C. E. MACDUFFEE.

SUBMARINE ARMOR.

APPLICATION FILED DEC. 6, 1910.

989,530.

Patented Apr. 11, 1911.

4 SHEETS—SHEET 1.

Fig. 1.

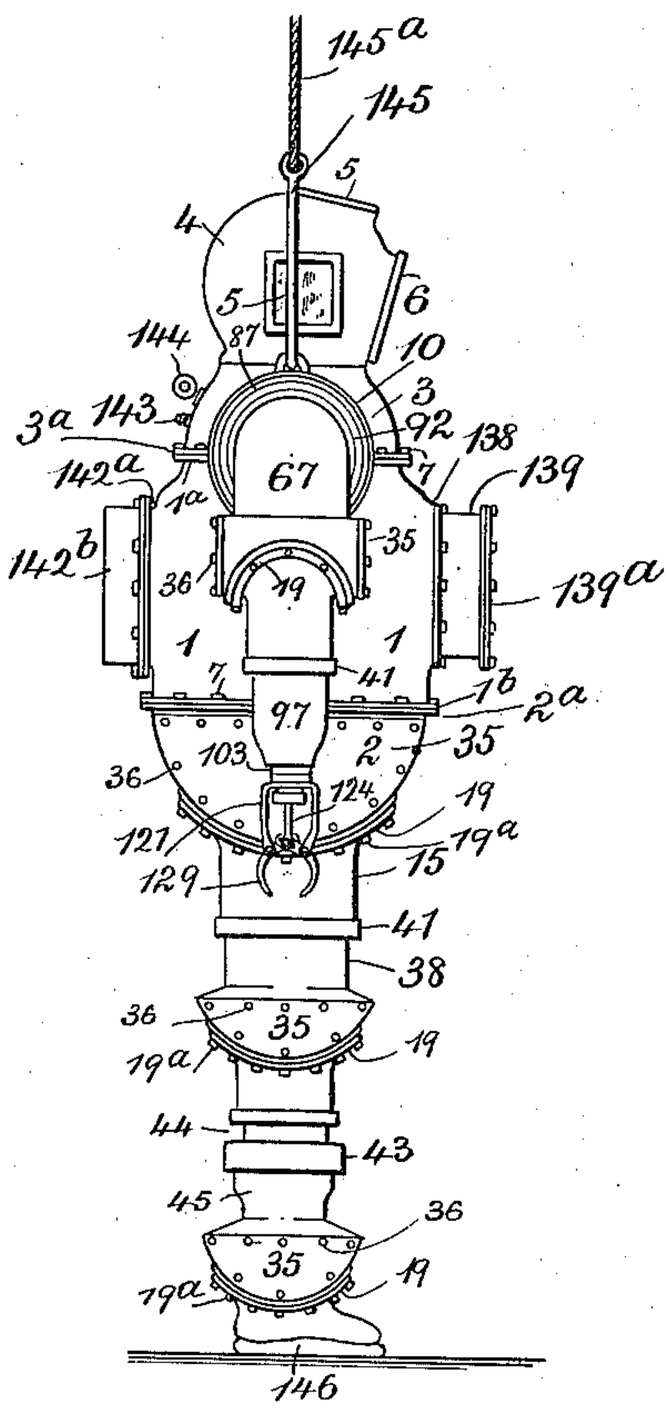
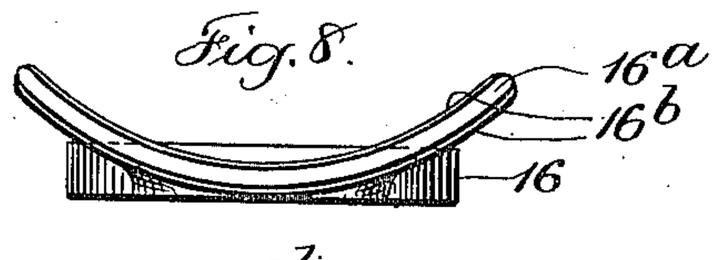


Fig. 8.



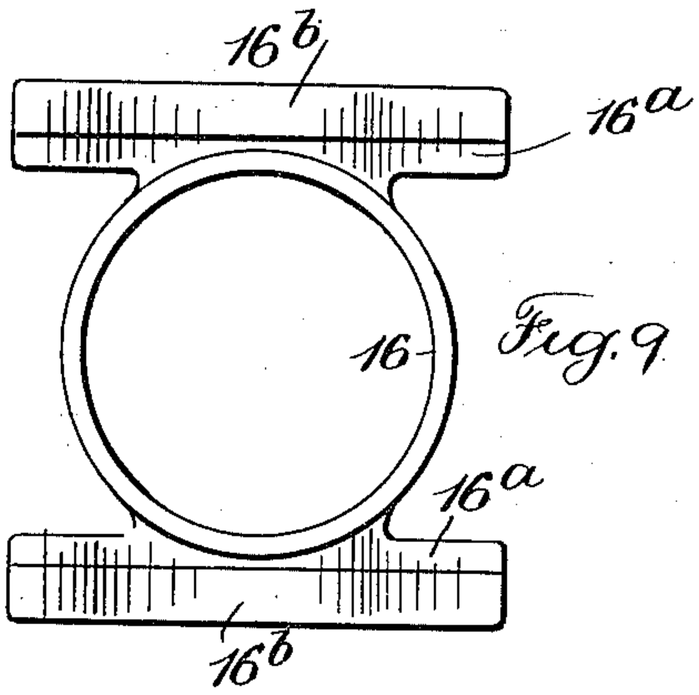


Fig. 9

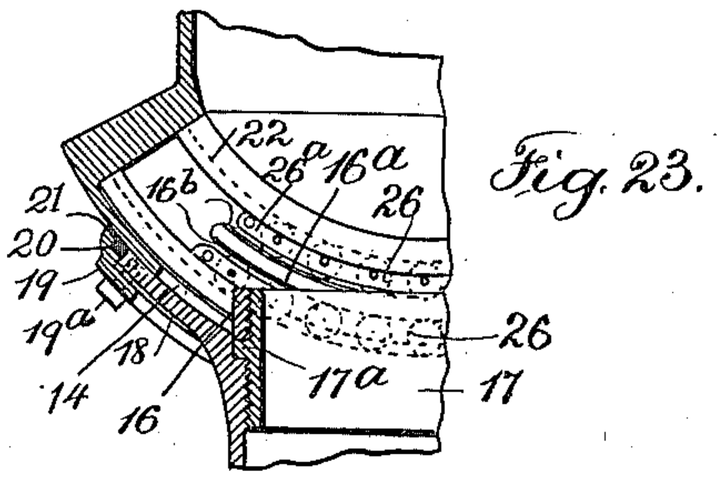


Fig. 23.

Fig. 10

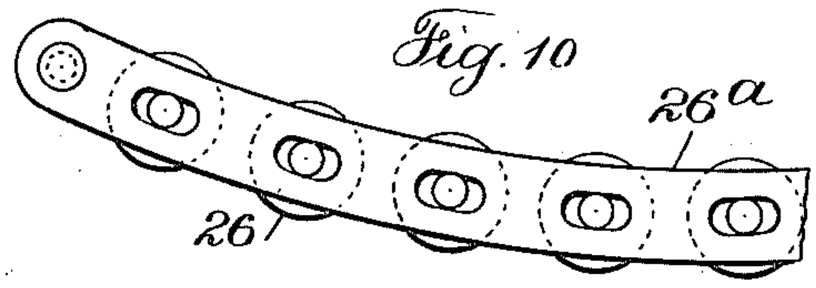
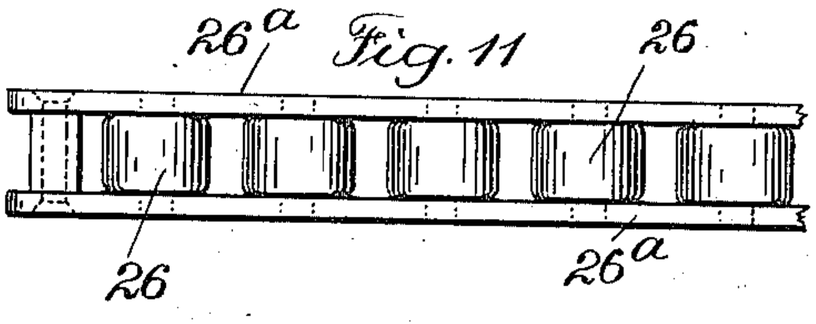


Fig. 11



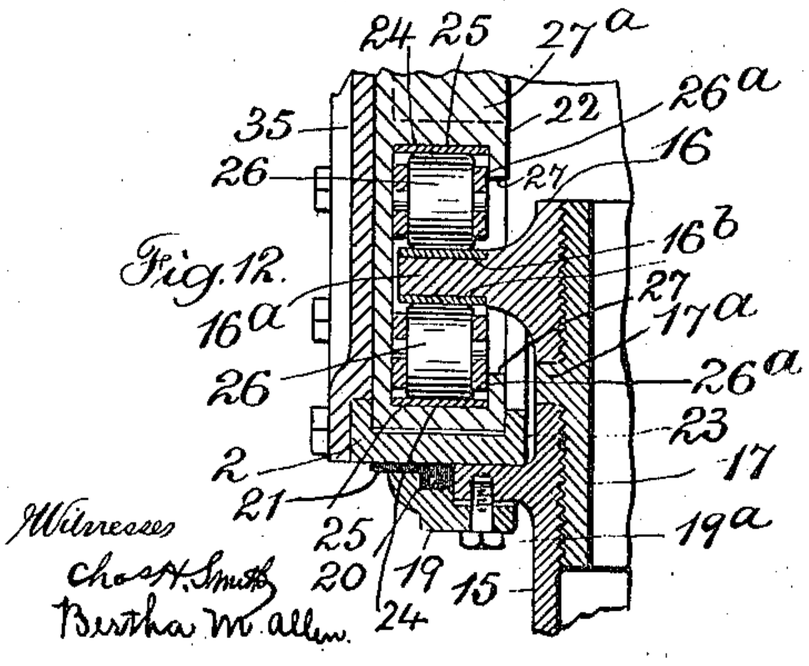


Fig. 12.

Witnesses
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4 SHEETS—SHEET 2.

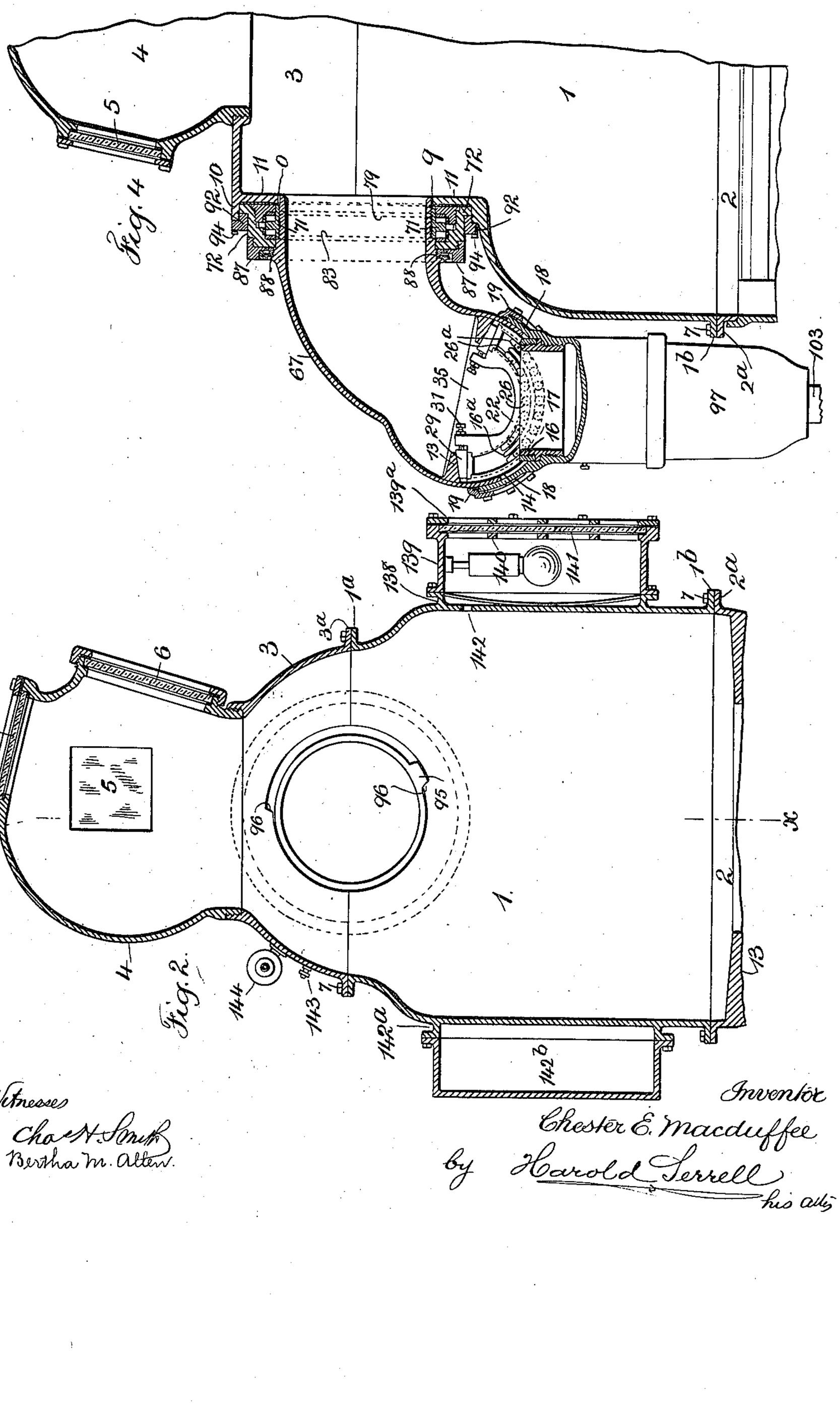

Fig. 4

Fig. 2.

Witnesses

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4 SHEETS—SHEET 3.

Fig. 3.

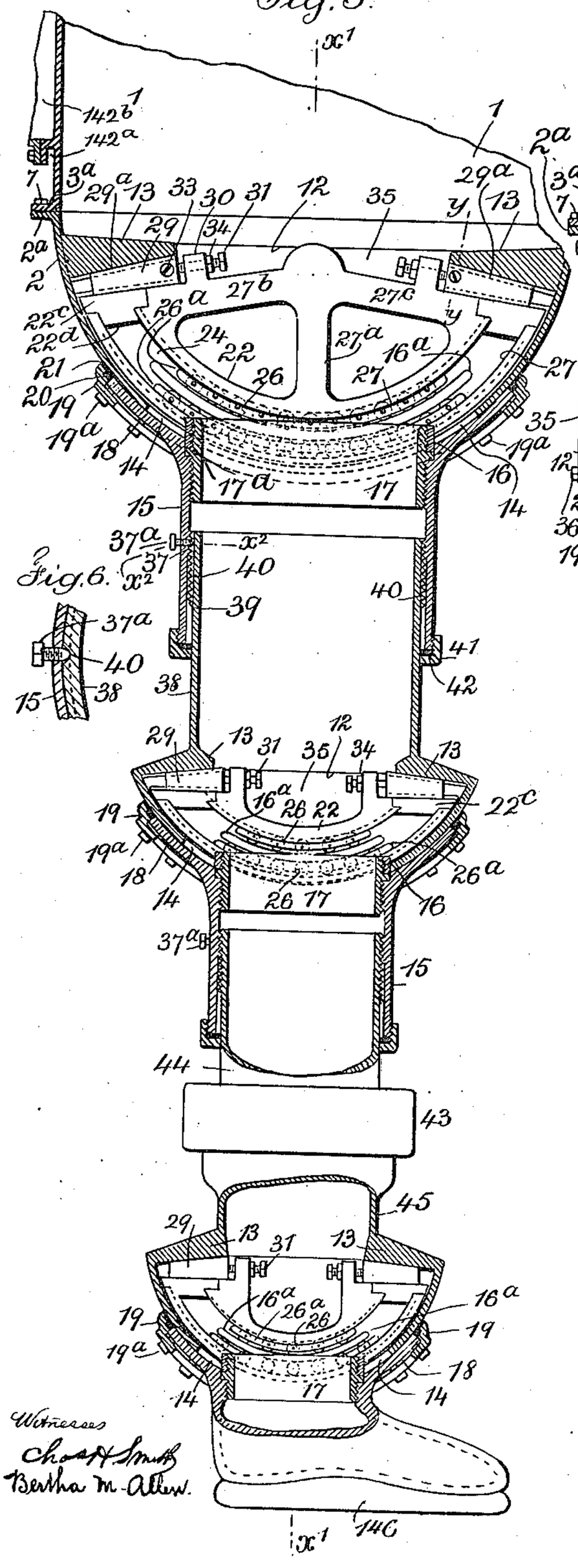

Fig. 6.

Fig. 5.

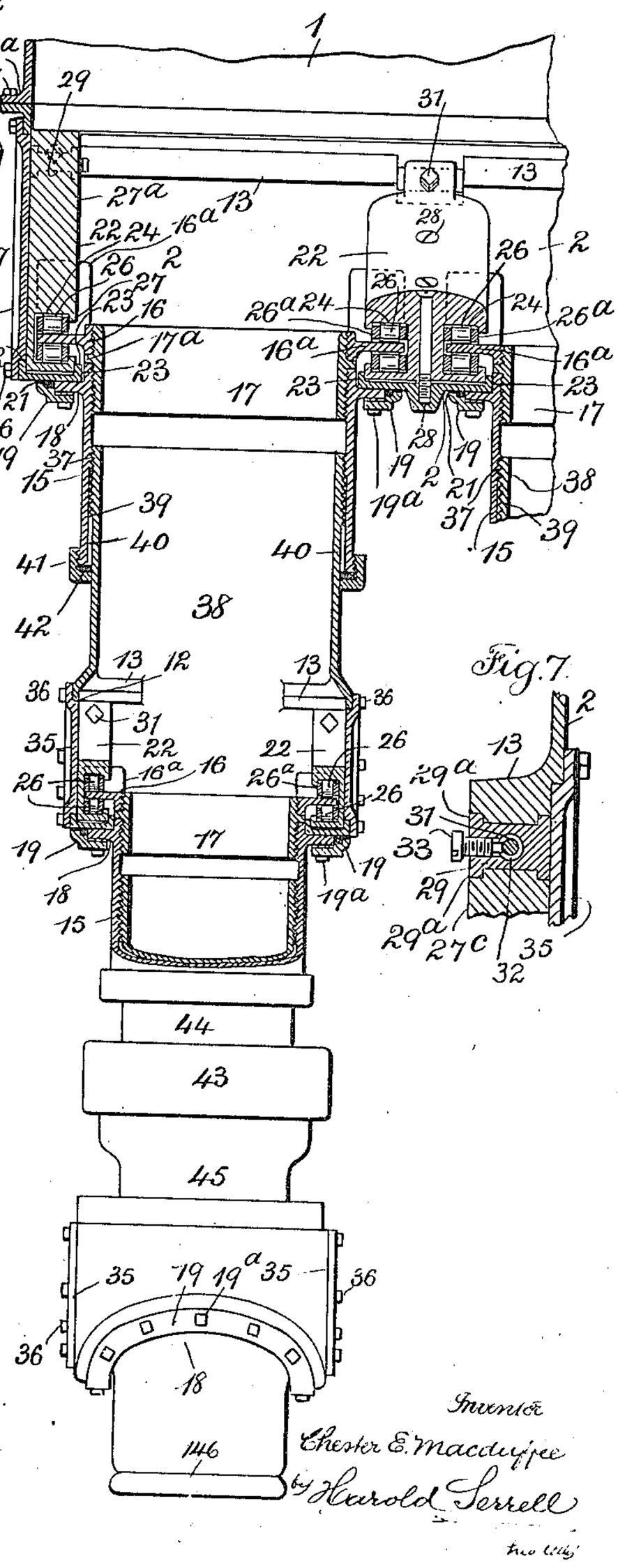

Fig. 7.

Witnesses

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4 SHEETS—SHEET 4.

Fig. 13.

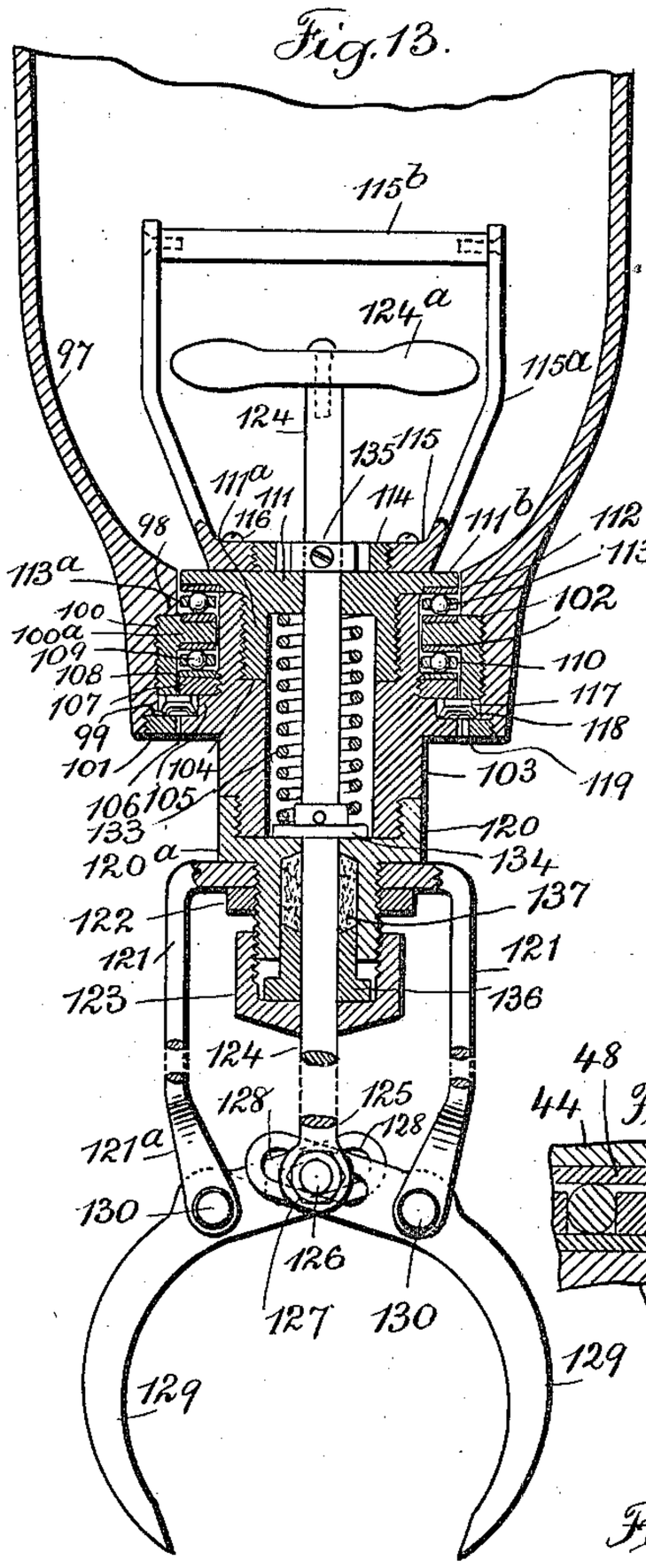


Fig. 16.

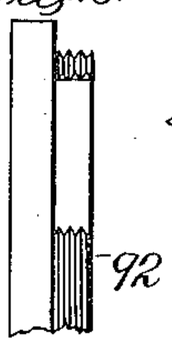


Fig. 15.

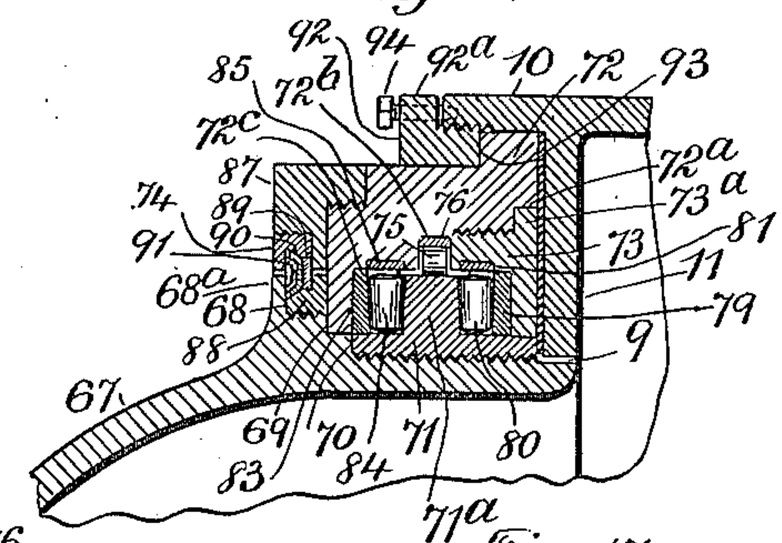


Fig. 17.

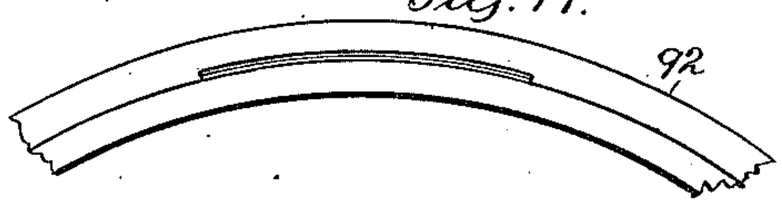


Fig. 18.

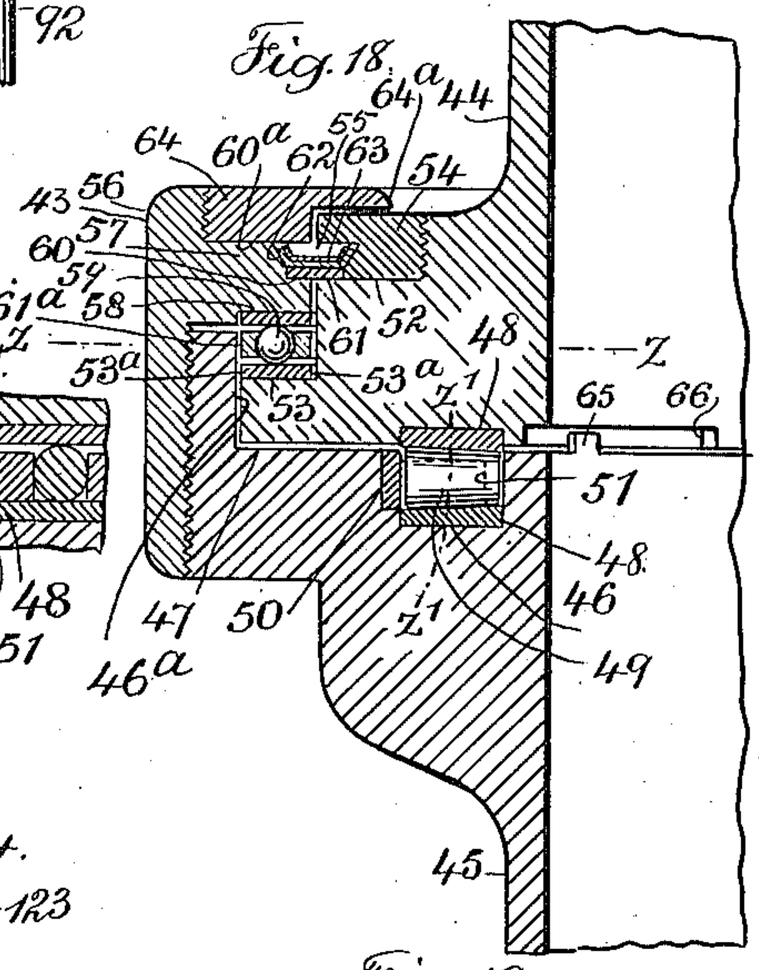


Fig. 14.

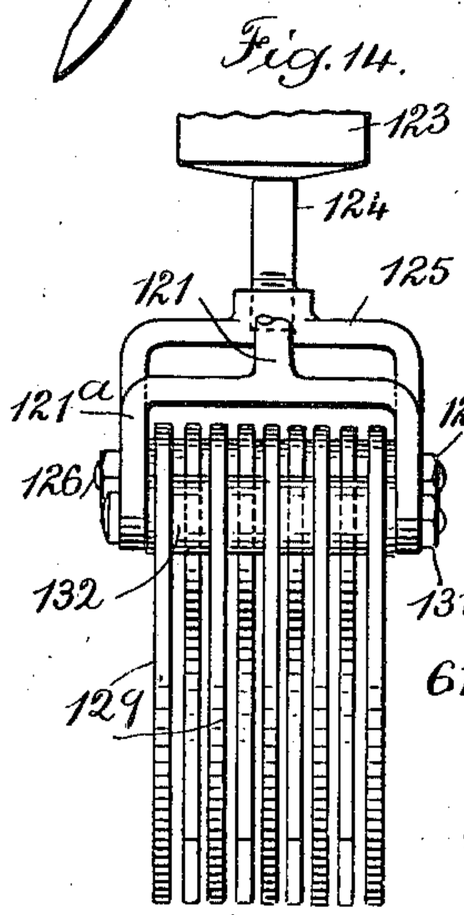


Fig. 19.

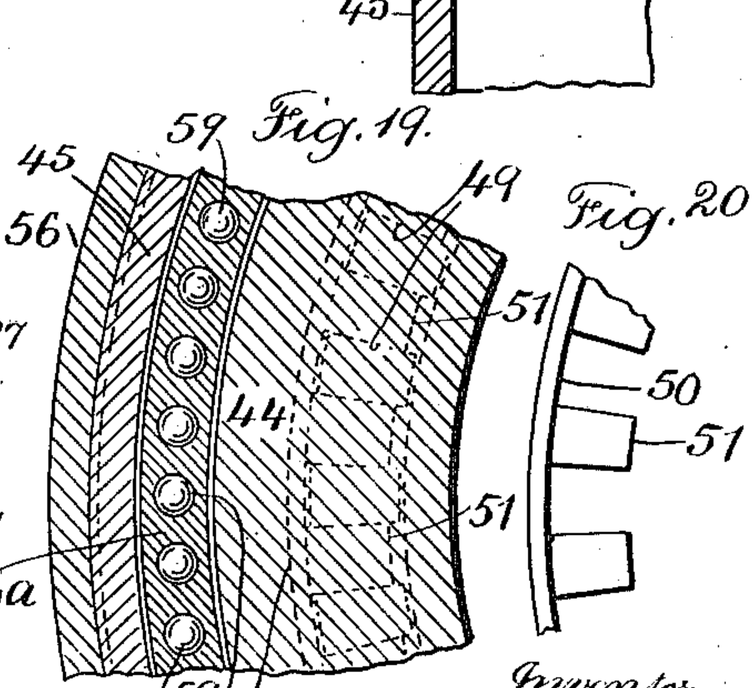
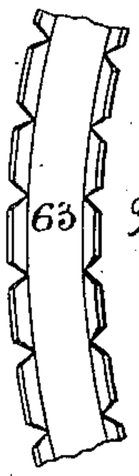


Fig. 20

Fig. 22.



Witnesses

Chas. F. Smith

Bertha M. Allen.

Inventor.

Chester E. Macduffee

by Harold Serrell his atty.

UNITED STATES PATENT OFFICE.

CHESTER E. MACDUFFEE, OF NEW YORK, N. Y., ASSIGNOR OF ONE-FIFTH TO GEORGE A. TRAVER, OF BROOKLYN, NEW YORK, ONE-FIFTH TO JAMES P. REID, OF NEW YORK, N. Y., ONE-FIFTH TO JOHN L. GORDON, OF WEST HOBOKEN, NEW JERSEY, AND ONE-FIFTH TO ERNEST MEYER, OF TUXEDO, NEW YORK.

SUBMARINE ARMOR.

989,530. Specification of Letters Patent. Patented Apr. 11, 1911.

Application filed December 6, 1910. Serial No. 595,847.

To all whom it may concern:

Be it known that I, CHESTER E. MACDUFFEE, a citizen of the United States, residing at the borough of Manhattan, city, county, and State of New York, have invented an Improvement in Submarine Armor, of which the following is a specification.

In the diving suits heretofore employed consisting of a one piece suit of rubber and canvas with a metallic breast-plate or collar, and a metal helmet secured thereto, work and exploration under water is limited to a certain depth, on account of the enormous water pressure on the diver. With diving suits of such character only persons of perfect health and physique can pursue the calling; and a powerful pump must be constantly at work above water for supplying air while the diver is down, because a stoppage of the pump at such time would result in the almost instant death of the diver from the pressure of the water.

My invention relates to a submarine armor for divers comprising a metallic suit conforming in general configuration to the shape of the human body and so constructed as to withstand the water pressure at great depth, and in which the diver is completely incased; the armor being provided with articulated sections occupied by the legs and arms of the occupant, so as to allow of natural motion of the body and limbs, enabling the diver to move from place to place, while prosthetic hands operated by a rod and connections moved by the natural hands inside enable the diver to grasp and retain the objects of his search, and perform other duties in the premises; and the further objects of my invention are (1) to provide means for lengthening and shortening the limb sections of the armor so that it may be adapted to divers of different stature; (2) to provide joints capable of being adjusted to regulate friction; (3) to provide means for allowing the feet of the diver to be moved in all directions, and (4) to provide the armor with a permanently attached holder for electric light lamps, so that the diver may be relieved from carrying a lamp in his hand, as has heretofore been necessary.

I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is an elevation of my improved submarine armor. Fig. 2 is a longitudinal section of the upper body and helmet portions of the armor. Fig. 3 is a longitudinal section and partial elevation of the hip and leg sections of the armor. Fig. 4 is a section and partial elevation at the dotted line x, x, of Fig. 2. Fig. 5 is a section and partial elevation at the dotted line x^1 x^1 of Fig. 3. Fig. 6 is a section at the dotted line x^2 x^2 of Fig. 3. Fig. 7 is a section at the dotted line y, y, of Fig. 3. Fig. 8 is a side view and Fig. 9 a plan view of the ring member and its runners for supporting the leg sections. Fig. 10 is an elevation and Fig. 11 is a plan view of a portion of a roller frame and its rollers employed at the various joints. Fig. 12 is a sectional view in larger size of one of the side bearing frames and upper leg connection. Fig. 13 is a sectional view in larger size of the gripping devices at the lower end of each fore-arm section. Fig. 14 is an elevation at right angles to Fig. 13, of the lower portion of said gripping device. Fig. 15 is a sectional view of the joints at the shoulders. Fig. 16 is an edge view and Fig. 17 a plan view of a portion of the rings that secure the various parts of the shoulder joints. Fig. 18 is a sectional view in larger size of the swivel joint between the knees and ankles. Fig. 19 is a section at the dotted line z, z, of Fig. 18. Fig. 20 is a plan view of a portion of the spacing rings shown in Fig. 18. Fig. 21 is a section at the dotted line z^1 z^1 Fig. 18. Fig. 22 is a plan of a portion of the presser packing rings. Fig. 23 is a sectional view of a modification of the roller bearing frames.

Similar reference letters and numerals refer to similar parts throughout the several views.

The main body portion of the armor is of a general shape and configuration to conform as nearly as possible with the shape and configuration of the human body consistent with the character of the structure. This body portion is preferably made in three sections as shown, that is, a central or stomach section 1, an abdominal and hip

section 2 and a chest and neck section 3. The helmet 4 may be made integral with the chest and neck section 3 if desired, but I prefer to make it a separate part to be screwed into the upper body section 3 as has heretofore been done, or it may be removably secured thereto in any other suitable manner. The helmet 4 is provided with three glasses at 5, one on top and one on either side to admit light into the helmet, and these glasses are permanently secured in a water-tight manner as usual. There is also a front glass 6 on the helmet which is made to unscrew and enable the diver to receive or give instructions without removing the helmet, when the diver is above water.

The chest and neck section 3 has a flange 3^a extending around its lower edge, and the abdominal and hip section 2 has a flange 2^a extending around its upper edge, while the stomach section 1 has a flange 1^a extending around its upper edge, and a flange 1^b extending around its lower edge, and when the parts are assembled, the flange 1^b of the section 1, rests upon the flange 2^a of the section 2, while the flange 3^a of the section 3 rests upon the flange 1^a of the section 1 and the sections are then secured together in any suitable manner, but preferably by bolts 7 passing through bolt-holes in said flanges. These connections are of course rendered water-tight by means of suitable packing. I prefer that the sections 1 and 3 be connected at a point central of the shoulder joint as shown.

At the shoulder on each side of the armor there is a circular opening 9, the metal surrounding such openings on the interior being inwardly extended a predetermined distance and forming annular sockets 10 interiorly screw-threaded and having inturned flanges 11 to receive and support the arm sections hereafter described. See Figs. 4 and 15. The bottom of the lower section 2 is shaped semi-circularly from front to rear, the sides being flat at these parts and the metal cut out leaving an opening 12 at each side for the purposes hereafter described. A rib 13 extends across on the interior surface of the section 2 from one side to the other thereof, both at the front and back, which ribs may be secured to the section 2 in any suitable manner, but I prefer that they be made integral therewith. The ribs 13 are in parallel plane and are preferably somewhat V-shaped in cross section, but may be of any shape desired where the under surface is inclined from front to back.

Two openings 14 are formed at a predetermined distance apart in the bottom and curved portion of the section 2 which openings are slightly elongated in a direction from front to rear. The top portions of the upper leg sections 15 are interiorly screw-threaded and of slightly less diameter than the width of the elongated openings 14 so as to be received therein and have forward and backward movement without friction.

Within the abdominal or hip section 2 there are bearing members consisting of a cylindrical part 16 interiorly screw-threaded and having at the top on either side right angle projections 16^a curved to conform to the curvature of the lower portion of the abdominal or hip section 2. These right angled projections 16^a form supporting runners for the leg sections as hereinafter described and are preferably provided on their top and bottom surfaces with flat hardened steel strips 16^b securely fastened thereto in any suitable manner. See Fig. 12. These bearings members 16 are connected with the upper leg sections 15 by cylindrical couplings 17 screw-threaded on their exterior at top and bottom, and having an intervening or central annular rib 17^a forming stops for both the bearing members and the upper leg sections.

Upon the upper leg sections 15 and preferably made integral therewith are guard-plates 18, curved to conform to the curvature of the abdominal or hip section 2 and coming closely adjacent to said section 2, but not in frictional contact therewith. These guard plates 18, are of a size to overlap and completely cover the openings 14 in the lower section 2 in all movements of the upper leg sections within such openings.

Around the outer edge of each of the guard-plates 18 I provide a metallic clamping ring 19, which are securely fastened to the guard-plates 18 by bolt or screws 19^a. These clamping rings 19 are rabbeted at 20 to receive a leather or other suitable packing 21 which fills the rabbeted portions 20 all around and extends outward therefrom in reduced thickness to the outer edges of the clamping rings 19, and between the same and the outer surface of the abdominal and hip section 2 and entirely fills such spaces, thus preventing the leakage of water between the guard-plates 18 and the said section 2.

At each side of the abdominal and hip section 2 below the ribs 13 I employ bearing frames 22, the outer edges of which are curved to exactly correspond with the curve of the said section 2. These bearing frames 22 are placed immediately inside the openings 12 in the section 2 and bear against ribs or stops 23 secured to or made integral with the metal of the section 2. In that surface of each of these bearing frames facing inward is cut a groove 24 the entire length of the frame, which grooves have exactly the same curvature as the outer edges of the bearing frames and consequently the same curvature as the abdominal and hip section 2.

The upper and lower surfaces of the grooves 24 are preferably covered with flat strips 25 of hardened steel, see Fig. 12. These grooves 24 are of a depth and width sufficient to receive one of the curved supporting runners 16ª at the outer side of the hip joint at each side, and also bearing rollers 26 which are placed both above and below the runners 16ª within the grooves; the outer edges of said grooves are provided with lips 27 which retain the rollers within the grooves when the supporting runners 16ª are placed between the upper and lower sets. The rollers 26 are preferably slightly tapered or rounded at their edges see Fig. 12, and are provided with trunnions which enter elongated openings in a curved frame 26ª on either side which frames are connected together at their ends, the rollers being of slightly greater diameter than the width of the side frames, and the side frames having a curved shape corresponding to the curvature of the grooves 24. These rollers and these runner frames are illustrated in enlarged size in Figs. 10 and 11. The rollers 26 form a top and bottom bearing for the supporting runners 16ª while they in turn have a bearing upon the hardened steel surfaces at the top and bottom of the grooves. To give additional strength to the bearing frames 22 I provide the braces 27ª 27ᵇ and 27ᶜ which are preferably made integral with the grooved frames 22. The crotch bearing, that is, the bearings for the inner sides of the leg sections, is made the same as the side bearing just described, except that the member 22 is made double, that is, provided on each side with the grooves 24, and the two sets of rollers 26 with their runner-frames 26ª in each groove, receiving between them the supporting runners 16ª for the inner sides of the right and left leg respectively. On each side of this central bearing frame 22 there is a rib or stop 23 attached to the abdominal and hip section 2 by which lateral movement of the frame 22 is prevented.

It being necessary for the occupant of the armor to straddle this central bearing, the braces 27ª 27ᵇ and 27ᶜ are dispensed with and the top surface of the bearing is rounded at the edges, while in lieu of the braces spaced apart holes are bored through the frame 22 from top to bottom into which are passed screws or bolts 28 screw-threaded on their lower ends and which ends screw into screw-threaded holes in the bottom of the section 2, the metal at this point being thickened outwardly for such purpose. The heads of the screws or bolts 28 are counter-sunk in the frame 22 so that the top of this frame may present a smooth surface to the occupant. These screws or bolts 28 are only inserted after all adjustment of the parts has been effected.

The ends of the respective bearing frames 22 are inclined correspondingly to the inclined surface of the ribs 13 and between the ends of the frames 22 and the under surface of the ribs 13, adjustable wedges 29 are inserted, by which means the joints may be adjusted to accommodate them to the water pressure at varying depths. That is to say the water pressure upon the guard-plates 18 will vary at different depths and affect the compression of the packing 21 and frictional contact of the same with the abdominal and hip section 2 to a greater or less extent accordingly, and the object of the wedges 29 is to relieve the compression on the packing 21 and thereby lessen the friction between the same and the said section 2 when the water pressure is of too great force.

The wedges 29 are rendered adjustable by the following means. Lugs 30 are formed upon the respective ends of the bearing frames 22 at such distance from the outer edges of such frames as to come in front of and closely adjacent to the front edge of the ribs 13 when the parts are assembled. These lugs each have a screw-threaded hole into which is passed a bolt 31 preferably provided with a square-head and screw threaded on that portion within the hole in the lug and meshing with the screw thread therein. The other end of the bolt is without screw thread and is provided with an annular recess or groove 32. This end of the bolt passes into a hole in the end of the wedge 29, and is revolubly retained therein by a pin 33 which passes through the side of the wedge and enters the recess or groove 32 in the end of the bolt. A lock nut 34 is preferably provided for each bolt to hold the same in the position to which the wedge may be adjusted. It will readily be seen that by forcing the wedges 29 between the end of the bearing frames 22 and the ribs 13 by means of the bolts 31 the frames 22 will be forced downward, and carry with them all the parts of the upper leg sections and consequently relieve the pressure upon the packing 21 or vice versa.

If desired, cap pieces 22ᶜ may be employed at the ends of the frames 22, said caps having tenons 22ᵈ to fit into the grooves in said frames, so that the wedges 29 may have a solid bearing surface; and also if so desired the wedges 29 may have lips 29ª see Figs. 3 and 7, along their upper and lower longitudinal edges which lips will fit over the edges of the ends of the frames and prevent any side-wise movement of the wedges; and in this case there may be cross-grooves provided in the ribs 13 to receive the projecting lips on the upper part of the wedges.

After all the parts are properly assembled and adjusted, the side openings 12 are closed by cover-plates 35, which are secured to the abdominal and hip section 2 by bolts

36, a suitable packing intervening to render the joint water-tight. It is preferable that the metal composing these cover-plates 35 be ribbed to give additional strength to these parts.

Having thus fully described the construction of the hip joints, I would say that the same description is applicable to the joints for the knees, ankles and elbows, and I have placed the same reference numerals and letters upon the corresponding parts in such joints; the respective sections at these points being enlarged as shown, for the reception of the parts; and it may be remarked that in some of the smaller joints the braces 27^a 27^b and 27^c are not necessary, as shown for instance in the ankle joints, and in such joints I may if desired, dispense with the wedges 29 and ribs 13; the ends of the bearing frames 22 in such cases being made to fit and bear against the extended portion of the metal of the armor as shown in Fig. 23.

I will now describe those features of my invention which provide for lengthening and shortening the limb sections so that the armor may be adapted to divers of different stature.

The upper leg sections 15 have upon their interior surface at a suitable distance from their lower ends a screw-threaded portion 37. The leg sections 38 above the knees are of smaller diameter than the sections 15 so as to telescope or be capable of vertical or revoluble movement therein, and upon the outer surface of the sections 38 for the greater part of that portion within the sections 15 there is provided a screw-thread 39 which meshes with the interior screw threads 37 on the sections 15, thus allowing the length of the leg sections between the hips and knees to be lengthened or shortened, and if desired, a scale may be marked on the parts to assist in accurate adjustment. A vertical groove or recess 40 is cut on the opposite sides of each section 38, which grooves extend the entire length of the threaded portions, and when the sections 15 and 38 are adjusted in the desired relation to each other, they are locked in such position by set-screws 37^a which pass through holes in the sections 15 and enter the grooves 40 in the sections 38. See Figs. 3 and 6.

The lower ends of the sections 15 are exteriorly screw-threaded, and packing rings 41 are provided which screw upon such screw-threaded ends of the sections 15, there being a suitable packing 42 between the rings 41 and the lower end of the sections 15, which packing also extends between the ring 41 and the outer surface of the section 38, thus rendering these telescopic connections water-tight. This extensible arrangement is provided between the knees and ankles and also in the arm sections, and the construction being alike in all these places, further description is unnecessary, and the same reference numerals are used upon the corresponding parts.

At a suitable distance above the ankle joints I provide swivel joints 43, for the purpose of allowing free lateral movement to the feet of the diver, see Fig. 1. The construction of these swivel joints is shown in the enlarged sectional view Fig. 18. The metal of the leg sections 44 and 45 at their meeting ends where these swivel joints are formed is thickened on the outside of the leg openings, and the outer surfaces of these sections are screw-threaded. A comparatively deep annular recess 47 is formed in the upper part of each of these lower leg sections 45 which recesses extend from the wall 46^a thereof all the way across the top of the sections 45. At a point slightly distant from its leg openings in each of the sections 45, an annular recess 46 is formed. Within these recesses 46 and secured to the bottom thereof are flat strips of hardened steel forming annular bearing rings 48. Rollers 49 preferably tapered to follow a true circle, are placed within the recesses 46 and rest upon the bearing rings 48. Spacer rings 50 having projections or lugs 51 which come between the rollers 49 keep the rollers in regular spaced apart order. These spacer rings 50 are preferably of hardened steel. These spacer rings and rollers are plainly illustrated in enlarged size in Figs. 10, 19, 20 and 21.

The outer portion of the leg section 44 at its lower end is stepped forming shoulders 52 and 53 and is provided with screw threads for a short distance above the shoulder 52. A ring section 54 interiorly screw-threaded surrounds this portion of the leg sections 44, the screw threads on each meshing together, while the bottom of the ring 54 rests upon the upper shoulder 52. This ring 54 is undercut on its outer surface forming an annular recess 55 see Fig. 18 of peculiar shape. Flat hardened steel rings 53^a rest upon the shoulders 53. The outside cylindrical members 56 extend the full width of the joints and are interiorly screw-threaded to mesh with the screw-threads on the outer surfaces of the leg sections 45, above which point they are provided with an interior angular projection 57, the extreme inner portion of which comes closely adjacent to that portion of the leg sections 44 between the shoulders 52 and 53 while they are recessed at a point registering with the shoulders 53, in which recess is a hardened steel ring 58 and into the space thus formed between the two rings 53^a and 58 are placed steel balls 59, which have bearing upon said rings. These balls may be spaced apart in any suitable manner, but I prefer to employ revoluble rings 61^a provided with

spaced apart holes into which the balls are contained and revolve, similar to the rings 110 hereafter described. At a point on a line with the shoulder 52 this inwardly projecting portion of the member 56 is provided with a corresponding shoulder 60 and within the recess formed by these shoulders is placed a packing ring 61. Beginning at a point on a line with the upper surface of this packing ring 61 the inner surface of the member 56 is inclined upwardly to a point on a line with the undercut in the ring 54, above which inclined portion is another shoulder 60^a from which point the member 56 is screw-threaded to its top.

Within the recess formed between the inclined portions of the member 56 and the ring 54 which recess is somewhat Y-shaped in cross section is placed a packing 62 cup-shaped in cross section and within this cup-shaped packing is placed a presser ring 63. This ring is formed of a flat circular strip of spring metal notched along the edges and those portions between the notches turned slightly upward. These portions press against the inner sides of the cup-shaped packing and force them outwardly in contact with the sides of the recess. This presser ring is illustrated more clearly in Fig. 22. The packings 62 acting in conjunction with the packing ring 61 upon which they rest, effectually render these swivel joints watertight.

After the parts described have been assembled the top ring 64 is screwed into place when it rests upon the shoulder 60^a of the member 56 while the broad annular flange 64^a upon said ring 64 extends over the top surface of the ring 54. The short lugs 65 taking against the stops 66 limit the movement on each side. The upper arm sections 67 are stepped on their outer circumference forming annular shoulders 68, 69 and 70, the shoulder 68 being extended upwardly forming the annular flanges 68^a. The surface of these arm sections between the shoulders 68 and 69 is provided with screw threads; that portion between the shoulders 69 and 70 being plain and smooth, while that portion extending inwardly from the shoulders 70 is screw-threaded to the point where these arm sections enter the sockets 10. Upon these screw-threaded portions of the arm sections 67 are screwed hardened steel rings 71 having an annular thickened rib or projection 71^a.

The cylindrical members 72 are of a diameter to fit snugly within the shoulder sockets 10 and their inner ends rest against the flanges 11 of said sockets. These members 72 are stepped on the interior leaving annular shoulders 72^a 72^b and 72^c and are provided with a screw-thread between the shoulders 72^a and 72^b. Between these members 72 and the steel rings 71 there is provided the ring member 73 having flanges 73^a which contact with the shoulders 72^a of the members 72 and are screw-threaded to mesh with the screw-threads on the members 72. The outer ends of these members 73 do not reach as far as the shoulders 72^b upon the members 72 thus leaving an annular space between the outer ends of the member 73 and the shoulder 72^b on the member 72. Within these annular spaces are bearing balls or rollers 75 and hardened steel rings 76 intervene between these rollers 75 and the surface of the member 72. The rollers 75 have a bearing on one side against the steel flanges 71^a of the rings 71 and on the other side against the rings 76. Another and larger annular recess is formed between the outer surface of the lower portion of the member 73, and the inner surface of the flange 71^a on the ring 71.

Flat but slightly tapered hardened steel rings 79 are secured to the outer surface of the members 73 and between the same and the inner surface of these flanges 71^a on the ring 71, which are also slightly tapered, and having a bearing on such surfaces are placed steel rollers 80 tapered to follow a true circle; these rollers are to be separated one from the other in any suitable manner but preferably by a ring 81 provided with projections coming between the rollers such as the rings 50 before described in connection with the lower leg joint illustrated in enlarged size in Fig. 18. A similar bearing is provided in the annular space between the outer surface of the flange 71^a and the shoulder 72^c on the member 72, by means of the flat steel ring 83, the steel rollers 84 and the spacer ring 85.

A recess for packing, which recess is somewhat Y-shaped in cross section is formed between the ring section 88 and the ring section 74 which is screwed to the section 87. Within this recess is placed a leather or other suitable packing ring 89 and upon this packing ring is placed another packing strip 90 cup-shaped in cross section, and within this cup-shaped packing is placed a presser-ring 91, all similar to those before described and illustrated in enlarged size in Fig. 18.

After the parts described have been assembled within the shoulder sockets 10, the locking rings 92 are screwed into the shoulder sockets 10 down upon the shoulders 93 of the cylindrical members 72, and to provide against any possibility of these locking rings 92 working loose, I make use of the set-screws 94 which pass through holes in the flanges 92^a on the locking rings 92 and enter screw-threaded holes in the metal of the sections 1 and 3. Any desired number of these set-screws 94 may be employed at spaced apart distances around the flanges 92^a. I prefer that the screw-thread upon these locking rings 92 have intervening blank

spaces as shown in Fig. 16 and that the screw-threads on the sockets 10 be of like character, so that the locking rings can be quickly positioned and the parts locked by a fraction of a turn. Lugs 95 upon the inner ends of the upper arm sections 67 limit the swing of the arms by coming in contact with the stops 96. See Fig. 2. The tubular cylindrical ends of the lower arm sections 97 are interiorly screw-threaded between the shoulders 98 and 99 and on those portions below the shoulders 99. A flanged tubular section 100 exteriorly screw-threaded to mesh with the screw-thread on each arm section 97 is screwed into place with its top in contact with the shoulder 98 on the arm section 97. A ring 101 of a depth to fit between the shoulder 99 on each arm section 97 and the ends of such sections, and exteriorly screw-threaded to mesh with the screw-thread on such portions of the arm section 97 and of such width that its inner circumference coincides with that part of the flanged section 100 having the largest inner diameter, is screwed into position on each arm section 97. Upon both the upper and lower surfaces of the flanges 100[a] of the sections 100 and recessed therein is secured hardened steel rings 102.

The tubular cylindrical sections 103 have inner shoulders 104, and outer shoulders 105 and 106. Below the shoulders 106 the outside diameter is reduced for a certain distance and then again reduced for a shorter distance to its lower end, and this portion of smallest diameter at the end is exteriorly screw-threaded. These tubular cylindrical sections 103 are also exteriorly screw-threaded for a short distance immediately above the shoulders 105, and onto these screw-threaded portions are screwed rings 107 interiorly screw-threaded for such purpose. Upon the tops of these rings 107 and secured thereto are flat rings 108 of hardened steel, and in the annular recesses between these steel rings and the steel rings 102, on the under surfaces of the flanges 100[a] are steel balls 109, which are preferably carried in rings 110, there being spaced holes in said rings which are drilled slightly larger than the diameter of the balls, and slightly swaged after the balls are introduced to keep the balls in place. The balls projecting through the rings on either side.

Head sections 111 having a tubular cylindrical portion 111[a] exteriorly screw-threaded to mesh with the screw threads on the interior of the sections 103 are provided and when screwed into place the bottom of the tubular cylindrical portions rest upon the interior shoulders 104 of the section 103. On the under surfaces and adjacent the ends of the flanges 111[b] of the sections 111 are secured hardened steel rings 112, and between these rings 112 and the steel rings 102 on the tops of the flanges 100[a] of the sections 100 are steel balls 113 carried in a ring 113[a] in a similar manner to the rings 110 before described. There is an annular projection 114 exteriorly screw-threaded upon the top of each section 111, to which are screwed the frames 115; the base of these frames are ring-shaped and interiorly screw-threaded to mesh with the screw-threads on the projections 114; and there are upwardly extending arms 115[a] and top cross bars 115[b], which form supports for the hands of the occupant of the armor. These supporting frames 115 are further secured in place by means of the screws 116 which pass through their base and into screw-threaded holes in the head sections 111.

In the annular recesses formed between the rings 101 and 107 there are packings such as before described, that is, flat rings 117 of leather or other suitable material; rings 118 cup-shaped in cross section and spring presser rings 119, which prevent the entrance of water at these points. Attached to the lower part of the sections 103 by screw-thread connection are the tubular cylindrical sections 120 exteriorly screw-threaded below their undercut heads 120[a] and bearing against these undercut heads there are gripper supporting frames 121, consisting of horizontal arms having ring-shaped centers interiorly screw-threaded to mesh with the screw-threads on the sections 120, the ends of these horizontal arms being curved downwardly and having right-angled branches 121[a] of bowed form with bolt holes at their lower ends. Ring nuts 122 are screwed up against the under surfaces of the horizontal arms to further secure them in position.

Hollow cylindrical end sections 123 interiorly screw-threaded are screwed upon the exteriorly screw-threaded portions of the sections 120. There are central circular openings through these end sections 123 and also through the head-pieces 111 which openings are of corresponding circumference and in true alinement. Round steel rods 124 of a diameter to slide up and down and revolve without undue friction are placed within these openings and project for predetermined distances both above and below the sections 111 and 123. The upper ends of these rods 124 are provided with handles 124[a]. These handles may be secured to the rods by screws as shown or in any other suitable manner.

The lower ends of the rods 124 are screw-threaded and are screwed into interiorly screw-threaded hubs of bowed frames 125, (see Fig. 14) the lower ends of which are provided with bolt holes which receive the bolts 126, which are shouldered against the inside of the frames and retained in position by nuts 127 on the outside of said

frame. These bolts 126 pass through elongated openings 128 in the upper ends of inwardly curved gripper fingers 129 which are pivotally mounted upon the bolts 130 on the frames 121 which bolts are provided with end nuts 131. The curvatures of the gripper fingers on the oppositely positioned bolts face each other and the fingers are separated one from the other on each bolt the desired distance apart by suitable intervening washers 132.

A helical spring 133 surrounds the rods 124 within the tubular sections 103 and 111, the lower ends of these springs taking against a fixed collar 134 on the rods 124 while their upper ends bear against the under surfaces of the head sections 111. Stops 135 securely fixed to the rods 124 above the head sections 111, limit the downward movement of the rods and consequently the outward throw of the gripper fingers 129. The cross bars 115[b] form a rest for the palms of the natural hands of the occupant of the armor and at the same time permit his fingers to grasp the handles 124[a] by which he may operate the mechanism in either direction and be able to grasp an object by the gripping fingers 129 and retain the same. The stuffing boxes receive a soft packing material 137 by which water is prevented from entering around the rods 124 at their lower parts.

136 are followers acting upon the packing.

When the diver pulls up the rods 124, the springs 133 are compressed, and the ends of the oppositely disposed gripper fingers are brought toward each other, and it is preferable that they be so positioned as to allow the ends of the fingers to slightly pass between those opposite, which will enable the diver to grasp a smaller article than if the oppositely disposed fingers met at their ends. When the diver loosens his grasp on the handles 124[a] the springs 133 expand and force the rods 124 downward, thus causing the outward throw of the gripper fingers 129 by the action of the bolts 126 in the elongated openings 128 in the upper ends of said grippers; this outward throw of the grippers being limited by the stop 135.

The springs 133 will be made of various sizes or strength according to the depth of water to be worked in, that is, of sufficient tension to overcome the water pressure, friction of packing and a surplus tension to automatically force down the rods 124 and cause a full opening of the gripper fingers when the diver releases his grip on the handles. The gripper fingers may be varied as to size and shape if desired.

On the stomach section of the armor there is a boss 138 preferably flanged for the reception of a casing or holder 139 for electric lamps. This holder 139 may be of any desired shape, but I prefer to make it of rectangular shape as shown, having a rear flange for attachement to the boss 138 by bolts or otherwise and provided with transverse ribs 140 which form a support for the front glass or glasses 141 which must be of sufficient thickness to withstand the pressures to which it may be subjected. The transverse ribs also act to strengthen the casing. The holder 139 is provided at the front edge with a flange to which the frame 139[a] which holds the glass in position is attached by bolts. A suitable bushing with proper insulation is fixed in an opening 142 in the armor behind the holder 139 for the passage of the electric conductors, which enter the armor through a suitable bushing 143 at the back of the shoulders.

An attachment for hose connection is indicated in Figs. 1 and 2 at 144, and 145 illustrates a swinging attachment connected to the shoulders of the suit for the hoist rope 145[a]. A boss or flanged portion 142[a] is provided on the back of the armor for the attachment of a casing 142[b] to contain a pump (not shown). The bottoms of the shoes or feet sections 146 are preferably weighted to assist in maintaining the equilibrium. The metal comprising the ribs 13 may be cut away between those portions forming bearings for the wedges 29 if desired, thereby giving additional space at such points within the armor. The diver enters the armor before the upper sections are united to the abdominal section, and by my peculiar construction of joints, the diver can readily occupy the leg and feet sections without separating any of those sections from each other.

I claim as my invention:

1. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, and means for lengthening or shortening such sections so that they may be accommodated to divers of different stature.

2. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, and means for adjusting the joints to vary the frictional contact of the parts to compensate the pressure of water at varying depths.

3. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, means for lengthening or shortening such sections, and means for adjusting the joints to vary the frictional contact of the parts to compensate pressure of water at varying depths.

4. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, and in combination, means for lengthening or shortening such jointed sections, and means

for locking the same in the positions to which they may be adjusted.

5. An armor for submarine divers, having jointed sections which permit natural movements to the limbs of the diver, and in combination means for adjusting the joints to vary the frictional contact of the parts to compensate the pressure of water at varying depths, and means for maintaining the adjustment.

6. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, and in combination, means for lengthening or shortening such sections, means for locking the same in the adjusted positions, means for adjusting the joints to vary the frictional contact of the parts to compensate the pressure of water at varying depths, and means for maintaining the adjustment.

7. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, the sections between the joints telescoping and the outer sections being interiorly screw-threaded and the inner sections exteriorly screw-threaded to mesh with the screw threads of the outer sections whereby the limb sections may be lengthened or shortened, and means for securing the sections in the positions to which they may be so adjusted.

8. An armor for submarine divers, comprising jointed sections which permit natural movements to the limbs of the diver, the sections between the joints telescoping, the outer sections being interiorly screw-threaded and the inner sections exteriorly screw-threaded to mesh with the screw threads of the outer sections, whereby the limb sections may be lengthened or shortened, means for securing the sections in the positions to which they may be so adjusted, and means for preventing the leakage of water between such sections.

9. In an armor for submarine divers, and in combination, jointed sections which permit natural movements to the limbs of the diver, means for adjusting the joints of such sections so as to regulate the frictional contact of the parts to compensate the pressure of water at varying depths, the sections between the joints telescoping, the outer sections being interiorly screw-threaded and the inner sections exteriorly screw-threaded to mesh with the screw threads of the outer sections whereby the sections between the joints may be lengthened or shortened, means for securing such sections in the positions to which they may be adjusted, and means for preventing the leakage of water between such telescoping sections.

10. In an armor for submarine divers and in combination with the under part of the lower body seotion, having two spaced apart elongated openings, of three bearing frames within such lower body section, one of said bearing frames being at either side of such section and the third extending across the center of said section from front to rear, said side bearing frames each having a correspondingly curved groove in its inner face, and said central bearing frame having a correspondingly curved groove on each side thereof, means for maintaining said bearing frames in their respective positions, tubular cylindrical sections, one of which extends through each of said elongated openings, each of said tubular cylindrical sections having curved right-angled projections at the top on each side, which projections enter the curved grooves in said bearing frames and are slidable therein, and spaced apart rollers within each of said grooves both above and below such right-angled projections providing a top and bottom bearing therefor.

11. In an armor for submarine divers and in combination with the under part of the lower body section, having two spaced apart elongated openings, of three bearing frames within such body section, one being at either side of such section and the third extending across the center from front to rear thereof, said side bearing frames each having a correspondingly curved groove in its inner face, and said central bearing frame having a correspondingly curved groove on each side thereof, ribs upon the bottom of said body section upon which said bearing frames bear and by which they are held from lateral movement, projections upon the said body section at the front and back thereof at predetermined points above the top ends of said bearing frames, adjustable wedges between such projections and the top ends of the bearing frames, tubular cylindrical sections, one of which extends through each of the elongated openings in the bottom of the body section, each of said tubular cylindrical sections having curved right angled projections at the top on each side which projections enter the curved grooves in said bearing frames and are slidable therein, and rollers within each of said grooves upon which said projections have a bearing.

12. In an armor for submarine divers and in combination with a bottom body section curved from front to rear and having two spaced apart elongated openings therein, of three bearing frames within said body section, one being at either side thereof and the third extending across the center from front to rear, said side bearing frames each having a correspondingly curved groove in its inner face and said central bearing frame having a correspondingly curved groove on each side thereof, side bearings for said frames upon the interior surface of the bottom of said body section, projections upon

the interior surface of said body section at the front and back at predetermined points above the top ends of each of said bearing frames, adjustable wedges between such projections and the top ends of the bearing frames, tubular cylindrical sections, one of which extends through each of the elongated openings in the bottom of the body section, each of said tubular cylindrical sections having curved right angled projections at the top on each side, which projections enter the curved grooves in said bearing frames and are slidable therein, rollers within each of said grooves upon which said projections have a bearing, a guard plate upon each of said tubular cylindrical sections at a point outside said body section but closely adjacent thereto, said guard-plates being of curved form corresponding to the curvature of the body section, and means for preventing the leakage of water between said guard-plates and said body section.

13. In an armor for submarine divers and in combination with a bottom body section curved from front to rear, having two spaced apart elongated openings therein, of three bearing frames within said body section, one being at either side thereof and the third extending across the center from front to rear, said side bearing frames each having a correspondingly curved groove in its inner face, and said central bearing frame having a correspondingly curved groove on each side thereof, side bearings for said frames upon the interior surface of the bottom of said body section, projections upon the interior surface of said body section at the front and back at predetermined points above the top ends of each of said bearing frames, adjustable wedges between such projections and the top ends of the bearing frames, tubular cylindrical sections, one of which extends through each of the elongated openings in the bottom of the body section, each of said tubular cylindrical sections having curved right angled projections at the top on each side, which projections enter the curved grooves in said bearing frames and are slidable therein, rollers within each of said grooves upon which said projections have a bearing, a guard plate upon each of said tubular cylindrical sections at a point outside said body section but closely adjacent thereto, said guard plates being of curved form corresponding to the curvature of the body section, clamping rings secured to the guard plates around their outer edges, such clamping rings being rabbeted, and a packing material within which such rabbeted parts extending outward therefrom in reduced thickness to the outer edges of the clamping rings and bearing against the outer surface of the body section.

14. In an armor for submarine divers and in combination with a cylindrical body and tubular cylindrical limb sections with articulate connection between the body and leg sections, of knee, ankle and elbow joints, each of such joints comprising in combination, two meeting sections, the upper one of said sections having a curved bottom and an elongated opening therein, bearing frames within such section, one at each side thereof and each provided with a curved groove in its inner face, bearings upon the interior surface of the bottom of the curved section for said frames, the lower one of said meeting sections extending through the said elongated opening in the upper section and having curved right angled projections at the top on each side which projections enter the curved grooves in said bearing frames and are slidable therein, rollers within each of said grooves forming bearings for said projections, a guard-plate upon said lower section at a point outside the upper section but closely adjacent thereto, said guard-plate being of curved form corresponding to the curvature of the bottom of the upper section, and means for preventing the leakage of water between said guard-plate and said upper section.

15. In an armor for submarine divers, the combination with the body, leg, foot and arm members having articulated connecting sections, of swivel joints located between the knee and ankle joints, comprising in combination, upper and lower tubular cylindrical sections composing the lower leg section of the armor, said upper sections having annular shoulders on their outer surfaces, and said lower sections being recessed in their upper part and having annular grooves below such recessed portions, and receiving the said upper sections within said recesses, bearing rollers in said annular grooves, spacer rings separating said bearing rollers one from the other, outer ring sections screwed to the said lower sections and having inwardly projecting flanges, bearing balls between said flanges and the lower annular shoulders on said upper sections, top ring sections screwed into the said outer sections above the flanges thereon, ring sections screwed upon the said upper sections above the top annular shoulders thereon leaving annular recesses between the same and the inner surfaces of the flanges on said outer ring sections, and a packing within such annular recesses.

16. In an armor for submarine divers, the combination with the body, leg and foot members having articulated connecting sections, of connections for the arm sections to the body member, comprising in combination, sockets upon the body member, one at each side thereof projecting inwardly and having inturned flanges on their inner ends, said sockets being partially interiorly

screw-threaded, arm sections stepped on their outer circumference forming annular shoulders thereon, steel rings (71) having an annular projection (71ª) and screwed to the arm sections, cylindrical members (72) whose inner circumferences fit within the said sockets with their inner edges resting against the flanges thereon, said cylindrical members having outer shoulders near their inner ends and interior annular shoulders and screw-threaded between two of the inner shoulders, ring-members (73) having flanges which contact with the inner shoulders on said cylindrical members, and which are screw-threaded to said members, bearing rollers between the said cylindrical members and the annular projections on said rings (71) and bearing upon the periphery thereof, steel rollers on either side of the projections upon the said steel rings (71) and forming bearings between said projections and the cylindrical members and also between said projections and the flanges of the said ring member (73), a packing to prevent leakage of water between the parts, and locking rings screwing into the sockets around the outer surfaces of said cylindrical members and contacting with the outer shoulders on said members.

17. In an armor for submarine divers, the combination with the body, leg, arm and foot members thereof having articulated connecting sections, of tubular cylindrical sections within the open ends of the fore-arm sections, ball bearings for the same, rods passing centrally through said tubular cylindrical sections, handles upon the ends of said rods within the fore-arm sections, gripper fingers exterior of the fore-arm sections and pivotally connected with the ends of said rods and by which they are operated, springs within the said tubular cylindrical sections bearing against the upper one of said sections at their tops, collars fixed to said rods and forming a bearing for the lower ends of said springs, and packings for preventing the leakage of water into the fore-arm sections.

Signed by me this first day of December 1910.

CHESTER E. MACDUFFEE.

Witnesses:

GEO. A. TRAVER,

GEO. T. PINCKNEY.