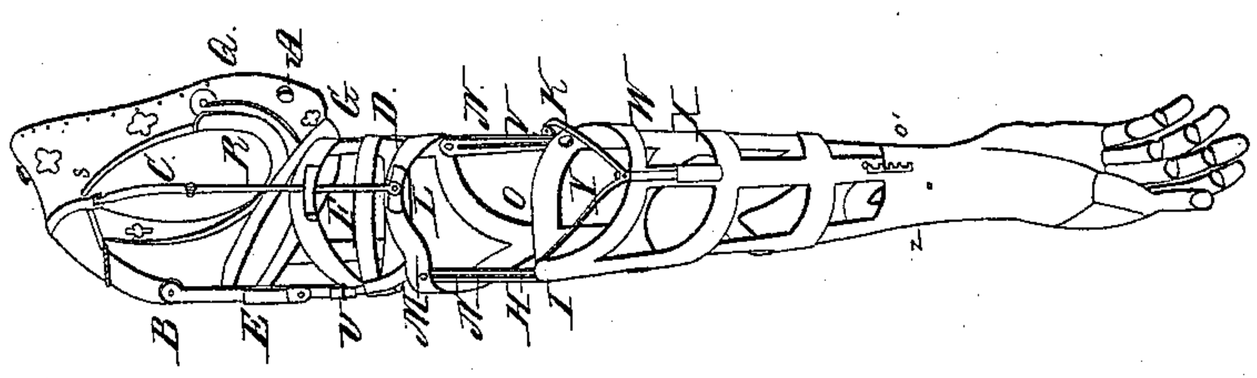


Fig: 1.



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2 Sheets. Sheet 2.

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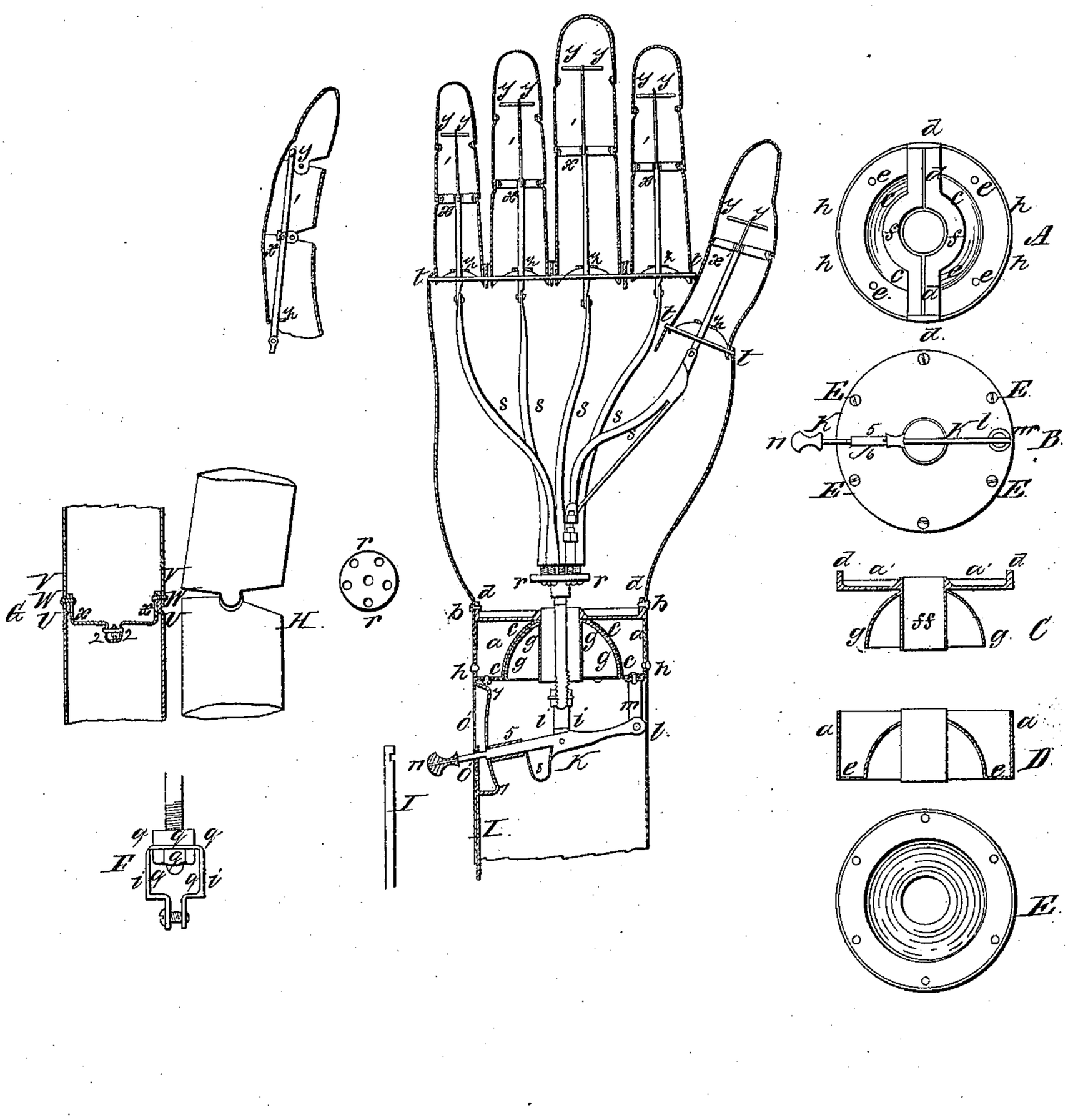
Artificial Arm.

No. 43,590. Patented July 19, 1864.

Fig: 5.



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UNITED STATES PATENT OFFICE.

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IMPROVEMENT IN ARTIFICIAL ARMS.

Specification forming part of Letters Patent No. **43,590**, dated July 19, 1864.

To all whom it may concern:

Be it known that I, JON. H. KOELLER, of the city and county and State of New York, have invented a new and Improved Mode of Constructing the Artificial Arm and Hand; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The nature or object of my invention is to substitute or supply an artificial arm and hand in cases where that member has been lost by amputation below the shoulder-joint and above or below the joint of the elbow, so as to leave a sufficient length of the upper portion of the arm or "stump" to accomplish by its movements the general movements of the whole arm, as well as those of "flexion" and "extension" of the forearm and of the thumb and fingers.

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation.

The Figures I, II, III, IV represent the mechanical construction of my invention from varied points of view, while Fig. V represents in detail the mechanism employed for the required movements of the wrist and finger-joints.

Fig. I.—As a substitute for the "ball-and-socket" joint of the shoulder in the natural arm I construct a shoulder-cap, A A, out of thin metallic plate accurately molded to fit the shoulder and kept in position by straps from the opposite shoulder and side of the body. From this shoulder-cap I suspend or hang the frame-work of the arm and hand by means of three jointed or hinged straps, B C D, which work through their respective slides or guides E F G. The strap B is connected by the slide E to the strap or band H, which latter is, by a pivot or pin, fastened to the outer side of the forearm at I, while the strap D is similarly connected to the inner side of the forearm at K, the two pivots or pins thus constituting or forming the elbow-joint.

The manner in which motion—that is, flexion and extension—of the forearm, as well as the fingers, is given, will be seen by observing the connection of the strap C. This strap is attached at L to a part of the frame-work of the arm L M, which, unlike the other rings forming the skeleton or outer shell of the arm, has a special motion of its own, and is guided in its movement by pivots or pins sliding in the slots N N. This ring L M, or portion of the arm, having a specific movement of its own, is also attached at *o* by a hinge-junction to the extreme point of the elbow, and thus the action of the strap C in moving this ring L M up and down, or from one end of slot H to the other, gives the forearm the two opposite motions of flexion and extension. In the natural arm extension is effected by muscular effort concentrated virtually at the same place—that is, at the "accromion process," or point of the elbow-bone, while the flexing or bending of the forearm is effected by muscular power displayed on the opposite side of the arm, whereas in this artificial arm both of those movements are effected by means of the strap C, placed and operating primarily or directly on the fore part of the arm, and, secondarily, by the connection of the ring L M to the forearm at O. It only remains to explain how the strap C is made to communicate to the ring L M the alternating movement that accomplishes this flexion and extension of the forearm, and also, as will be seen hereinafter, the same movements in the thumb and fingers. This shoulder-cap being firmly attached to the shoulder and the stump of the arm being within the frame-work of the upper part of the skeleton arm, the movement of the extremity of the stump in a forward direction carries the fixed portions or rings of the upper arm forward and at the same time upward, and, as the upper end of the strap C is fixed and stationary at the shoulder, the effect of this movement is to cause the ring L M, to which the other end of the strap C is attached, to move away from the shoulder and along the slides N N, and, as the opposite portion of L M is connected at O to the forearm, this motion is communicated to it, and thus produces the flexion or bending the forearm upon the upper portion of the arm, or that which in the natural arm is denominated the "humerus" or arm bone proper. To enable the end of the "stump" to be thus moved forward and at the same time upward, the strap G (seen most distinctly in Fig. IV) has its upper end attached to the lower portion of the shoulder-cap by a ring, P, Fig. IV, which ring traverses or plays on the rod Q,

Figs. IV and I, attached to the lower part of the shoulder-cap A A, occupying the extent of the "axilla" or armpit and guarded by the shield R, which prevents the underclothing from interfering with its movements on the rod or slide. To further increase and facilitate this forward motion of the stump the strap C has its hinge-joint at *c*, beside that where it is attached to the shoulder-joint at S. For the same reason, and to give the stump also its motion sidewise from the body or chest, the strap B has its hinge and pivot joints at T, B, and U. The forearm in its general structure, it will be seen, is constructed measurably the same as the upper arm—that is, the outer shell, which constitutes that portion of the arm, has portions of its shell cut out or removed, leaving longitudinal braces, and giving it also the ring-like construction or appearance, rendering it lighter and yet giving it the requisite degree of strength. The flexion and extension of the thumb and fingers is primarily accomplished, it will be seen, by the flexion and extension of the forearm, and is derived from the fixed points or pivots I K at the elbow joint. The two lateral straps B D or slides N N at their lower end have short arms or shoulders V V. These are connected to the strap W, which passes through the slide X, and is then connected to the rod moving the thumb and fingers. These shoulders or arms, forming a species of "bell-crank," are brought in connection with this "finger-strap" by means of the wire rod Y, resembling in shape the breast bone or "merry-thought" of the fowl. From this construction it is evident that if the centers or pivots I K are fixed or stationary and the forearm be flexed or extended, that motion, to a certain extent or limit, will be communicated to the strap W, and thus, through it, to the fingers. Now, as the greater extent of flexion and extension of the forearm is more than is necessary to flex and extend the thumb and fingers, this surplus of motion is absorbed or taken up and regulated by the length of the short arm of this bell-crank, or the distance apart of the pivots I and V. The shell or skeleton of the forearm terminates at the point Z, where the hand is connected to it in such manner as to give to the wrist joint, not the flexing or hinge movement, as in the natural wrist, but simply the semi-rotative motions denominated by anatomists "pronation" and "supination"—that is, turning the palm of the hand up and the back down, and then reversing that position—to wit, the back of the hand up and the palm down. These movements are accomplished by the following mechanical construction of the wrist portion of the hand and arm.

Fig. V.—In Fig. V, *a a* is a structure that, for the purposes of description, may be denominated a "box" or "cup" joint. It is inserted or let in to the hand portion of the shell forming the wrist, and that part of the box, with its connections, kept in place by means of screws *b b*, passing through the outer shell and into the two lugs *d d*, as shown in the center and marginal drawings in Fig. V.

The marginal drawing A, Fig. V, shows the interior of this box or case as seen from the direction of the fingers, showing the ribbed cross-bar *d' d'* and the two lugs *d d* at its either end. *c c c c* is a cup or "semi-socket" soldered—*i. e.*, connected at its base *e e e e* with this case or box, as shown also in sectional view, marginal Fig. D. This cross-bar has attached or soldered to it the tube or cylinder *f f*, extending the depth or length of the box or case, and when put in its position or place with the said tube or cylinder passing through the center of the cup *c c c c*, the smaller cup or semi-socket *g g*, made accurately to fit the other cup, is then soldered to the tube or cylinder, where it passes through this latter cup, thus forming what might be called a "semi-hollow ball-and-socket joint," restricted to lateral or horizontal movement, or, perhaps, more properly a cup-joint, with the same restrictions of motion. This free and rotatory motion of the cups on each other is, in the motions required for the hand, restricted or limited by the flanges *h h h h*, marginal Fig. A. The marginal Fig. B represents the top plate of this box or case as seen when viewed or looking from the forearm toward the fingers and as fastened to the case by the screws *e e e e*. Marginal Fig. E represents the arm end or portion of the case or box with this plate removed. This case or box thus constructed is placed in the outer shell of the "hand portion" of the wrist, and one portion of its mechanism—to wit, the cross-bar *d' d'* and its connections, the tube *f f*, and cup *g g*—are connected to the hand, as before stated, by the lugs and screws *b b* and *d d*, while the other or arm end or portion of the box or case *e e e e*, marginal Fig. B, is let in and attached to the wrist portion of the forearm by means of the screws *h h*. Thus the one cup or socket and its connections being in connection with the hand, and the other cup and its connections being connected with the forearm the cups move freely upon each other, limited only by the flanges *h h h h*, as before described, giving to the hand the capacity of partial rotation denominated anatomically pronation and supination.

The intent or object of the cylinder or tube *f f*, before described, is to admit the passage of the rod P, moving the thumb and fingers.

The mechanical expedients and construction of the different parts necessary to give the flexion and extension movements to the thumb and fingers are also shown in Fig. V and its marginal drawings.

i i, an enlarged marginal drawing of which is shown by Fig. F, is a stirrup-shaped strap, one end of which is connected with the lever K K at K', one end of which lever works on a pivot, *l*, in the standard *m*, upon the top plate

shown at marginal Fig. B. The other end, *n*, having a knob on it, passes through a notched slot, *o' o'*, the object of which will be hereinafter explained. The rod *p p* is connected with the other end or portion of this strap and adjusted or lengthened and shortened by means of the two screw-nuts *g g g g*, while the other end of this rod is attached to the center of the plate *r r*. The rods or bent wires *s s s s s* are connected to this plate *r*, and their respective lengths adjusted by means of screws passing through the plate *r* and into the ends of the rods *s s s s*, or by screw-nuts, as described, in the attachment of the rod *p p* to the stirrup-strap *i i*, in marginal Fig. F.

The different joints of the thumb and fingers having the same construction, a description of the mechanism of one finger will include or describe all the others. The first joint of the thumb and forefingers is formed by the rods or wires *t t t t* passing through their hand ends and the extremities of these wires riveted to the shell forming that part of thehand. These ends of the fingers are let in, as shown in the drawings, sufficiently far to take this wire or rod, each fitting loosely in their own separated places.

The construction of the second joints of the thumb and fingers is more distinctly shown in the marginal drawings G and H, the latter being a side view of the same. These portions of the fingers are not let into each other, but each have lateral tongues or projections, the inner tongue pressed in so as to receive the outer tongue, thus making the outer surface of the fingers flush. The pin or pivot forming this joint passes through these tongues and is riveted in the ends of the yoke *x x*, and, being also riveted to the exterior tongue, the joint plays upon the inner tongue, and any motion communicated to the yoke will of course move that portion of the finger with which it is thus connected. The third joint of the fingers is similarly constructed in regard to the tongues; but with the exception of the yoke, in place of which they, as well as the thumb, have the wires or pins *y y y y* passing through the back of the fingers from side to side, and riveted there for the final attachment of the rods *s s s s s*. These rods, marked *s*, after leaving the plate *r r*, pass through the guides *z z z z* to the yoke X, and, having their ends bifurcated or split, so as to receive the ends of the terminal wires 1 1 1 1, both are connected to the yoke by the pivot 2 2, (marginal drawing, G,) upon which they both play. The other ends of the wires 1 1 1 1 are, as before observed, finally attached to the wires *y y* at the dorsal end of fingers and thumb. From these mechanical arrangements it is evident that if the rod *p p* be moved in a direction toward the fingers, it will extend or straighten them out, and if moved in the opposite direction it will flex or bend them, as in the natural movement of the fingers in closing or grasping any substance, while at the same time the thumb will be brought in close contact with the bent forefinger, and when that finger is extended will be partially removed from it.

To allow the requisite degree of motion in the fingers, portions of the outer shell are cut away at their inner parts, as shown in Fig. 1.

The manner in which the movements of the strap W, Figs. I, II, III, before described, is communicated to the rod *p p*, Fig. V, remains to be described. This strap, after passing through the slide or guide X, Figs. I, II, III, passes through another slide or guide on the inside of the shell at 3, Fig. II, which slide or guide allows it some lateral play, and is connected with the lever *k k*, Fig. V, by means of a notch in its side, as shown in the marginal drawing I, Fig. V. While this lever is in the notch every movement of the stump that flexes and extends the forearm flexes and extends the thumb and fingers also; but when it is required to keep the fingers in a permanent flexed or grasping position, or an extended position, and yet have flexion and extension going on in the forearm, this lever is by means of the knots *n* thrown out of the notch in the strap W or I and into any of the notches in the slot *o' o'*, (*vide* also photograph, Fig. 1,) which permits the end of the strap I (marginal drawing, Fig. V) to move by the side of the lever K. To accomplish this purpose there is on the lever *k k* a slide, 5, (marginal drawing B,) with an arm or shoulder, 6, having two grooves or notches in it, which are made to catch in the wire rod or steadiment 7 7 (one end of which is also seen in Fig. II photographed at 7.) This slide is kept in contact with the wire rod or steadiment by means of the spring 8, and the angular shape of the notches in the arm 6 and the yielding of the spring enables the lever *k k* to be readily thrown from the notch in the strap to the notches in the slot, and thus throw the fingers "in and out of gear," so to speak, with the movements of the stump and the forearm.

What I claim in the foregoing specification, and desire to secure by Letters Patent, is—

1. The shoulder cap A A as the foundation or basis for the required movements in the arm, forearm, wrist, and thumb and fingers.

2. The combination of the strap C with its hinge at the shoulder-cap A, and its middle hinge near C, and its connection at L to the ring L M, together with the straps D and E, with their respective hinge-joints and connections to the cap A and lower part of upper arm at D and U, for the purposes hereinbefore described and set forth.

3. Suspending the arm, forearm, and hand by means of the straps B C D, constructed as before described, enabling the stump of the arm or forearm by its movements within this outer skeleton to effect or accomplish the required motions in the forearm, wrist, and fingers.

4. The construction and application of the ring L, together with its connection with the straps D C D and with the forearm, at the elbow-joint, guided in its movements by the

slots M N and operating for the purposes hereinbefore specified and described.

5. In connection with the strap D, the wire rod or guide Q and shield R, for the purposes and operating as before described.

6. The application and construction of the bell-crank at the elbow joint I K, together with the bent wire Y and strap W, to which it is connected, for the uses and purposes hereinbefore set forth and specified.

7. The method or mode of constructing the wrist-joint, as described in the specification and as shown in the marginal drawings A B C D E, plate V.

8. The method or mode of constructing and the application and arrangement of the wires or rods moving the thumb and fingers, together with the yoke *x x*, as specified and described and fully set forth in the central drawings, Fig. V, and in the marginal drawings F of the same figure.

9. The mode or method of connecting the lever K K with the rod P by means of the stirrup *i i*, thus allowing semi rotation of the hand, as described in the specification and shown in the marginal drawing F, Fig. V.

10. The method or mode of constructing the thumb and finger-joints, as set forth and described, and shown in the marginal drawings G H, Fig. V.

11. The arrangement of the lever K K, the spring 8, slide 5, wire rod or guide 7 7, the notches in the slot O′, and the notch in the slot I, Fig. V, and marginal drawing B, for the purpose of connecting or disconnecting the motion of the thumb and fingers from and with that of the arm and forearm, as heretofore more fully described and set forth.

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