Nov. 16, 1971 D. H. DANE 3,620,095

MECHANICALLY ACTUATED TRIGGERED HAND

Filed Sept. 3, 1970 3 Sheets-Sheet 1

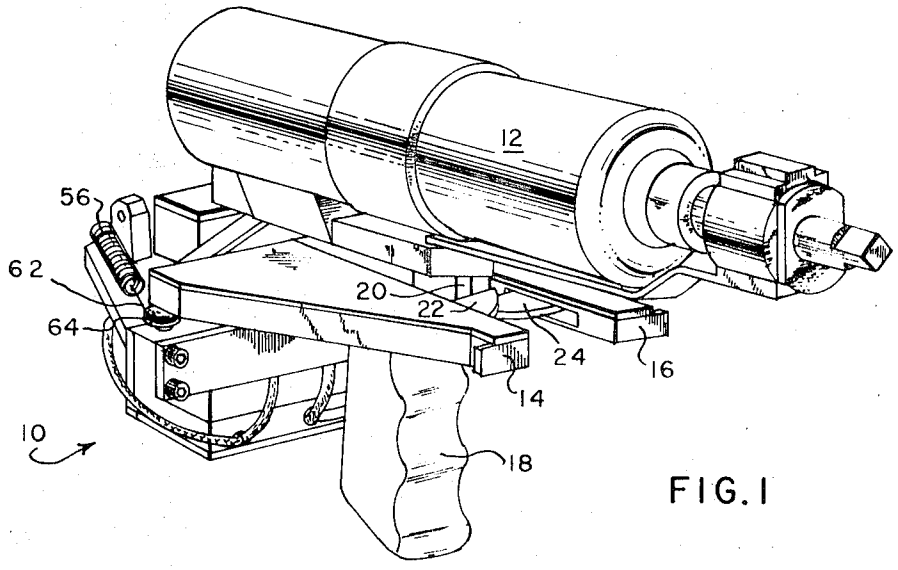


FIG. 1

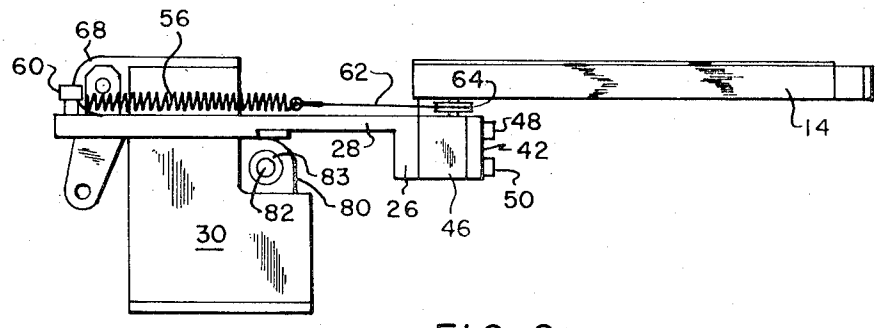


FIG. 2

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MECHANICALLY ACTUATED TRIGGERED HAND

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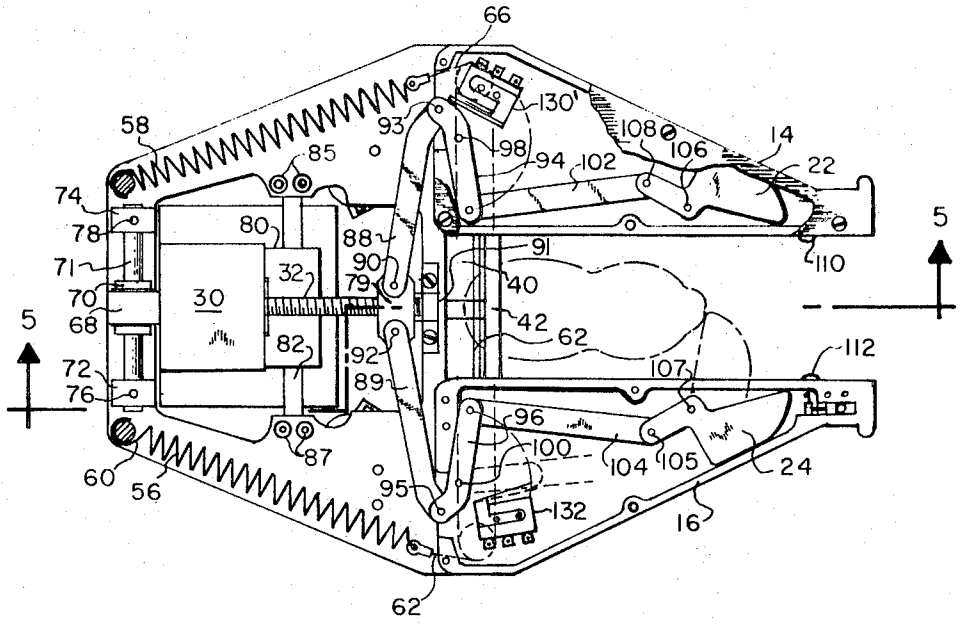


FIG. 3

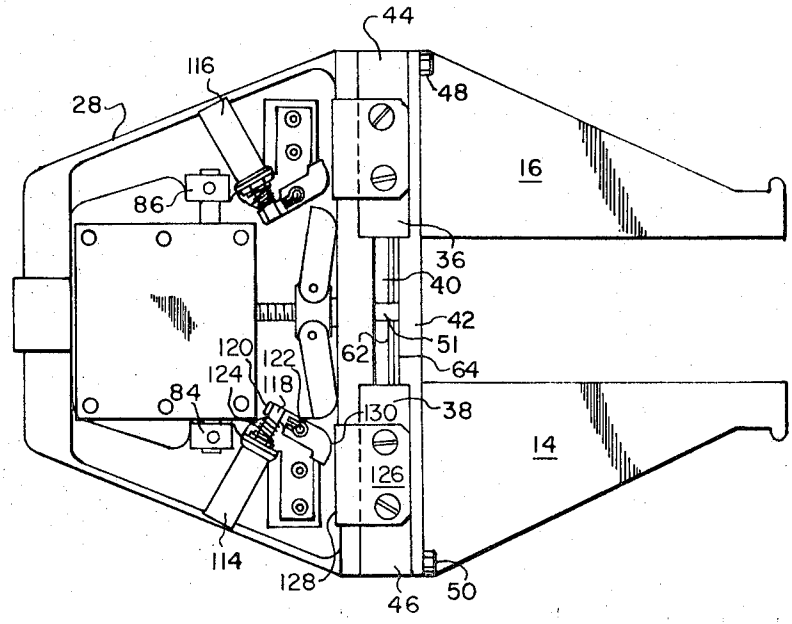


FIG. 4

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MECHANICALLY ACTUATED TRIGGERED HAND

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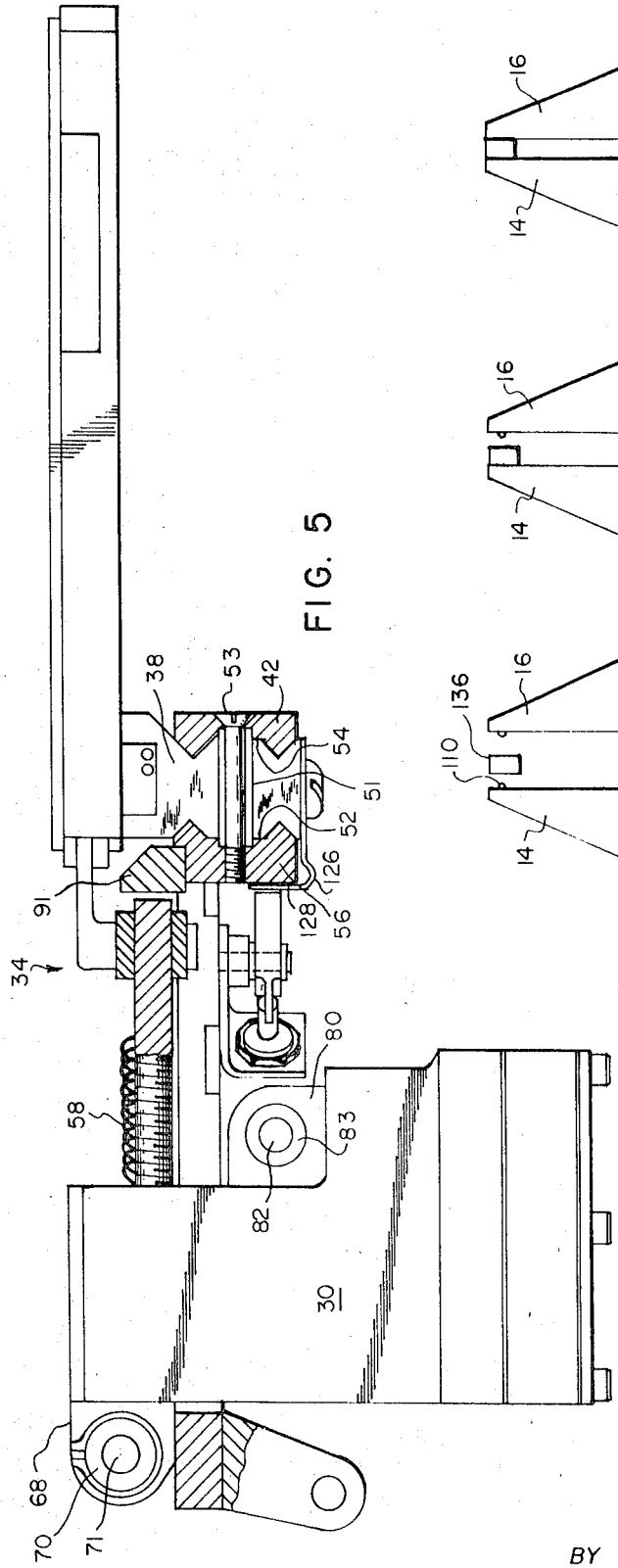


FIG. 5

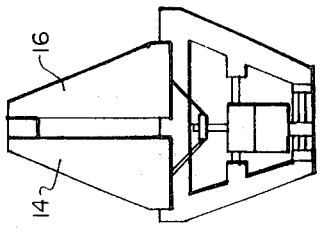


FIG. 8

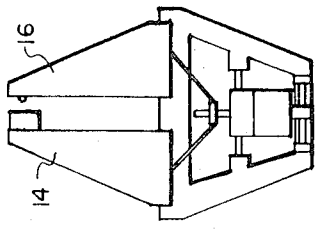


FIG. 7

FIG. 6

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MECHANICALLY ACTUATED TRIGGERED HAND

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Int. Cl. A61f 1/06
U.S. Cl. 74—469 7 Claims

ABSTRACT OF THE DISCLOSURE

A mechanically actuated hand that can grasp an object like a trigger actuated tool and depress the trigger of the tool. The hand includes a supporting frame, a pair of jaw members slidably mounted on the frame and a drive assembly slidably mounted on the frame and mechanically coupled to the jaw members for permitting movement thereof along the frame. A trigger device mounted in each jaw member is connected by a mechanical linkage to the drive assembly so as to be actuated thereby. A brake mechanism is mounted on the frame adjacent each jaw member for selectively immobilizing the jaw members. A touch control device mounted in each jaw member is actuated by a predetermined contact force with an object being grasped and the touch control in turn actuates the brake mechanism to immobilize the jaw member relative to the frame.

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the U.S. Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates in general to mechanical hands for mounting on some type of manipulator arm or boom. More particularly, the invention relates to mechanical hands which can in addition to grasping an object like a tool, also manipulate some portion of the tool like, for example, the trigger thereof.

Discussion of prior art

Numerous artificial hands known and described in the prior art are capable of grasping and moving objects about. However, these known hands have not been capable of selectively manipulating other moveable mechanisms or parts of the object being grasped. Many prior art devices have also faced the problem of toppling, or possibly crushing, an object while attempting to grasp it. This is an inherent disadvantage of mechanical hands and the problem is compounded by the customary mounting of the mechanical hand on a manipulator arm having two or more pivotal sections.

SUMMARY OF THE INVENTION

The present invention avoids the above mentioned disadvantages at least to some extent. Assume that the tool to be manipulated is an impact tool for applying an impact load to a workpiece; such a tool must be grasped and then the trigger thereof depressed to actuate the tool. The present invention accomplishes this by mounting a triggering device in each of two jaw members which hold the tool. The triggering device is actuated after the tool is grasped.

The hand includes a supporting frame on which the two grasping jaws are slidably mounted. A motorized drive assembly is slidably mounted on the frame and this

assembly is connected to a pivotal linkage mounted in each jaw member. This linkage is also connected to the triggering device in each jaw member so that in addition to opening the jaw members it will actuate the triggering device in each jaw member. The jaw members are closed by a spring and cable assembly connected between the carriage and each jaw member.

Each of the jaw members have a touch control device mounted therein that is electrically connected to a brake mechanism mounted on the frame. The purpose of the brake mechanism is to immobilize the jaw members and there are two brake mechanisms, one for each jaw member. The touch control devices are actuated by contact with an object being grasped and each one actuates a brake mechanism to immobilize a jaw member. With one jaw member immobilized the other jaw member will continue to move until it engages the object being grasped. Control means in the form of limit switches and the like are included in the hand to control the operation thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial view showing the hand grasping an impact tool;

FIG. 2 is a side view of the hand with certain components removed for clarity of illustrations;

FIG. 3 is a top view of the hand, that is looking down on the hand as shown in FIG. 1, with portions thereof removed to illustrate the linkage that moves the jaw members out and actuates the triggering links;

FIG. 4 is a bottom view of the hand showing the underside thereof as positioned in FIG. 1;

FIG. 5 is a cross sectional side view of the hand taken along lines 5—5 of FIG. 3;

FIG. 6 is a schematic illustration of the hand positioned for grasping a small lightweight object;

FIG. 7 shows the hand after the jaw members have been moved so that one jaw is in contact with the object being grasped;

FIG. 8 shows the hand grasping the object with both jaw members.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1 a mechanical hand **10** is shown grasping an impact tool **12**. The hand has two moveable jaw members **14** and **16** and in FIG. 1 these jaw members are closed on handle **18** of the impact tool. A trigger **20** is mounted in handle **18** of the tool for actuating the tool. Trigger **20** is depressed by triggering links **22** and **24** mounted in the jaw members.

In FIG. 2 the hand is illustrated with several parts of the hand removed in an attempt to clarify the construction of the hand. The jaw members are slidably mounted on a downwardly extending flange **26** on one end of frame member **28**. A motor drive assembly **30** is mounted on the rearward end of the frame **28**. The drive assembly includes an electric motor and suitable gear reduction mechanism for driving a threaded shaft **32** (see FIG. 3) at a desired rate. The frame member has a horseshoe like shape and the drive assembly is positioned in the approximate center thereof. A linkage mechanism **34**, connected between threaded screw **32** and jaw members **14** and **16**, is shown in FIG. 3 and to some extent in FIGS. 4 and 5. The details and operation of the linkage will be discussed hereafter. Linkage mechanism **34** is not shown in FIG. 2.

The jaw members have Teflon blocks **36** and **38** (see FIGS. 4 and 5) mounted to the undersides thereof and these Teflon blocks slide in a guideway **40** formed by flange **26** of frame **28** and crossbeam **42**. Crossbeam **42** is maintained in a spaced position relative to flange **26** by spacer blocks **44** and **46**, secured in place at each end of crossbeam **42** by through bolts **48** and **50**, and by a

tubular spacer **51** secured by a bolt **53** (see FIG. 5). The through bolts screw into threaded openings (not shown) in flange **26**. Flange **26** and crossbeam **42** are provided with concave grooves **52** and **54** that form the guideway **40** in which the Teflon blocks slide. The Teflon blocks have convex surfaces thereon that exactly fit grooves **52** and **54**.

A pair of coil springs **56** and **58** (see FIG. 3) are mounted on frame **28**. The two springs apply a force to the jaw members that tends to slide the jaw members together. Spring **56** is anchored at one end to frame **28** by a screw **60** and the other end thereof is connected to a cable **62**. Cable **62** passes over a pulley **64** (see FIGS. 1 and 2) and fastens to jaw member **16**. The length of the cable and the arrangement of spring **56** is such that outward movement of jaw member **16** by the drive assembly and linkage, described in detail hereafter, will expand spring **56**. Thus, if not restrained, jaw member **16** will slide inward due to the action of spring **56**. Spring **58** is connected to a cable **66** that is similarly arranged over a pulley (not shown) and connected to jaw member **14** so as to tend to pull jaw member **14** inwardly.

The motor drive assembly **30** includes an electric motor that drives a gear reduction mechanism which in turn drives threaded screw **32** at a desired rate of rotation. For the hand illustrated this rate is 120 revolutions per minute, however this rate would be varied for different hand sizes. The rearward side of drive assembly **30** has a mounting lug **68** formed thereon. The lug has a through hole in which a Teflon bushing **70** is mounted. Bushing **70** slides over a polished shaft **71** which is supported at each of its ends in mounting lugs **72** and **74** that are an integral part of frame **28**. The lugs are provided with set screws **76** and **78** to secure shaft **72** in place. The forward end of the drive assembly is provided with a projecting portion **80** that has a through hole which accommodates a polished shaft **82** supported by mounting lugs **84** and **86** are bolted to frame **28** by bolts **85** and **87**. Shaft **82** **86**. Lugs **84** and **86** are bolted to frame **28** by bolts **85** and **87**. Shaft **82** is secured in its mounting lugs by set screws. The through hole in projecting portion **80** is provided with a Teflon bushing **83**. As is probably apparent, housing **30** is slideable on shafts **71** and **82** relative to frame **28** and the reason for this will become apparent as the description of the invention progresses.

A collar **79** that has a threaded hole formed therein is mounted on threaded screw **32** so that rotation of screw **32** will result in movement of collar **79** along the length thereof. Forward movement of collar **79** is limited by stop **91** mounted on frame **28**. A first pair of links **88** and **89** are pivotally mounted at one of their ends to collar **79** by pins **90** and **92**. The other ends of links **88** and **89** are pivotally connected by pins **93** and **95** to the ends of a pair of intermediate links **94** and **96**. The two intermediate links are pivotally mounted on their respective jaw members at a point intermediate the ends thereof by pins **98** and **100**. The intermediate links are in turn each pivotally connected to an end of one of a pair of end links **102** and **104**. The other ends of links **102** and **104** are pivotally connected to triggering links **22** and **24**. As shown in FIG. 3, triggering link **22** is pivotally connected to jaw member **14** by a pin **106** and to end link **102** by pin **108**. Triggering link **24** is similarly connected to jaw member **16** and end link **104** by pins **105** and **107**.

When the linkage is in the position shown in FIG. 3 clockwise rotation of screw **32** will move collar **79** toward motor drive assembly **30**. This will cause that part of the linkage connected by pins **93** and **95** to move inwardly resulting in two possible motions of the linkage. If the two jaw members have not moved against an object to be grasped then the jaw members will move toward one another under the action of springs **56** and **58** as links **88** and **89** move rearwardly towards the motor drive assembly. As soon as the jaw members contact an object such as the handle of impact tool **12** the jaw members are no longer free to move inwardly and continued rearward movement of links **88** and **89** will result in pivotal movement of intermediate links **94** and **96** about the pinned connection made by pins **98** and **100**. Such movement will cause, as is apparent from the consideration of FIG. 3, forward movement of end links **102** and **104** so as to pivot triggering links **22** and **24** outwardly out of the jaw members into a position like that shown in FIG. 1 where the triggering links will engage the trigger of impact tool **12**. In FIG. 3, the position of intermediate link **96** and link **104**, when intermediate link **96** has been pivoted about pin **100**, is shown in dotted lines. In FIG. 3, it can be seen how forward movement of end link **102** will move pin **108** relative to pin **106** causing triggering link **22** to rotate about pin **106**. The connection between triggering link **24** and end link **104** is identical to that of triggering link **22** and end link **102**. The pivoted position of link **24** is shown in dotted lines.

The jaw members are each provided with a touch control system that includes switches **110** and **112** mounted in the forward end of each jaw member. Switches **110** and **112** are suitable electrical switches actuated upon contact with an object positioned between the jaw members. The switches are electrically connected to solenoid brake devices **114** and **116** mounted on frame **28**; which function to immobilize the jaw members. Solenoid brake mechanism **114** includes (see FIG. 4) an axially moveable plunger **118** fastened to a lever **120** that is pivotally mounted to frame **28** by means of a pin **122**. A spring **124** is mounted around shaft **118** so as to normally bias lever **120** away from the jaw members. Jaw member **14** has an L-shaped plate **126** mounted thereto that includes a surface **128** (see FIG. 5) against which lever **120** bears. Lever **120** of the brake mechanism is provided with a friction type surface **130** which engages surface **128** when the solenoid brake mechanism is actuated. When the solenoid is actuated plunger **118** is pulled to the rear and this pivots lever **120** about pin **122** causing surface **130** to impinge against surface **128** and results in jaw member **14** being immobilized. Brake mechanism **116** functions in an identical manner to immobilize jaw member **16**. The touch control system is intended for use in applications where small or lightweight objects are to be picked up so as to prevent toppling of the small object to be grasped. The touch control will not be needed when large objects like tool **12** are to be grasped.

Each jaw member has a limit switch mounted therein that is engaged by the linkage, described above, during some stage in the operation of the hand. Limit switch **130'** in jaw member **14** is contacted by one end of intermediate link **94** when the linkage mechanism is in the position shown in FIG. 3. When the linkage has moved to the position shown partially in phantom in FIG. 3 then limit switch **130'** is no longer engaged by intermediate link **94** and limit switch **132** is contacted by intermediate link **96** so as to actuate limit switch **132**.

Two modes of operation of the invention will now be discussed; the grasping of a small lightweight object and the grasping and triggering of a tool like the impact tool **12** shown in FIG. 1. In grasping a lightweight object, assuming that frame **28** is connected to a suitable manipulator arm and the jaws of the hand are open as shown in FIG. 6, the hand is positioned adjacent an object such as a small container **136** that is to be grasped. The hand would be moved to a position where container **136** would be positioned between the jaws. The motor drive assembly would then be actuated to begin rotation of threaded screw **32** which in turn pulls collar **79** towards the motor drive assembly. Jaws **14** and **16** would thus be permitted to slide inwardly under the actions of springs **56** and **58** until, as illustrated in FIG. 7, jaw **14** engages container **136** and touch control device **110** is actuated by this contact. Actuation of switch **110** of the touch control system activates solenoid **114** so as to immobilize jaw **14** relative

to frame **28**. However, the drive motor assembly continues to run and threaded screw **32** turns and collar **79** continues to travel rearwardly. Considering the fact that frame **28** is held stationary by the manipulator arm upon which it is mounted, and jaw member **14** is held stationary relative to frame **28** by brake mechanism **114**, it is apparent that something must slide if the collar **79** and links **88** and **89** continue to move rearwardly. Jaw **16** is still free to slide and this will permit inward movement of link **89**, but in order for link **88** to move rearwardly it is necessary that either jaw member **14** be able to slide or for drive assembly **30** to move to the left as viewed in FIG. 7. In order for the jaws to grasp object **136** as illustrated in FIG. 8, it is necessary that housing **30** slide to the left before jaw member **16** can close on object **136**. Movement of the drive motor assembly is, as previously described, made possible by slidably mounting the motor drive assembly on shafts **71** and **82**. By providing the jaw members with a sensitive touch control system delicate objects can be grasped without injury or toppling.

Another mode of operation is where the hand is used to grasp a tool as illustrated in FIG. 1 of the drawings. Here the object is to grasp the handle of the tool and thereafter actuate the trigger so as to operate the tool. This is accomplished by first positioning the jaws of the hand around the handle of the tool in a manner illustrated in phantom lines in FIG. 3. The motor drive assembly is then actuated to move collar **79** rearwardly and permit the jaws to close upon the handle of the tool. The grasping force of the jaws is controlled by the amount of spring tension in springs **56** and **58**. The linkage connected between collar **79** and the jaws does not apply a positive inward force on the jaw members, but only permits the jaw members to come together under the action of their respective spring and cable assemblies. When further inward motion of the jaw members is stopped because of an object placed therebetween, then continued rearward movement of collar **79** will cause rotation of intermediate links **94** and **96** which in turn results in motions of links **102**, **104** and trigger links **22** and **24**. Rotation of intermediate link **94** will result in link **94** becoming disengaged from limit switch **130** stopping the operation of the drive motor assembly. This of course only occurs after both jaws have moved against the object to be grasped. Thereafter, actuation of the drive motor assembly so as to continue the rearward movement of collar **79** on threaded screw **32** will cause the linkage to pivot about its various points causing triggering links **22** and **24** to impinge upon the object being grasped. When the linkage has pivoted as far as possible then intermediate link **96** engages limit switch **132**, as illustrated in phantom lines, and again stops the operation of the drive motor assembly.

The circuitry involved in controlling the operation of a hand like that disclosed herein can either be very sophisticated or quite simple depending upon the nature of the use to which the hand is to be put. For this reason the circuitry has not been disclosed in detail because designing and fabrication of a suitable circuit for a particular application of the hand could be readily accomplished by one skilled in that art.

What is claimed is:

1. A mechanically actuated triggered hand for grasping and activating a device comprising:

a frame upon which the parts of the hand are mounted,

a first jaw member slidably mounted on said frame,

a second jaw member slidably mounted on said frame adjacent said first jaw member,

triggering means mounted in said jaw members for exerting a force on the object being grasped, and

drive means slidably mounted on said frame and operatively connected to said first and second jaw members and said triggering means, said drive means operating to slide either or both of said first and second jaw members along said frame to a grasping position and to actuate said triggering means.

2. The triggered hand recited in claim **1** which further includes:

a pair of brake mechanisms mounted on said frame for engagement with said jaw members, one of said brake mechanisms immobilizing said first jaw member and the other brake member immobilizing said second jaw member, and

a touch control means mounted on said jaw members and connected to said brake mechanism for actuation of the brake mechanisms.

3. The triggered hand recited in claim **2** wherein said touch control means includes,

a sensing element is mounted in each jaw member so as to contact an object being grasped, said element being connected to said brake mechanism for selectively actuating one of said brake mechanisms when a predetermined force is exerted on said touch control means by engagement thereof with an object being grasped.

4. The triggered hand recited in claim **3** wherein:

a crossbeam is mounted on one end of the frame to provide a guideway in which the first and second jaw members can slide,

said first and second jaw members each having a block member mounted thereon that is positioned in said guideway for supporting said first and second jaw members for slidable movement relative to said frame and each other.

5. The triggered hand recited in claim **4** wherein said triggering means includes:

a pair of links pivotally mounted in said first and second jaw members, a single link being mounted in each jaw member in a position such that the links are in opposing relation and bear against an object being grasped by said jaw members, and

linkage means pivotally mounted on said first and second jaw means and connected to said pair of links and to said drive means for actuating said pair of links.

6. The triggered hand recited in claim **5** wherein:

said drive means includes a motor slidably mounted on said frame that has a threaded shaft extending therefrom and rotated thereby, and

said linkage means includes an internally threaded coupling mounted on said threaded shaft whereby rotation of said shaft by said motor will result in motion of the internally threaded coupling which in turn will actuate said linkage means to move said jaw members and said trigger means.

7. The triggered hand recited in claim **6** which further includes:

spring means mounted on said carriage and connected to said jaw members so as to tend to move said jaw members away from each other, said spring means being expanded by movement of said jaw members away from one another by said drive means.

References Cited

UNITED STATES PATENTS

3,171,549 3/1965 Orloff ..... 294—106

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U.S. Cl. X.R.

3—12; 214—1 CM; 294—111, 113, 115