

- [54] **ELECTRICALLY DRIVEN HAND EXERCISER**
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- [51] Int. Cl. **A61h 1/02**
- [58] Field of Search **128/24-26**

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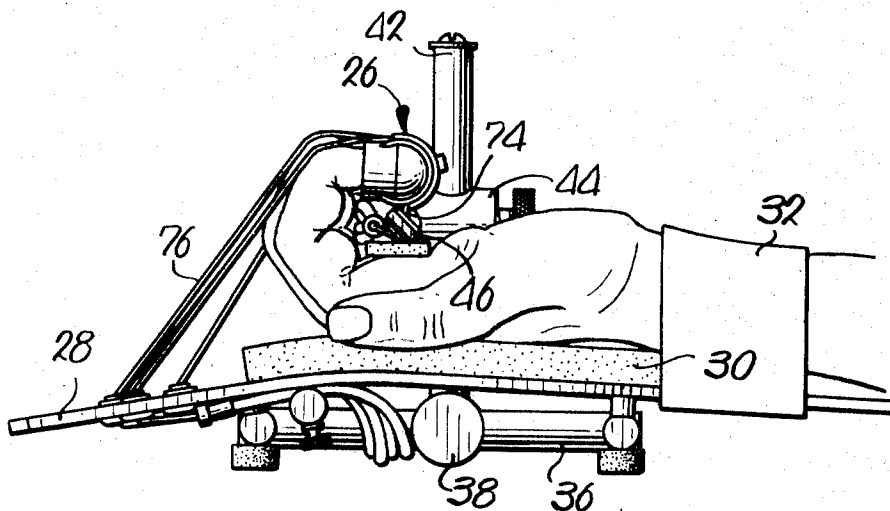
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[57] **ABSTRACT**

A hand splint for exercising the fingers of the hand which splint includes a base for supporting the hand, and a plurality of elements each secured to corresponding fingers and operatively connected with a power source that repetitively shifts the elements in order to exercise the fingers. Power transmitting means, in the form of flexible cords extending from the power source to each of the elements, are coupled to the base in such a manner as to shift the elements along a preselected path between protracted and retracted positions to thereby shift the fingers in a natural motion between an extended position and a position naturally folded toward the palm of the hand.

17 Claims, 11 Drawing Figures

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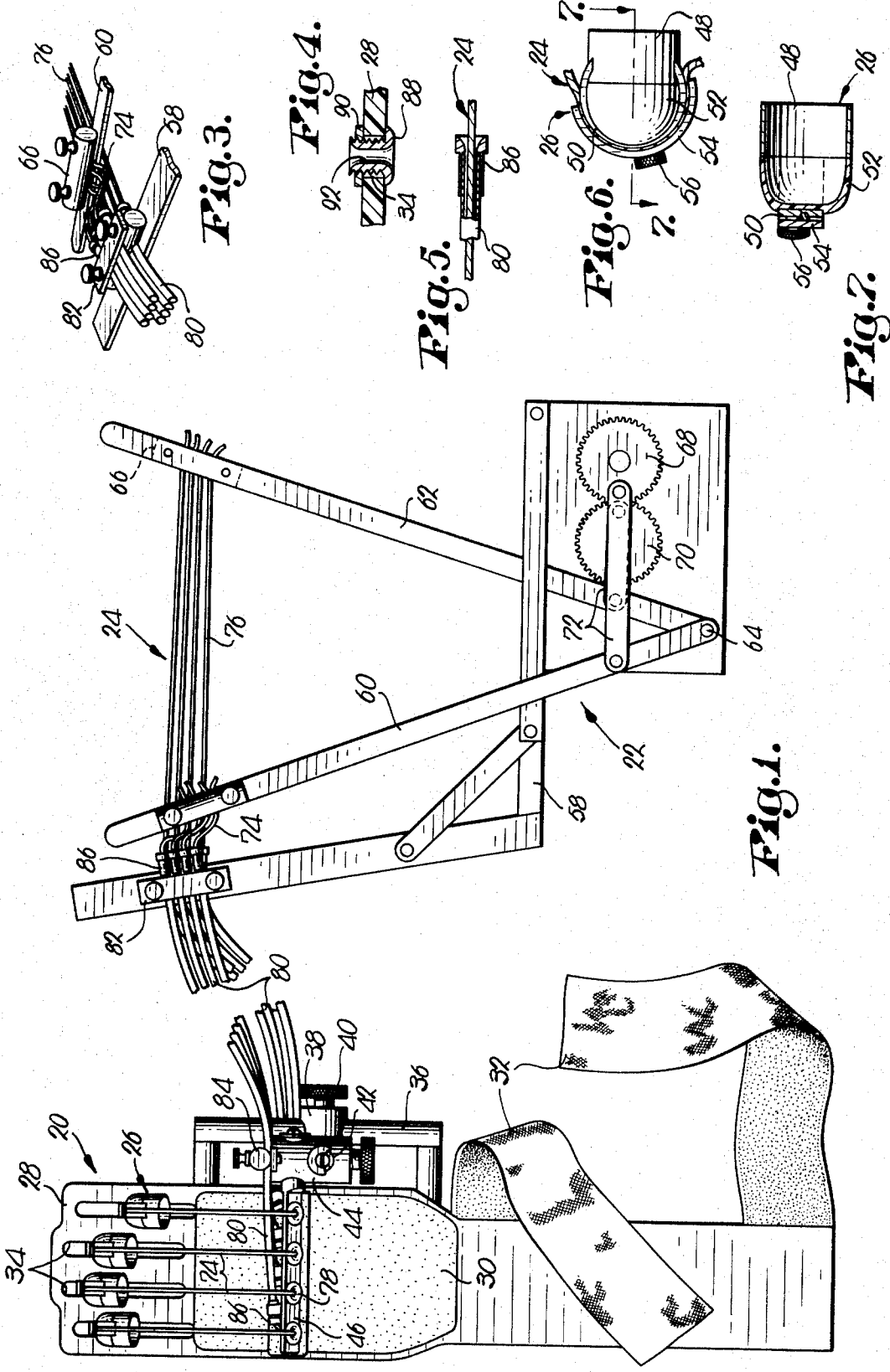


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 1.

FIG. 2.

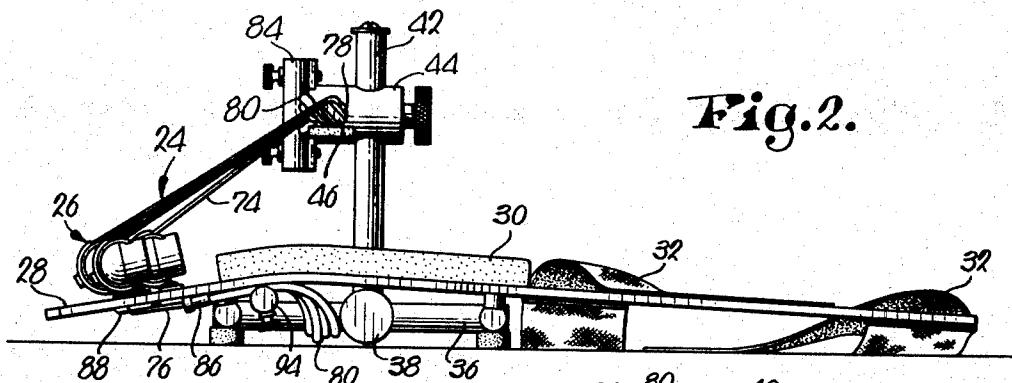


Fig. 2.

Fig. 8.

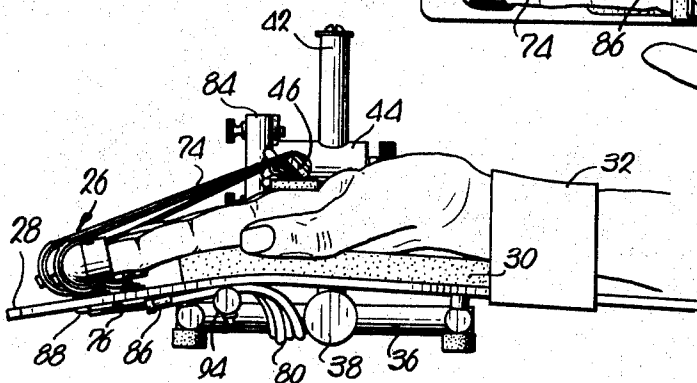
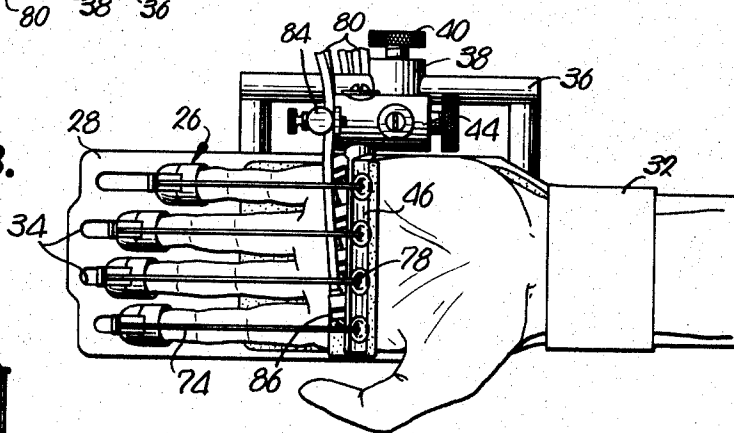


Fig. 9.

Fig. 10.

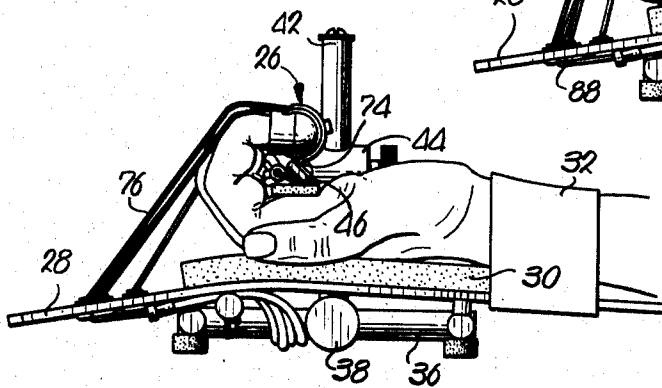
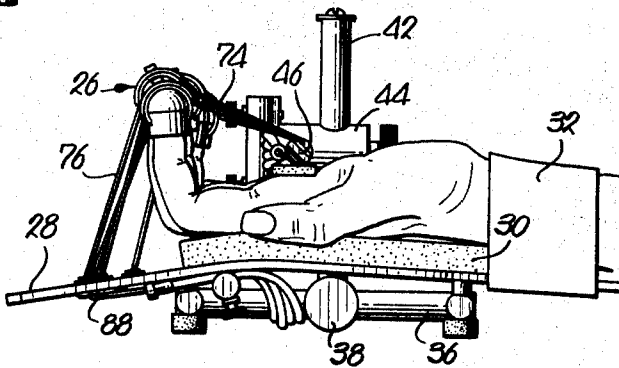


Fig. 11.

ELECTRICALLY DRIVEN HAND EXERCISER

This invention relates to hand splints and the like for repetitively exercising the fingers of a human hand.

Curative procedures associated with diseases, ailments or injuries to the human hand oftentimes require finger exercises wherein the fingers are repetitively flexed between extended positions and folded fist-like positions. Such exercising is recommended, for instance, as a part of the post-operative procedure associated with implantation of prosthetic devices in the finger or fingers of a human hand. In such instances it is desirable that the fingers be flexed through a relatively prolonged period and in a natural manner. Various factors, including the incapacity of the finger itself, will inhibit the proper and necessary movement of the hand during self-exercising by the patient. This, combined with the tiring and bothersome aspects of exercising the hand over a prolonged period of time makes it desirable to provide automatic power apparatus for exercising the hand in the proper manner.

Accordingly, it is a primary object of the present invention to provide a hand splint for repetitively flexing a finger in the human hand in a natural motion so as to effect proper, curative exercising thereof.

It is an object of the present invention to provide a hand splint for flexing a finger of the human hand which includes a base for supporting the hand, a movable element adapted to be secured to a finger of the hand, and drive means operatively connected with the element for repetitively shifting the latter along a preselected path so as to shift the finger in a natural motion between an extended position and a position wherein the finger is naturally folded toward the palm of the hand.

Another object of the invention is to provide power transmitting means extending between the drive means and the element and coupled to the base so as to shift the element along the preselected path and move the finger in the desired natural motion.

Another object of the present invention is to provide power transmitting means in the form of a flexible cord coupled to the base through guide means that is effective to guide the element along the preselected path, the cord being in a pair of sections separately secured to the drive means so that the latter alternately drives the first section to shift the finger in a natural motion toward its folded position and drives the second section of cord to move the finger in a natural motion toward the extended position.

A more particular object of the invention is to provide a hand splint of the type described wherein the base includes first and second vertically spaced supports to which the first and second sections of the power transmitting cord are respectively coupled, the supports being longitudinally and vertically adjustable so as to facilitate insertion and removal of the hand into the splint as well as to adjust the splint to fit the size of the particular hand being exercised.

These and other more particular objects and advantages of the present invention are specifically set forth in or will become apparent from the following detailed description of a preferred embodiment of the invention when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a top plan view of a hand splint constructed in accordance with the present invention, portions being broken away for clarity;

FIG. 2 is a side elevational view of the hand support apparatus;

FIG. 3 is a fragmentary perspective view of the cord clamps of the drive means;

FIG. 4 is an enlarged, vertical cross section of a guide bushing mounted upon the base plate;

FIG. 5 is a partial cross-sectional view of the end portion of the protective cord sheath;

FIG. 6 is an enlarged partial vertical cross section of a finger-engaging element;

FIG. 7 is a transverse cross-sectional view taken along lines 7—7 of FIG. 6;

FIG. 8 is a partial top plan view of the hand splint with a hand inserted therein;

FIG. 9 is a side elevational view of the splint showing the fingers of the hand in an extended position;

FIG. 10 is a view similar to FIG. 9 showing the fingers of the hand positioned intermediate an extended and folded position; and

FIG. 11 is a view similar to FIG. 9 with the fingers shown in a fully folded position.

Referring now more particularly to the drawings, the hand splint generally includes a base 20 for receiving and supporting a human hand, and power drive means 22 which are operatively connected with the base by power transmitting means in the form of a plurality of flexible cords 24. Each cord 24 is secured to a corresponding element 26, which element is adapted to be received upon the ends of the fingers of the hand when the latter is placed in proper position upon base 20.

Base 20 includes an elongated, longitudinal base plate 28 that underlies the entire length of the hand in supporting relationship thereto. A cushioning pad 30 on the top of plate 28 receives the back of the hand, and straps 32 are provided to wrap around the lower arm to hold the hand upon plate 28. Toward the outer end of plate 28 there are provided a plurality of longitudinal slots 34 corresponding to each finger.

Base 20 is provided with a longitudinal, cylindrical rod 36 upon which is movably mounted a bracket 38 which can be secured in position on rod 36 by means of a tightening set screw 40. Bracket 38 carries a vertical post 42 upon which is mounted another movable bracket set screw assembly 44 similar in structure and operation to bracket 38. Bracket assembly 44 carries a transversely extending support member in the form of bar 46 that is disposed in vertically spaced relationship from the hand support member presented by plate 28. Bracket assembly 44 is adjustably positionable upon post 42 to permit the movement of the bar 46 from its elevated position shown in FIG. 2 to a power position as in FIG. 9 in order to supportingly engage the palm of the hand adjacent the first joints of the fingers thereof.

Each finger receiving element 26 includes, as shown in FIGS. 6 and 7, a ring 48 sized to be received upon the corresponding finger. Element 26 further includes a circular end cap 50 which fits over the end of the finger and which is permanently affixed upon ring 48. Element 26 may also include a U-shaped portion 52 extending substantially transversely to cap 50 to provide further support for the end of the finger. A clamp 54 of circular, mating configuration to cap 50 is secured adjacent the outer surface of the latter by means of a threaded set screw 56. Flexible cord 24 extends along the outer surface of circular cap 50, and clamp 54 is

operable to releasably secure and hold cord 24 between cap 50 and mating clamp 54.

Drive means 22 includes a stationary frame 58 which carries a power source, not shown, preferably in the form of an electric motor. A pair of links 60 and 62 are pivotally mounted upon frame 58 at juncture 64, the opposite ends of links 60 and 62 being provided with clamp assemblies 66 for securing the opposite ends of cords 24 to the links 60 and 62. The links 60 and 62 are respectively connected to the interengaging driving gears 68 and 70 via the crank arms 72. The electrical power source is coupled to one of the gears so as to rotate the latter and move the links 60 and 62 in continual crossing, scissor-like action. During one portion of the rotation of gears 68 and 70, link 60 will move rightwardly as viewed in FIG. 1, pulling the section 74 of cord 24 attached thereto, while the other link 62, in following motion, moves leftwardly. Conversely, during the other part of the rotation of the gears, link 62 will be driven back rightwardly to its original position pulling the section 76 of the cord 24 attached thereto until the original position is reached.

The sections 74 of each cord 24 attached to link 60 extend from the latter to transverse support bar 46 and through corresponding apertures 78 provided therein. The apertures 78 in bar 46 are substantially aligned with the associated element 26 so that each cord section 74 extends from aperture 78 in a straight line generally parallel to the finger into securement with element 26. Each cord 74 is carried freely within a protective sheath 80 which extends from frame 58 to a location adjacent the transverse bar 46. The sheaths 80 are firmly secured upon the frame 58 by a clamp member 82 and upon bracket assembly 44 by another clamp 84. As illustrated in FIG. 5 each of the sheaths is provided with a metallic end support 86 having a smoothly curved inside surface for reducing wear upon cord section 74.

The other cord sections 76 extend from link 62 to the undersurface of base plate 28 as clearly illustrated in FIG. 2. Each cord section 76 is operatively coupled to base 28 by guide means in the form of an externally threaded bushing 88. Each bushing 88 is mounted within an associated slot 34 of base plate 28 at a location substantially adjacent the corresponding element 26 when the latter is in its protracted position as shown in FIG. 9. As best seen in FIG. 4, a lock nut 90 is utilized to releasably lock the bushing 88 in the desired position along slot 34, loosening of lock nut 90 permitting adjustable movement of bushing 88 along the associated slot. Each bushing is provided with a through aperture 92 which loosely receives the cord section 76 that extends from bushing 88 into securement with element 26. Similar to cord section 74, there is provided for each cord section 76 a protective sheath 80 that extends from underneath plate 28 up to the clamp 82 on the frame 58 of the drive means. If desired, a clamp 94 as shown in FIG. 2 may be included to rigidly secure the ends of sheaths 80 to the underside of plate 28.

In operation, the hand is placed upon plate 28 while the support bar 46 is in its elevated position as illustrated in FIG. 2. The fingers are inserted within the corresponding elements 26 which, if necessary, may be adjustably slid along the continuous cord 24 to alter the position of the element to correspond with the size of the hand to be exercised. With the elements 26 properly located, the set screws 56 thereof may be tightened

so that clamp 54 rigidly secures the associated element to the cord 24. The straps 32 are wrapped around the lower portion of the arm to firmly but comfortably secure the hand upon plate 28, and transverse bar 46 is then lowered onto the palm of the hand. Preferably bar 46 is positioned adjacent the first joints of the fingers, and to this end its longitudinal position may be adjusted by loosening set screw 40 and sliding bracket 38 along rod 36. With bar 46 in proper location, the set screw 40 and set screw assembly 44 may be tightened to hold the bar in the correct location.

The apparatus will now be in the proper exercising alignment as illustrated in FIGS. 8 and 9 with the fingers of the hand in extended positions and with the elements 26 in a corresponding, protracted position.

Upon actuation of the power source and drive means 22, the link 60 will first be driven rightwardly in order to pull cord section 74 and force the elements 26 to move along a preselected path toward transverse bar 46. The coupling of cord sections 74 to transverse bar 46 through aperture 78 and the consequent alignment of cord sections 74 with the associated fingers causes the latter to be drawn in a natural folding motion toward the palm of the hand. In FIG. 10 the hand is illustrated in an intermediate position, and as the link 60 continues its rightward travel, the fingers will be finally drawn to their folded position as illustrated in FIG. 11 with the elements 26 located in a fully retracted position adjacent bar 46. The relative flexible nature of cord section 74 permits the hand to flex in its desired natural manner.

In the preferred arrangement, tee drive means 22 is provided with suitable timing mechanism to permit a pause in the retracted position of FIG. 11 in order to permit relaxation of the hand. Subsequently, link 62 then is driven so as to pull the other cord section 76 and cause the elements 26 to again follow the preselected path in returning from the retracted position back to the protracted position in FIG. 9. Again, another pause occurs at the protracted position to rest the hand, and then the cycle is started over.

The apparatus, therefore, permits continuous flexing of the fingers in the desired and therapeutic manner while minimizing tiring of the hand muscles. The apparatus has been found to be particularly useful for prolonged exercising of the hand while the patient is asleep. The cycling period as well as the timing of the pauses during the exercises may be selected or varied as in keeping with the desired therapeutic exercising of the fingers of the hand.

While the element 26 which is secured to the fingers is illustrated as a cap and ring arrangement which fits over the very end of the finger, it will be apparent that the element 26 may be positioned at a different location on the finger in order to effect flexing of only those joints desired. In such case, of course, the apparatus still operates to shift the finger from the relatively extended position to the relatively folded position. Similarly, various other modifications and alterations to the preferred form of invention illustrated will be apparent to those skilled in the art. Accordingly, the foregoing detailed description is to be considered exemplary in nature and not as limiting to the scope and spirit of the invention as set forth in the accompanying claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A hand splint for repetitively flexing a finger of a human hand, comprising:

a base adapted to substantially fully support the hand and the finger with the latter being disposed adjacent said base when in a normally extended condition;

a movable element adapted to be selectively positioned and secured to the finger in a manner leaving the greater portion of the hand and finger exposed; and

drive means operatively connected with said element for repetitively shifting the latter along a preselected path between a protracted position and a retracted position,

said drive means having a single reciprocating power transmitting mechanism operatively coupling said element and said base to exert a reciprocable pulling force on the element wherein the finger is respectively naturally extended in said disposition and naturally folded toward the palm of the hand, said element and said mechanism cooperating to alternately shift the finger in a natural motion between said extended and folded position.

2. Apparatus as set forth in claim 1, there being a separate element secured to each finger of the hand when the latter is supported on said base, said drive means being operatively connected with each of the elements whereby to synchronously shift said elements alternately between said protracted and retracted positions and all of the fingers between said extended and folded positions.

3. Apparatus as set forth in claim 2, said mechanism being adjustable relative to said base whereby said fingers may be selectively flexed.

4. Apparatus as set forth in claim 1, said power transmitting mechanism including a flexible cord secured to said element and said drive means.

5. Apparatus as set forth in claim 4, said element including a transverse ring adapted to be received on the finger and a circular end cap affixed to said ring and adapted to fit over the end of the finger.

6. Apparatus as set forth in claim 5, there being a clamp releasably fastened upon said cap to secure said cord between said cap and the clamp.

7. Apparatus as set forth in claim 1, said base including first and second vertically spaced supports adapted to engage opposite sides of the hand to hold the latter upon the said base.

8. Apparatus as set forth in claim 7, said power transmitting mechanism being coupled to said first and second supports.

9. Apparatus as set forth in claim 8, said power transmitting mechanism including a cord having first and second sections thereof extending from said element to spaced positions on said drive means and respectively coupled to said first and second supports, said drive means being operable to alternately drive said first section to shift said element to said retracted position and drive said second section to shift said element to said protracted position.

10. Apparatus as set forth in claim 9, said drive means including first and second links and a power source for alternately reciprocally driving said first and second links, said first and second sections of cord being respectively secured to said first and second links.

11. A hand splint for repetitively flexing a finger of a human hand, comprising:

a base adapted to support the hand;

a movable element operatively coupled with said base and adapted to be secured to the finger; and drive means operatively connected with said element for repetitively shifting the latter along a preselected path between a protracted position and a retracted position wherein the finger is respectively naturally extended and naturally folded toward the palm of the hand, whereby to alternately shift the finger in a natural motion between said extended and folded positions;

there being power transmitting means operatively connected with said drive means and said element for transmitting power from said drive means to said element,

said power transmitting means being coupled to said base whereby to shift said element along said preselected path and thereby shift the finger in said natural motion,

said power transmitting means being operable to couple said element to said base,

said base including first and second vertically spaced supports adapted to engage opposite sides of the hand to hold the latter upon the said base,

said power transmitting means being coupled to said first and second supports,

said power transmitting means including a cord having first and second sections thereof extending from said element to spaced positions on said drive means and respectively coupled to said first and second supports,

said drive means being operable to alternately drive said first section to shift said element to said retracted position and drive said second section to shift said element to said protracted position,

said first support being a transverse bar adapted to extend transversely across and engage the palm of the hand,

said bar having an aperture longitudinally aligned with said element for receiving said first section of cord to guide the latter to shift said element along said preselected path.

12. Apparatus as set forth in claim 11, said base including means for adjustably securing said first support relative to said second support.

13. Apparatus as set forth in claim 12, said securing means permitting selective, vertical and longitudinal adjustment of said first support relative to said second support.

14. A hand splint for repetitively flexing a finger of a human hand, comprising:

a base adapted to support the hand;

a movable element operatively coupled with said base and adapted to be secured to the finger; and drive means operatively connected with said element for repetitively shifting the latter along a preselected path between a protracted position and a retracted position wherein the finger is respectively naturally extended and naturally folded toward the palm of the hand, whereby to alternately shift the finger in a natural motion between said extended and folded positions,

there being power transmitting means operatively connected with said drive means and said element for transmitting power from said drive means to said element,

said power transmitting means being coupled to said base whereby to shift said element along said preselected path and thereby shift the finger in said natural motion,
 said power transmitting means being operable to couple said element to said base,
 said base including first and second vertically spaced supports adapted to engage opposite sides of the hand to hold the latter upon the said base,
 said power transmitting means being coupled to said first and second supports,
 said power transmitting means including a cord having first and second sections thereof extending from said element to spaced positions on said drive means and respectively coupled to said first and second supports,
 said drive means being operable to alternately drive said first section to shift said element to said retracted position and drive said second section to shift said element to said protracted position,

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said second support being a longitudinal plate extending along substantially the entire length of the finger when the latter is in said extended position.

15. Apparatus as set forth in claim 14, there being guide means secured to said plate and operatively engaging said second section of cord for guiding the latter to shift said element along said preselected path.

16. Apparatus as set forth in claim 15, said plate having a longitudinal slot extending substantially parallel to the finger, said guide means including a bushing passing through said slot, said bushing having an aperture therethrough for receiving said second section of cord.

17. Apparatus as set forth in claim 16, said bushing being adjustably positionable along said slot to a location longitudinally adjacent said element when the latter is in said protracted position, there being means for releasably locking said bushing to said plate in said location.

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