

Description of an artificial hand / By Sir George Cayley.

Contributors

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Cayley's Artificial Hand.

1845

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DESCRIPTION
OF AN
ARTIFICIAL HAND.

BY
SIR GEORGE CAYLEY, BART.

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LONDON:
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1845.

95724



INSCRIBED


TO HIS HIGHLY VALUED FRIEND,

PETER MARK ROGET, M.D.,

SECRETARY OF THE ROYAL SOCIETY, VICE PRESIDENT OF THE SOCIETY OF ARTS, &c.

BY

THE AUTHOR.



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DESCRIPTION
OF
AN ARTIFICIAL HAND.

20, Hertford-street, March 5th, 1845.

SIR,—About eight years ago, George Douseland, a son of a tenant of mine, had the misfortune to lose his right hand, when I proposed to make him an artificial one, in the hope of rendering his loss rather less severe. The greater portion of this instrument was made, and the whole of it planned, at that time; but the stump was found to be so tender that it could not then be made use of, if completed; and the young man having gone to reside elsewhere, the thing was lost sight of, and was not renewed till about two months ago, when the remaining portion was executed; and he has found it of considerable use to him in his various daily occupations. I send you a sketch and description of this instrument, which is so simple, as scarcely to deserve the name of an invention; but trusting that it may be found equally useful to others under a similar misfortune, I wish to give it to the mechanical public through your valuable pages.

The instrument can be executed in many ways, though the means of deriving its firm and forcible grasp from the stump must remain much the same in all. Flexible tendons were adopted in the first sketch I made of this instrument, but I shall describe that which is now in use, and subsequently some very essential improvements. I hope by thus publishing it to prevent its being pirated and *patented*, as it is quite misfortune enough to lose a hand, without being obliged to forego the use of even so humble a substitute, for want of means to purchase it, or otherwise to procure it at an exorbitant price.

I am, Sir,

Your obliged and obedient Servant,

GEORGE CAYLEY.

Method of making an Artificial Hand, that will forcibly grasp substances of various sizes, and release them at will, so as considerably to supply the place of the natural hand, when that member is lost.

The movements of this instrument are derived from the stump, by fixing the hand to the upper portion of the arm above the elbow joint, by light frame work, within which the stump has its movements at full liberty; and by placing a shank or lever, connected with the machinery of the hand, to the termination of the stump, it is put into forcible and efficient use.

This will be more clearly understood by inspecting the sketch fig. 1, where AA represent metallic half hoops, riveted to the thin steel bars BB, and padded on the inside. When the arm is placed in these semi-hoops, it is secured there by the straps and buckles CC. The end of the stump is at the same time inserted into the padded hoop D, riveted on to the bars EE, which turn freely on the joints FF.

The hand, fig. 2, is fixed to a hoop G, which fits freely into the hoop H, fig. 1, at the termination of the arm bars KK, and can turn within it, but cannot escape from it, by means of three small screws working in a groove.

The joints FF are common to all these bars; but the bars KK can be fixed in any required position by a sliding spring bolt, working into teeth or holes in a circular part of the upper bar B; hence the horizontal pin, M, is made to move up and down by the muscular motion of the stump, although the hand remains stationary.

Fig. 1.

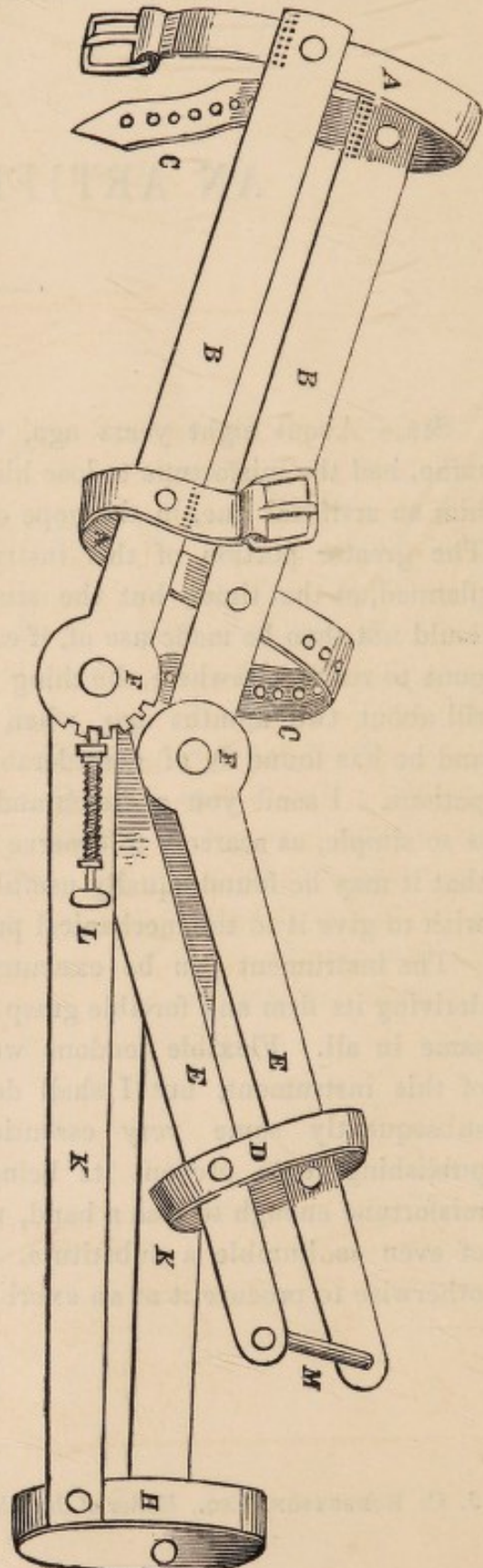
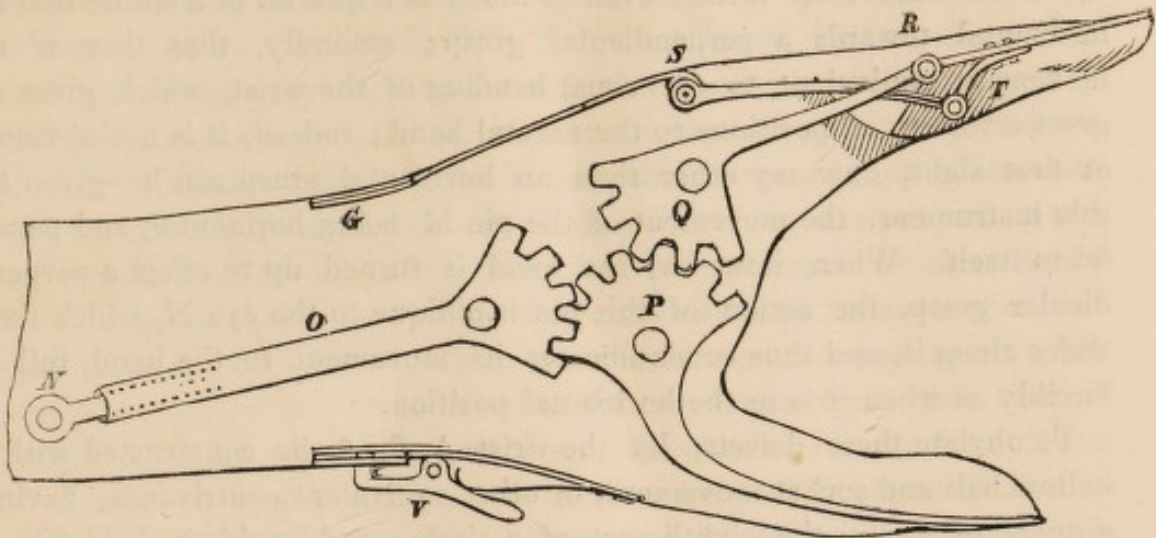


Fig. 2.

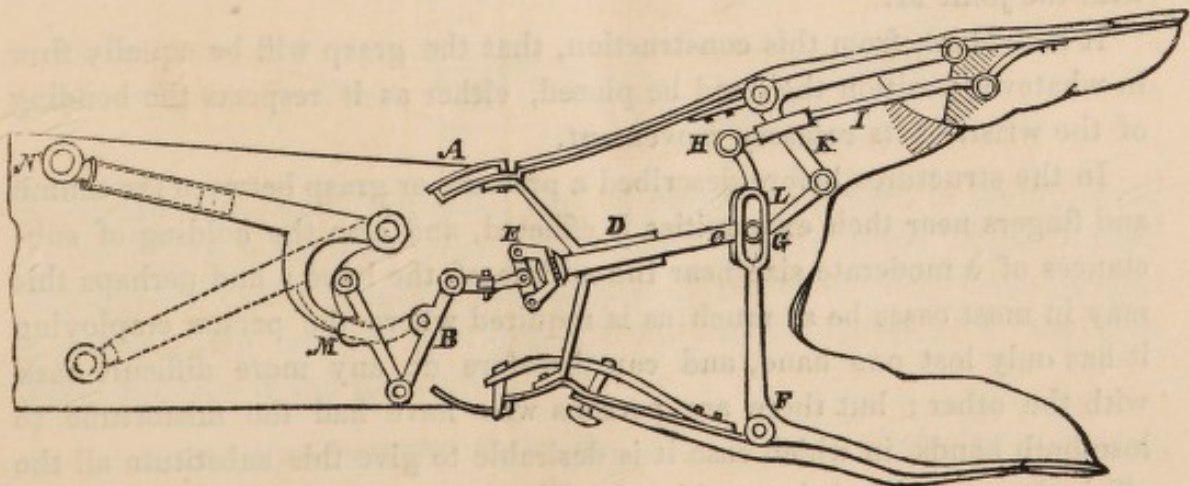


This pin M is inserted through the eye or loop N, fig. 2, the shank of which slides in the tubular lever O, carrying an arch head, with teeth and thus moving similar arch heads, P and Q, in opposite directions, the slender shanks of which form, when packed with cork, or other light but firm material, and covered with leather, the thumb and fingers of the hand.

A second and more rapid motion is given to the fingers at R, fig. 2, by means of a thin rod, or steel tendon, commencing at a stationary joint, S, terminating in a second joint or eye, T, and perforating the finger rod near its outer joint.

The whole hand can be twisted round into several positions by the ring on which it is fixed revolving within the outer ring attached to the upper arms; and it is retained in these positions by means of holes, through which a spring catch plays, as seen at V, fig. 2.

Fig. 3.



There are two considerable deficiencies in this construction ; first, that the hand cannot be turned even so much as a quarter of a circle from its horizontal towards a perpendicular grasp ; secondly, that there is no movement equivalent to the usual bending of the wrist, which gives so great a variety of positions to the natural hand ; indeed, it is not obvious, at first sight, how any other than an horizontal grasp can be given by this instrument, the movement of the pin M being horizontal, and parallel to itself. When, however, the hand is turned up to effect a perpendicular grasp, the action of this pin is oblique to the eye N, which then slides along it, and thus communicates its movement to the hand, full as forcibly as when it is in the horizontal position.

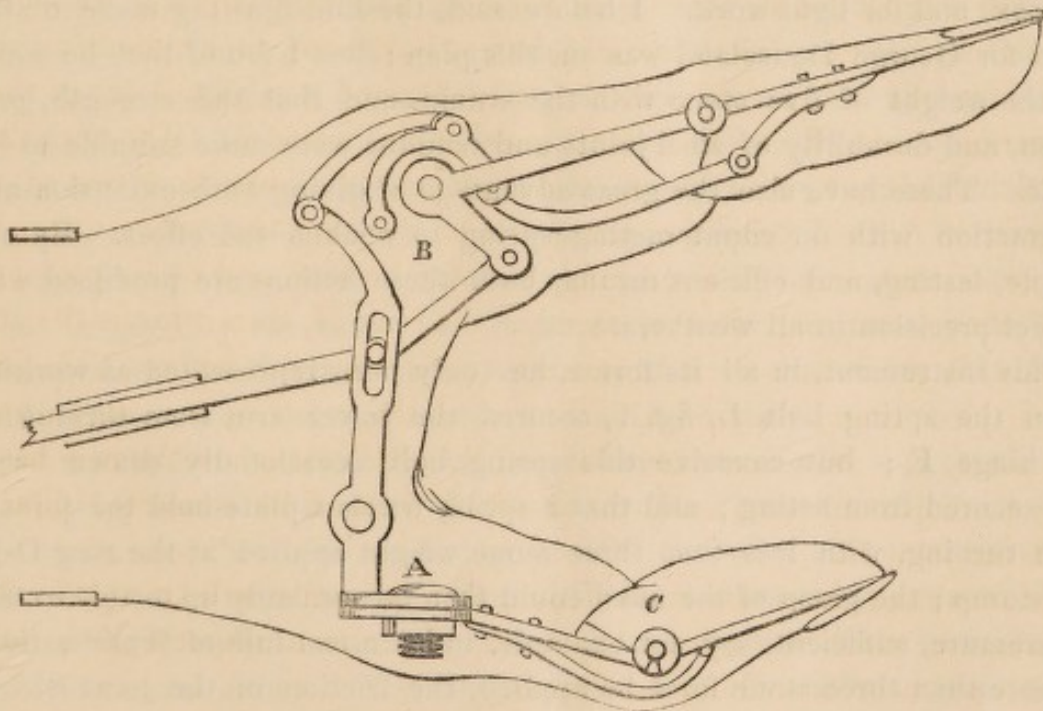
To obviate these defects, let the wrist A, fig 3, be constructed with a hollow ball and socket movement, or other equivalent contrivance, having a range of about the eighth part of a circle ; and let this be held fast at any required point by a spring catch as before, falling into a hole in the stationary portion, which must be drilled like a sieve, to suit every position. To the inner or moveable portion the hand is fixed ; and the movements of the fingers and thumb are communicated from the eye N, through a small rod B, turning on a hinge, and from thence, through a connecting-rod carrying universal joints at both ends, to a cylindrical rod, C. This rod slides freely in the tube D, and can permit one of these universal joints, E, to turn freely in a groove round it. The motion of the thumb piece F, which here, as in nature, is slower than that of the fingers, is derived from the centre pin of the joint G, passing through a slit or elongated eye in a rod hinged at the bottom, and on its prolongation above, carrying an eye, forming the joint H, from whence the steel tendon, I, gives the second movement to the fingers as before. The bent finger-piece is also coupled with the end of the rod C by a short connecting piece, L. In some cases the rod B, which elongates the movement, may be dispensed with, and the universal joint E be connected directly with the joint M.

It is evident, from this construction, that the grasp will be equally firm in whatever position the hand be placed, either as it respects the bending of the wrist, or its rotatory movement.

In the structures before described a pressure or grasp between the thumb and fingers near their extremities is effected, and also the holding of substances of a moderate size near the middle of the hand ; and perhaps this may in most cases be as much as is required where the person employing it has only lost one hand, and can therefore do any more difficult task with the other ; but there are persons who have had the misfortune to lose both hands, in which case it is desirable to give this substitute all the efficient movements it is capable of. With this view, let the thumb piece,

as at A, fig. 4, be furnished with a horizontal joint capable of being screwed firmly against a spring plate, so as to create sufficient friction to prevent its turning with inconvenient freedom, (any required position may also be secured by a spring catch or detent.) By means of this joint the thumb can at any time be turned, as in the natural hand, out of the way of the grasp of the fingers, so that these may close round till they meet the ball of the thumb. This will enable many things to be held more conveniently and firmly than when the thumb meets the extended fingers at some intermediate point, and stops their further progress. To effect this greater range of the joints of the fingers, some little adjustment of the former plan is required. It may be effected many ways, but let the arrangement shown at B, fig. 4, suffice for the present to explain what is intended. And these movements being chiefly similar to those in fig. 3, will readily be understood, without further explanation, by reference to that figure. George Douseland can write, though with difficulty, with the hand as constructed in fig. 2, but an inventive young friend of mine* has suggested the use of a spring movement in the last joint of the thumb, as at C, fig. 4, which will enable the pen to obey the pressure of the fingers

Fig. 4.



backward in the down strokes; and to propel it forward in the up ones, as the fingers relax their force. This light elasticity of the thumb ceases when pressed back to its natural position by the joint being made incapable of receding further; and, hence, it will be no detriment to the firm grasp between it and the fingers.

* Edward Stillingfleet Cayley, Esq., Jun., Trin. Coll., Cambridge.

To avoid confusion in the figures they are drawn so as to show the movement of one finger only ; and in the hand worn by George Douseland there is but one such movement, all the cork fingers being united side by side, and fixed to one broad thin steel plate, jointed, as shown in fig. 2, and covered with continuous leather, only stitched down to mark the distinction of the fingers under it. For common use in most cases this will be sufficient ; but where a more expensive apparatus can be afforded, and the appearance of having a real hand is an object, this thin steel plate can be separated into digits, though united at the base and jointed at the proper places in due proportion to each finger ; and the tendons piercing these plates may be either hinged to fixed joints, as at S, fig. 2, or worked from a horizontal extension of the joint H, fig. 3.

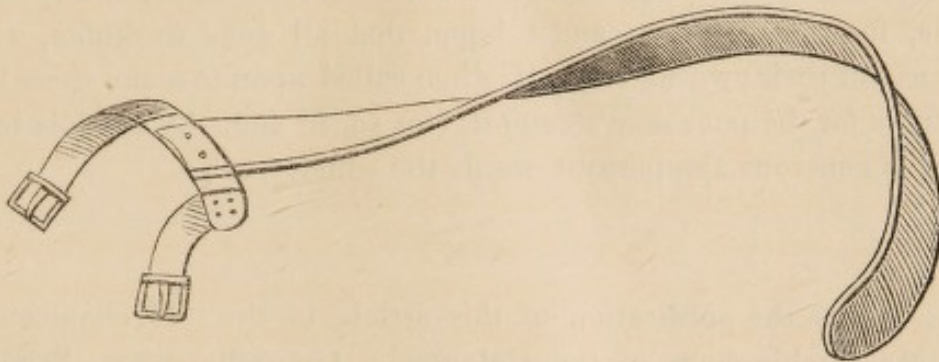
All the required movements can be effected by catgut or other tendons attached to the joints of the fingers, as in the natural hand, and terminating in loops or eyes, on different parts of such a hinged bar as F H, fig. 3, so as to give them different ranges of tension to suit their respective purposes. This structure implies the necessity of a counteracting worm, or other spring movement, to extend the fingers and thumb again. Very light and elegant hands may be made on this plan, which would be suitable for the fair sex, and for light work. I before said, the first drawing made of the hand for George Douseland was on this plan ; but I found that he could lift the weight of five stone with the stump, and that the strength, precision, and durability of steel joints and tendons were more suitable to his work. These have also the great advantage of giving both extension and contraction with no counteracting spring to weaken the effect. By one simple, lasting, and efficient means, both these actions are produced with perfect precision in all weathers.

This instrument, in all its forms, has only been represented as working when the spring bolt L, fig. 1, secured the lower arm from turning on the hinge F ; but conceive this spring bolt occasionally drawn back, and secured from acting ; and that a spring friction plate held the joint F from turning, with less than three stone weight applied at the ring D by the stump ; the grasp of the hand could then be used only up to that extent of pressure, sufficient, say, for example, to lift a can full of liquid ; thus, if more than three stone force be applied, the friction of the joint will be overcome, the can will still be retained with the same power, but the movement of the joint will allow it to be lifted to the mouth. This is only one example of a very important principle, applicable to innumerable instances, and which greatly increases the use of the apparatus.

The same principle may be carried out to a still greater extent in respect to convenient use, though not perhaps with so much power, by supplying the action of a strong spring in lieu of the friction plate. Let this spring

be so arranged as to keep a nearly equal tension or pressure to retain the rods B, and K, of the upper and lower arms, in a right line with each other, and to restore them to that position whenever the elbow joint is bent. By this means, supposing a glass, a spoon, or other matter of light grasp be lifted to the mouth, as before described, it will not then be necessary to take it away from that position with the other hand, as when the friction plate is used, for the reaction of the spring will continue the grasp, as the arm unbends by the downward movement of the stump.

Fig. 5.



One necessary aid to this instrument in all its forms is, to give support to its weight from the neck and shoulder; which, in the case of George Douseland, is effected by a padded flat iron hook, surrounding a considerable portion of the neck, under the collar of the waistcoat, and passing behind it, so as to terminate on the shoulder, where it is cupped a little, to give it firmness of seat. To this part the upper ring A of fig. 1 is attached by a couple of straps with buckles,—see fig. 5. By this means, the arm is not fatigued by the weight of the apparatus, and the joint F is at all times preserved in the same line of axis as that of the elbow joint, with which it has to move as on a centre common to both.

As the hollow ball and socket movement, previously suggested, will require very excellent workmanship to render it efficient, it will be as well here to remark, that with much coarser work the wrist movement may be effected by an external hoop, similar to H, fig. 1, containing a second, that can turn completely round freely within it, but confined from escaping by any of the usual means. The inside of this hoop should be cupped, so as to approach a section of the globular form; and a third hoop, externally, a similar segment of a globe, but a size smaller, must fit, without much nicety of adjustment, within the second. An axis passing through the centre of both these spherical portions is fixed to the inner one, but turns freely in a collar in the second, the end being flush with its exterior surface. The ball and socket action, so far as it is used, is here derived from the one turning on an *axis* within the other, and not from the accurate

fitting of these spherical portions. Any required position of the hand, which is attached to the inner ring, can be secured by a catch and holes to receive it as before. On the centre of this axis the tube D, fig. 3, may be fixed.

I am sorry to give you so many dry details, of no interest excepting to workmen, to whom, in fact, this communication is chiefly addressed, and without whose aid those who require the use of this instrument cannot procure it.

A much more simple and less costly hand than that worn by George Douseland, at the Polytechnic Institution, might be made, chiefly of wood or bone, for poor persons; and I hope, that all good workmen, who live by the use of their own hands, will, when called upon to make these humble substitutes for the poor man's *capital*, (for so, in fact, the hand is to him,) exercise a generous sympathy towards the sufferer.

G. C.

P.S.—Since the publication of this article in the "Mechanics' Magazine," Mr. Buckingham, of the Colonnade, Grenville-street, Brunswick-square, has practically carried out, in the most expert and ingenious manner, and with several modifications of his own, all the movements of the artificial hand here suggested.

