Sept. 5, 1944. D. GOLDBERG 2,357,323

ADJUSTABLE SPLINT

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Fig. 1.

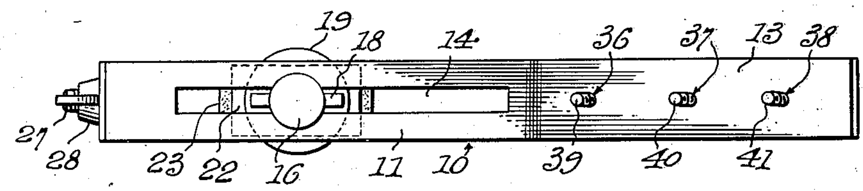

Fig. 3.

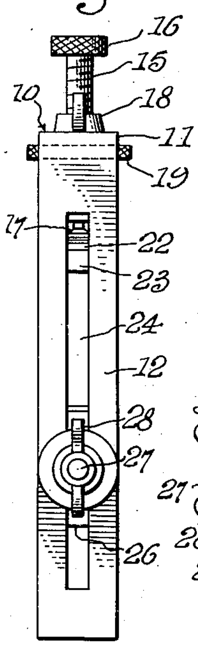

Fig. 2.

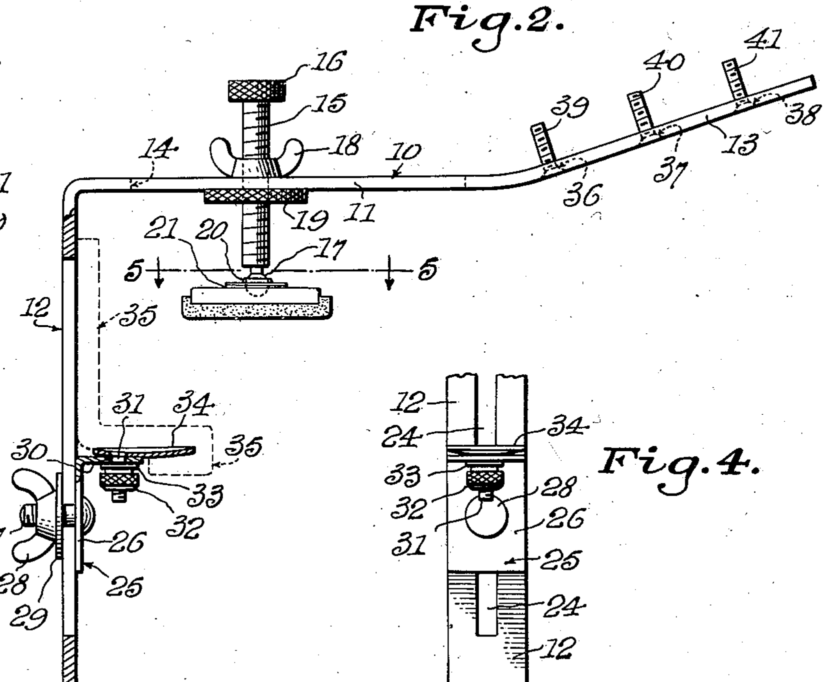

Fig. 4.

Fig. 5.

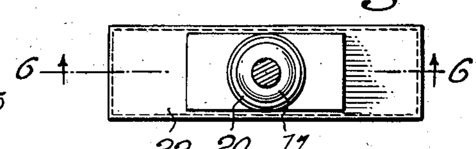

Fig. 6.

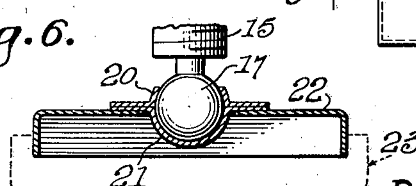

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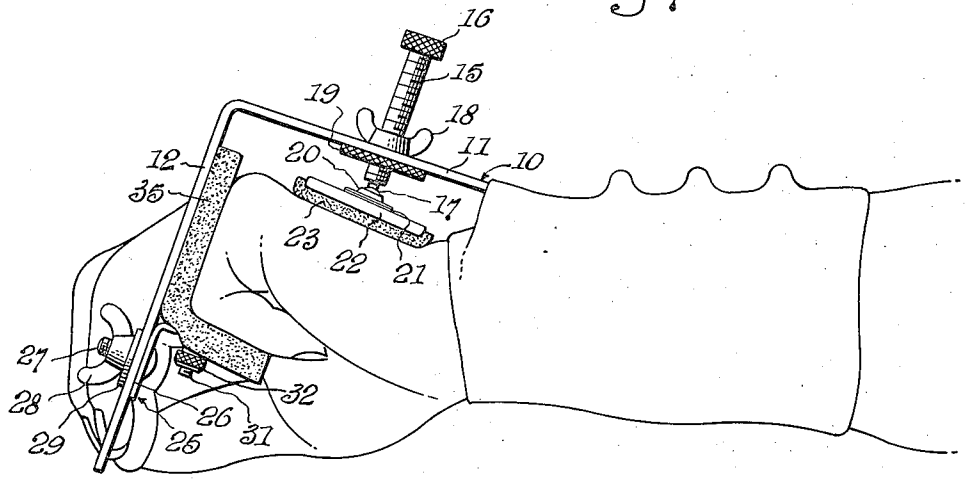
Fig. 7.



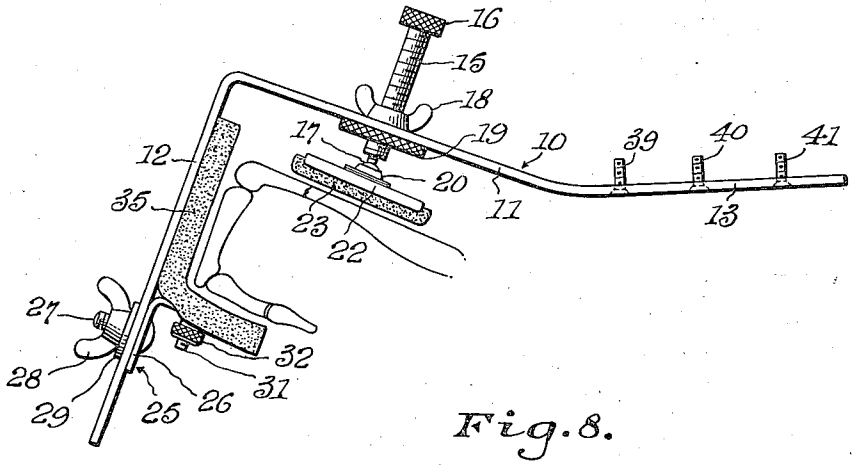


Fig. 8.

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ADJUSTABLE SPLINT

David Goldberg, United States Army,
Camp McCoy, Wis.

Application April 15, 1944, Serial No. 531,253

5 Claims. (Cl. 128—84)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without payment to me of any royalty thereon.

This invention relates generally to a splint, but more specifically to an apparatus to be utilized for the retention of fractured metacarpal bones in a fixed position after reduction of the fracture.

One object of the invention is to provide a simple and inexpensive device to effect the immobilization and maintenance of anatomical restoration of a reduced fracture.

Another object of the invention is to provide an apparatus for the treatment of transverse and impacted fractures of the last four metacarpal bones, which can be easily applied and adjusted without fear of pressure sores, infection, loss of position or deformities.

Still another object of the invention is to provide an instrument of the class described which anatomically and physiologically answers the purpose of the general practitioner.

Referring to the figures in which like parts are designated by similar reference characters:

Figure 1 is a top plan view showing the slot for longitudinal adjustment of the pressure plate;

Figure 2 is a front elevation of the apparatus;

Figure 3 is an end elevation showing the slot for the vertical adjustment of the finger bracket;

Figure 4 is an end elevation of a portion of the finger support and vertically movable bracket;

Figure 5 is a top plan view of the pressure plate taken on line 5—5 of Figure 2;

Figure 6 is a sectionalized view of the pressure plate taken on the line 6—6 of Figure 5 showing a portion of the universal connection thereto;

Figure 7 is a front elevation showing the apparatus attached to the hand of a patient; and

Figure 8 is a front elevation showing relative location of the pressure pad and elevating bracket with respect to fractured metacarpal bone and the adjoining phalanges.

Deformities of the hand often occur as the result of improper setting of a fractured bone. These fractures are characteristically found in the young or middle aged man, usually the result of a pugilistic encounter, or close hand to hand combat with the enemy in time of war. The neck of the metacarpal being the smallest and weakest portion of the bone, is the most common site of the fracture. The fracture is more frequently transverse in character. The resulting deformity is that of a depression of the head with dorsal angulation of the fragments. The more dorsal the striking force against the head, the greater is the depression of the knuckle. The more direct the force on the head in the longitudinal axis of the metacarpal, the greater the degree of impaction. A tangential force results in depression of the head with impaction and angulation of the fragments.

Ordinarily in this type of fracture, a simple roll of gauze bandage is placed in the palm of the hand. The fist is clenched and immobilized with another gauze bandage. Some recommend bandaging the hand over a tennis ball. More complicated and specialized devices have met with success in the hands of others. L. Kaplan in his work entitled "The treatment of fractures and dislocations of the hand and fingers; technic of unpadded casts for carpal, metacarpal, and phalangeal fractures" Surg. Clin. N. America, 1940, 20: 1695–1720, explains a device for reducing the fracture and holding it in position by the application of an unpadded cast made of two narrow plaster of Paris splints. The finger is held in extension and pressure is instituted below the head of the metacarpal and above the angulation while the plaster sets. H. Meltzer in the article on "Wire extension treatment of fractures of fingers and metacarpal bones" described in Surg. Gyn. Obst., 1932, 55:87–9, employs skeletal wire traction through the proximal phalanx. McNealy and Lichtenstein maintain the corrected position with a straight dorsal splint as explained in Western Journal of Surgery, 1935, 43:156–61. Wertheim in an article in The Journal of the American Medical Association, 1929, 92:2171, relative to a new type of splint for fractures of bones of the hand, advocates a kid glove into the finger of which he inserts ⅛ inch shoe leather to act as a splint. R. N. Carr, in an article in the South. Med. Journal, 1929, 32:543–6 entitled "A finger caliper for reduction of phalangeal and metacarpal fractures by skeletal traction," explains how to correct and maintain the position of the fragments by inserting specially constructed miniature ice tongs into the proximal phalanx. D. M. Bosworth, in an article on the internal splinting of fractures of the fifth metacarpal, in the Journal of Bone Surgery, 1937, 19:826, states that the fragments are first reduced and then maintained in position by fixing them to the adjacent metacarpal with nonflexible heavy wires. S. A. Jahss, in his discussion entitled "Fractures of the metacarpals; a new method of reduction and immobilization" in the Journal of Bone Surgery, 1938, 20:178–86, maintains the position of reduction by employing pressure beneath the head of the flexed proximal phalanx, a procedure similar in certain respects to that recommended in this paper. G. G. Davis, in

his discussion on the use of a ball splint for hand fractures in the International Clinic, 1928, Ser., 1:182, 8 pl., maintains position over various sizes of specially constructed wooden balls.

Since this type of fracture is usually first seen by the general practitioner, it is invariably treated by him with one of the many simpler methods available. Unfortunately, in this fracture which is so easily reduced, it is ordinarily difficult to maintain the corrected position. In consequence, many individuals are left with a residual deformity. This deformity in the laborer interferes with his grasp of an implement. The inability to fully flex the affected finger results in a weakness of the flexion power of the adjacent fingers. The prominent head of the metacarpal in the palm of the hand causes pain when an object such as a tool is grasped. The professional man, too, finds that this deformity interferes with the full use of both the affected and the adjacent fingers. The depression of the knuckle and the prominence on the dorsum of the hand is cosmetically objectionable to the women.

The ball or roll of gauze in the palm of the hand does not counteract but rather emphasizes the angulating pull of the interossei muscles thereby increasing the deformity. Skeletal traction of any form or skeletal fixation introduces the danger of infection and must be considered a specialized procedure. Plaster, as is well known, cannot be adjusted to exert varying degrees of pressure during the changing phases of the appearance and subsidence of edema and the subsequent development of atrophy. It is too difficult for the average physician to determine the exact amount of pressure which is necessary to exert upon setting plaster. Too little pressure will result in reangulation during the stage of atrophy. Too much pressure will result in pressure sores during the swelling stage which ensues within a few hours following the reduction. Constant immobilization of the flexed proximal interphalangeal joint for a period sufficient to see callous on the X-ray film, results in a flexion deformity.

The instrument to be described is devised primarily for application to the most common type of metacarpal fracture. This, as has been stated, is the simple, transverse, impacted fracture of the shaft.

With the fracture once reduced, the operator will find that very little upward pressure on the head and downward pressure over the distal end of the proximal fragment is necessary to maintain the corrected position. However, an upward force cannot be made on the plantar surface of the metacarpal head for any great length of time without the expectation of complications. Pressure of any consequence for four to six weeks in the intervening flexor tendon sheath would irritate its membrane and result in thickening and adhesions. In order to eliminate pressure over the flexor tendon sheath, the first phalanx is flexed to a right angle at the metacarpal-phalangeal joint. This places the base of the proximal phalanx beneath the head of the metacarpal. Pressure upward on the proximal phalanx now forces the metacarpal head upwards. The proximal interphalangeal joint is then flexed to an angle of ninety degrees. Very slight pressure exerted upwards against the head of the proximal phalanx easily maintains elevation of the metacarpal head and the corrected position of the fragments. The amount of pressure necessary is merely the equivalent of the angulating force caused by the pull of the interosseous muscle. The armamentarium necessary to maintain the corrected position of the fractured bone consists of the simple and easily applied apparatus described below and one four inch roll of plaster of Paris bandage.

The apparatus comprises a frame member which consists of an elongated rigid bar **10** formed of metal or other suitable material having a straight central or metacarpal portion **11**, and at either end a finger support, and a wrist or carpal and anterbrachium portion **12** and **13** which are bent at angles of ninety degrees and approximately fifteen degrees, respectively, to the central portion. The central portion **11** of the bar **10** is provided with a longitudinally extending slot **14** for the reception of a set screw **15** which is provided with a knurled head **16** and a ball member **17** at its lower extremity. The set screw **15** is held rigidly at any fixed position within the longitudinal slot **14** in the bar **10** by a winged lock nut **18** and a circular knurled lock nut **19** as shown in **1, 2, 3, 7** and **8**. The ball **17** at the lower extremity of the screw **15** is engaged by the socket members **20** and **21** which are attached to a pressure plate **22** provided with a pad or cushion member **23** which contacts the upper surface of the patient's hand. The pressure plate may be vertically adjusted by means of the set screw **15** and lock nuts **18** and **19** to regulate pressure of the pad **23** on the upper surface of the hand.

The finger or phalangeal portion **12** of the bar **10** which extends at ninety degrees to the central portion **11** is provided with a longitudinally extending slot **24** which provides for the attachment of an adjustable bracket **25**. This bracket is composed of an angular base member **26** slidably connected to the bar by means of a bolt **27** which may be retained in any position along the slot by tightening the thumb screw **28** which engages the threads of the bolt and increases the pressure on the washer **29** contacting the surface of the bar. The upper surface of the bracket **26** is provided with circular opening **30** for the reception of a bolt **31**, provided with a knurled nut **32** and washer **33** arranged as shown in Fig. 2, and adapted to retain a supporting plate **34** upon the upper surface of the bracket and to permit the angular adjustment of the same thereon. Upon the upper plate **34** is mounted an angularly shaped pad **35**, which is bent over the outwardly extending edge of the plate **34**, so as to prevent a soft contact surface to the hand of the patient. The height of the bracket **25** and the angularity of the plate **33** may be adjusted so that the finger of the patient may rest comfortably upon the pad **35**.

The wrist portion **13** of the bar **10** is provided with three circular openings **36, 37** and **38** for the reception of the screws **39, 40** and **41**. Instead of tapping the holes **36, 37** and **38** as shown the screws may be welded therein if a more permanent attachment is desired. These screws prevent slipping of the plaster of Paris bandage which is wrapped around the wrist and a lower portion of the arm to retain the frame **10** in a fixed position with relation to the patient's hand.

To apply the apparatus the upper and lower screws **15** and **27** are loosened. About five turns of the plaster of Paris splint bandage are taken about the wrist, the bandage being applied directly upon the skin. The instrument is then placed over the involved metacarpal and the remainder of the plaster roll is used to secure the instrument

to the wrist. The plaster sets in a few minutes and the instrument is ready for use. During this procedure the patient maintains the corrected position of the hand by placing the index finger of the other hand over the fracture site and his thumb beneath the head of the flexed proximal phalanx, thus making an assistant unnecessary.

The upper set screw **15** is then adjusted so that the pressure plate rests directly over the metacarpal and proximal to the fracture line. The lower support bracket **26** is raised so that it approximates the dorsal surface of the flexed second and third phalanges. The knuckle is thus maintained in its normal prominent position.

If the fifth metacarpal is involved, it will be noticed that the terminal two phalanges will deviate radially. Hence, a third set screw **31** as shown in Figs. 2, 4, 7 and 8 is placed at the lower support in order to adjust it to the proper angle. The lower support **33** is slightly cupped for comfort. The upper plate **22** is supported by a universal joint the parts of which are designated by the numerals **17**, **20** and **21**, the universal being used in order to allow for slight variations in the size and shape of the hand and still maintain an even distribution of force throughout the entire lower contact surface which is covered by the pad **23**.

If swelling is present on the day following the application of the device either one or both of the set screws can easily be adjusted and thus avoid pressure necrosis of the skin. It will nevertheless still be possible to maintain the necessary force to counteract the angulating pull of the interossei.

After a few days all swelling will have subsided. Some fibrous union of the fragments will then have taken place. The operator can then hold his finger beneath the metacarpal head, loosen the lower support and carry the flexed proximal interphalangeal joint through a full range of motion. The finger can also be cleaned with alcohol and the skin protected with any oil or cream. This latter procedure should be carried out two or three times a week during the entire stage of fixation.

The fragments should be supported for about three to five weeks, or until X-ray evidence shows sufficient callous about the fracture site to prevent the pull of the interossei muscles from reangulating the fragments.

When callous appears adequate and the apparatus is finally removed, there is a complete restoration of position without evidence of deformity throughout any portion of the hand. Two to three days after the removal of the apparatus, patients have been returned to full army duty without any resultant difficulty.

Modifications of the device, such as increasing the width of the pressure plate **22** and the supporting plate **33** for use in cases where more than one metacarpal bone is fractured, may be made without departing from the scope and spirit of the invention.

Having thus described my invention, what I claim as new and wish to secure by Letters Patent is:

1. An adjustable splint for use in maintaining a fractured metacarpal bone in anatomical alignment after reduction comprising a rigid frame having a central metacarpal portion, a depending phalangeal portion, and an angularly extending carpal portion, an adjustable pressure plate adapted to contact the dorsal surface of the metacarpal region of the patient's hand, and a vertically and angularly adjustable bracket member connected to said depending portion adapted to support the second row phalanx associated with the fractured metacarpal.

2. An adjustable splint for use in maintaining fractured metacarpal bones in anatomical alignment after reduction comprising a rigid frame having a central metacarpal portion, a depending phalangeal portion, and an angularly extending wrist portion, a vertically adjustable pressure plate provided with a padded surface adapted to contact the dorsal surface of the metacarpal region of the patient's hand, and a vertically and angularly adjustable bracket member provided with a padded surface and connected to said depending portion adapted to support the second row phalanges associated with the fractured metacarpals.

3. An adjustable splint for use in maintaining fractured metacarpal bones in anatomical alignment after reduction comprising a rigid frame having a central metacarpal portion, a depending phalangeal portion, and an angularly extending carpal and antebrachial portion, an adjustable pressure plate adapted to contact the dorsal surface of the metacarpal region of the patient's hand, and a vertically and angularly adjustable bracket member connected to said depending phalangeal portion adapted to retain the fingers of the fractured metacarpals doubled into the palm of the hand, and means in connection with said carpal and antebrachial portion of said frame adapted to retain a plaster of Paris bandage in fixed position.

4. An adjustable splint for use in maintaining a fractured metacarpal bone in anatomical alignment after reduction comprising a rigid frame having a central metacarpal portion, provided with a horizontal slot, a depending phalangeal portion provided with a vertical slot, and an angularly extending wrist portion, a vertically adjustable pressure plate, slidably supported within the horizontal slot in the metacarpal portion of said frame adapted to contact the dorsal surface of the metacarpal region of the patient's hand, and an adjustable bracket, slidably supported within the vertical slot in the phalangeal portion of said frame, adapted to support the second row phalanx associated with the fractured metacarpal.

5. An adjustable splint for use in maintaining a fractured metacarpal bone in anatomical alignment after reduction comprising a rigid frame having a central metacarpal portion, provided with a horizontal slot, a depending phalangeal portion provided with a vertical slot, and an angularly extending wrist portion, a vertically adjustable pressure plate, slidably supported within the horizontal slot in the metacarpal portion of said frame adapted to contact the dorsal surface of the metacarpal region of the patient's hand, and an adjustable bracket, slidably supported within the vertical slot in the phalangeal portion of said frame, adapted to support the second row phalanx associated with the fractured metacarpal and means comprising screws projecting from the upper surface of the wrist portion of said frame adapted to retain plaster of Paris bandage in a fixed position.

DAVID GOLDBERG.