No. 673,437. Patented May 7, 1901.

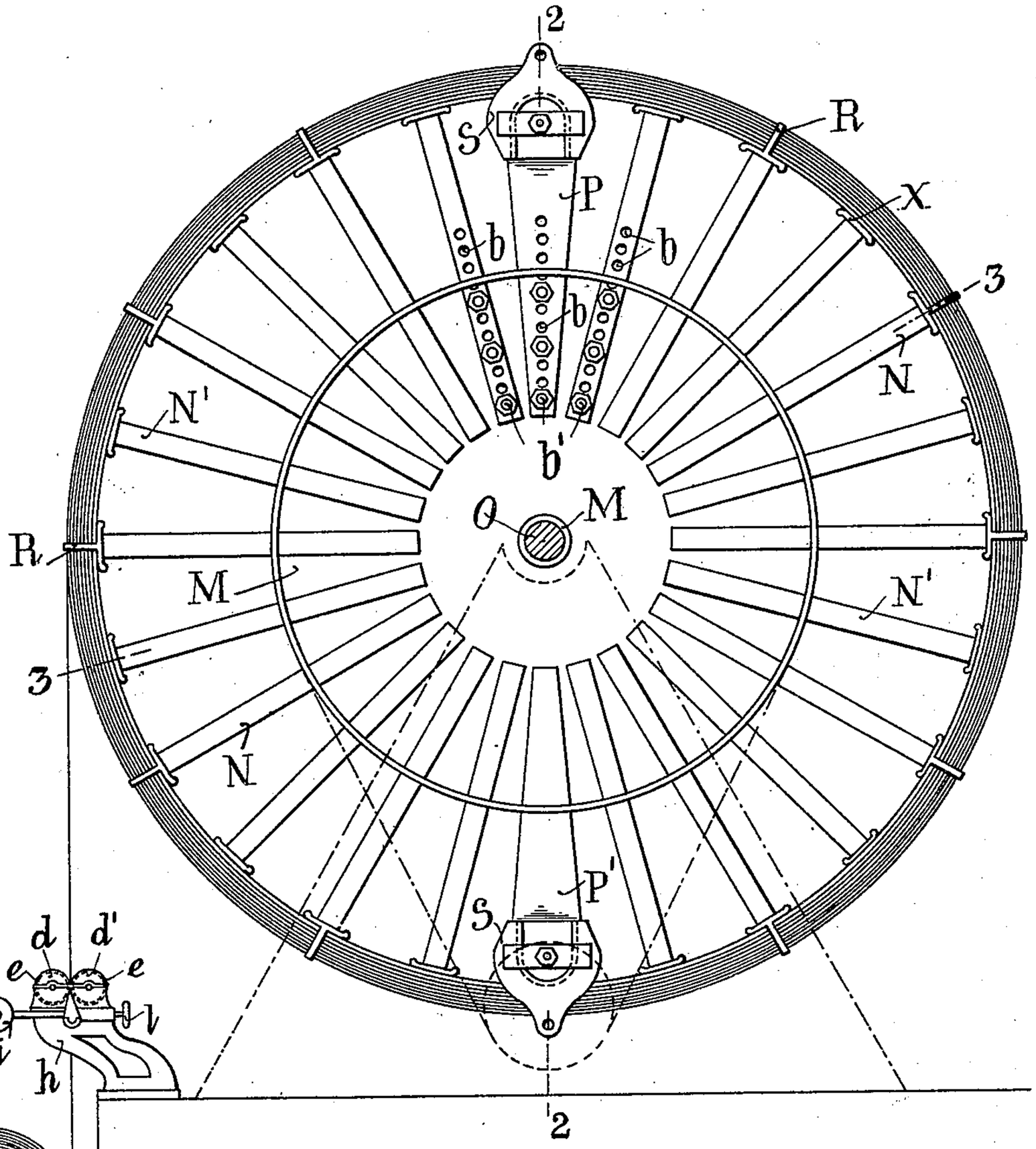
G. LINDENTHAL.

APPARATUS FOR THE MANUFACTURE OF WIRE LINKS FOR BRIDGES.

(Application filed June 28, 1897. Renewed Oct. 5, 1899.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

Fig. 2.

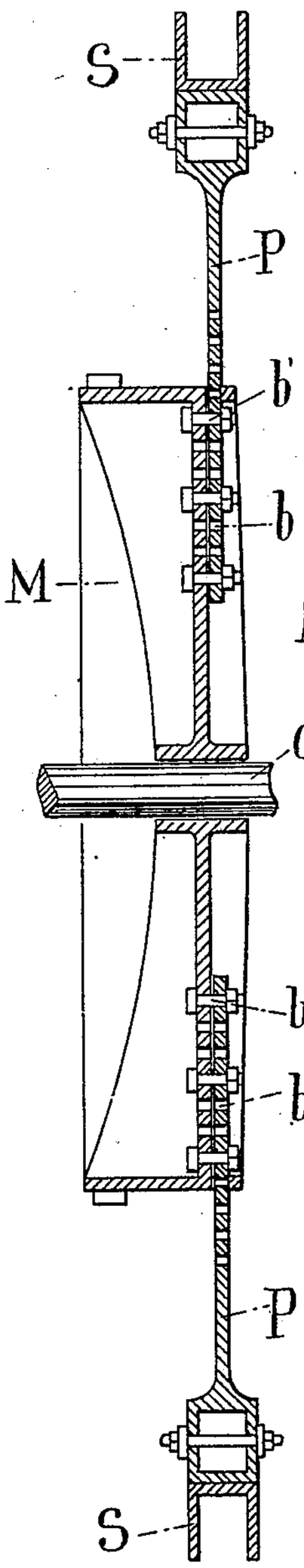


Fig. 3.

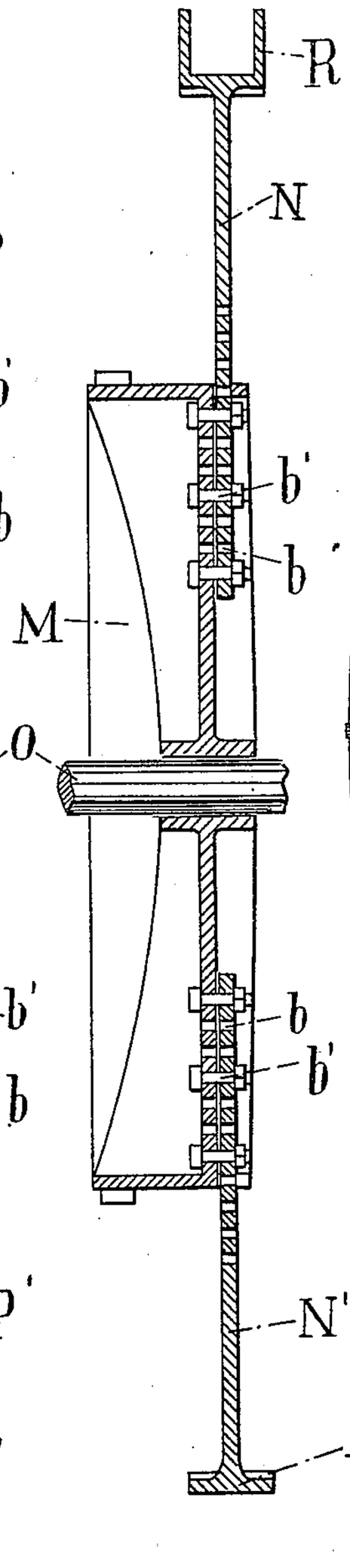
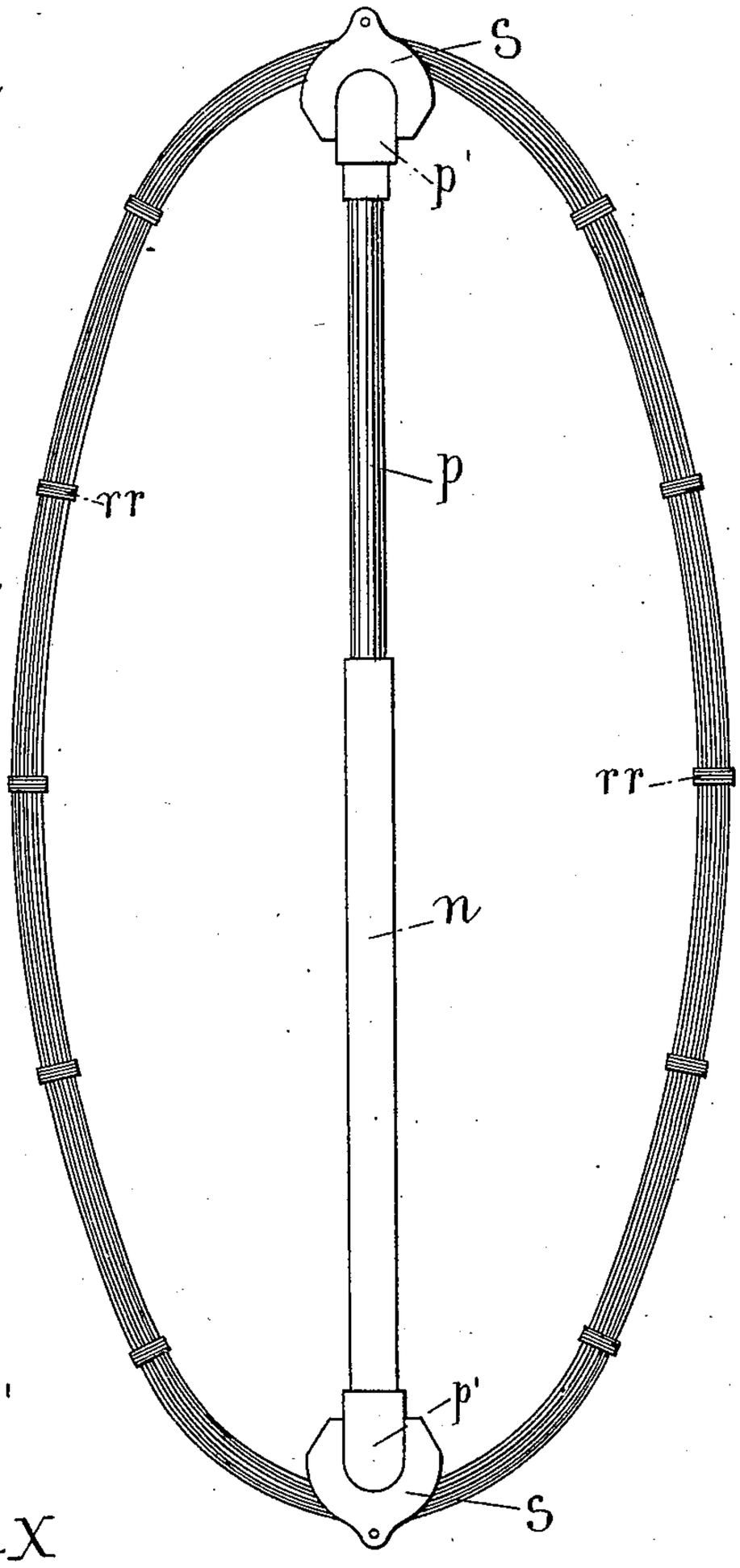


Fig. 7.



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(No Model.) 4 Sheets—Sheet 3

Fig. 5.

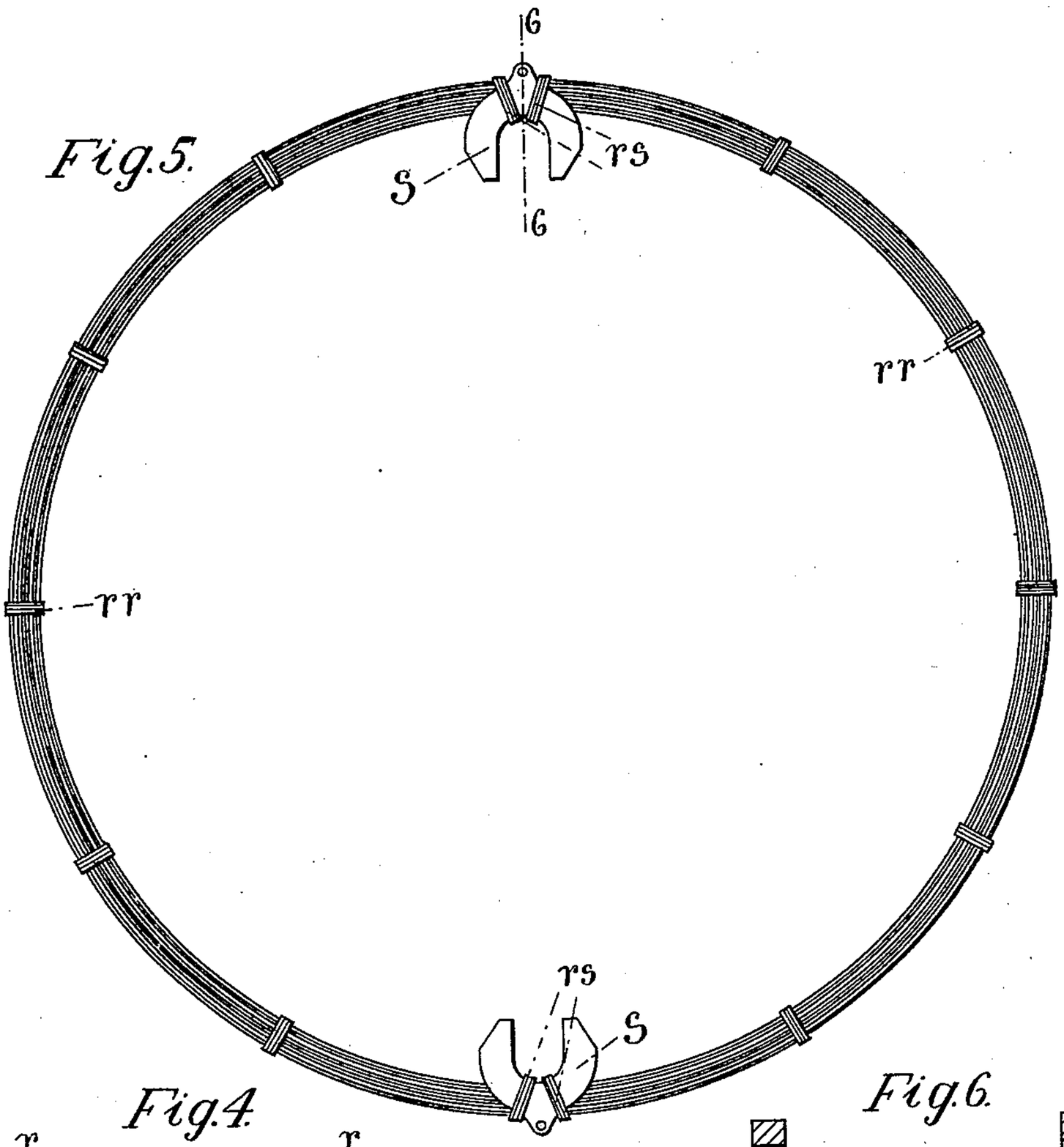


Fig. 4.

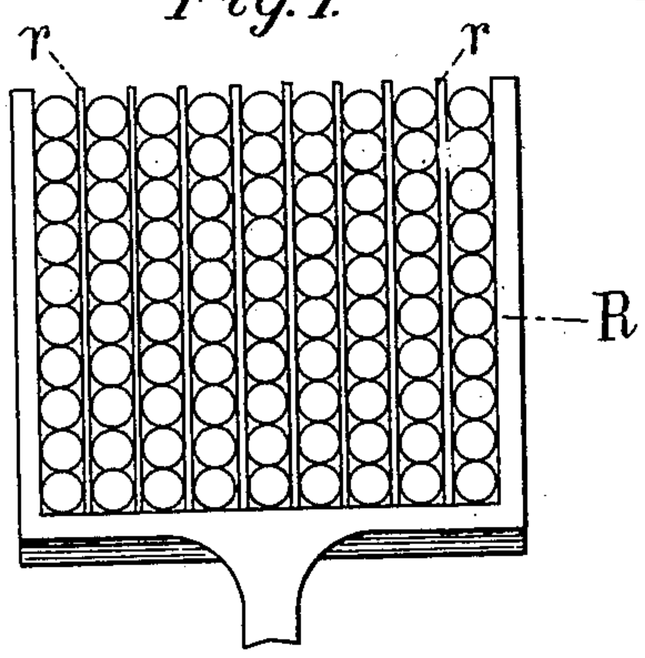
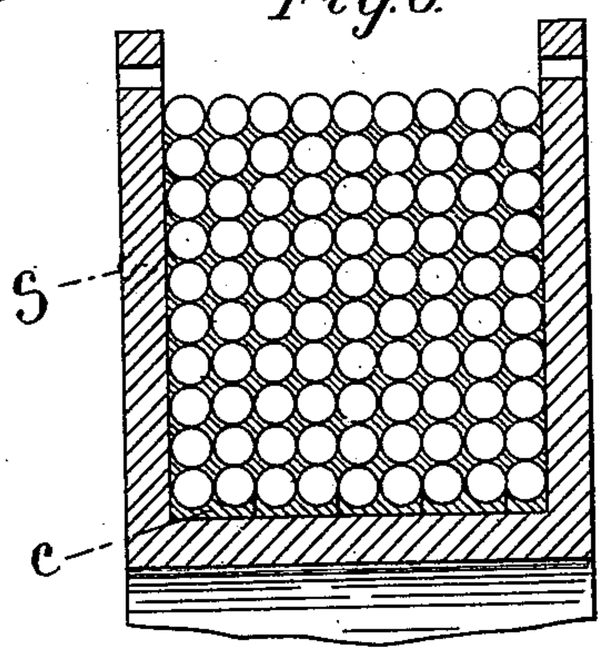


Fig. 6.



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(Application filed June 28, 1897. Renewed Oct. 5, 1899.)

(No Model.) 4 Sheets—Sheet 4.

Fig.8.

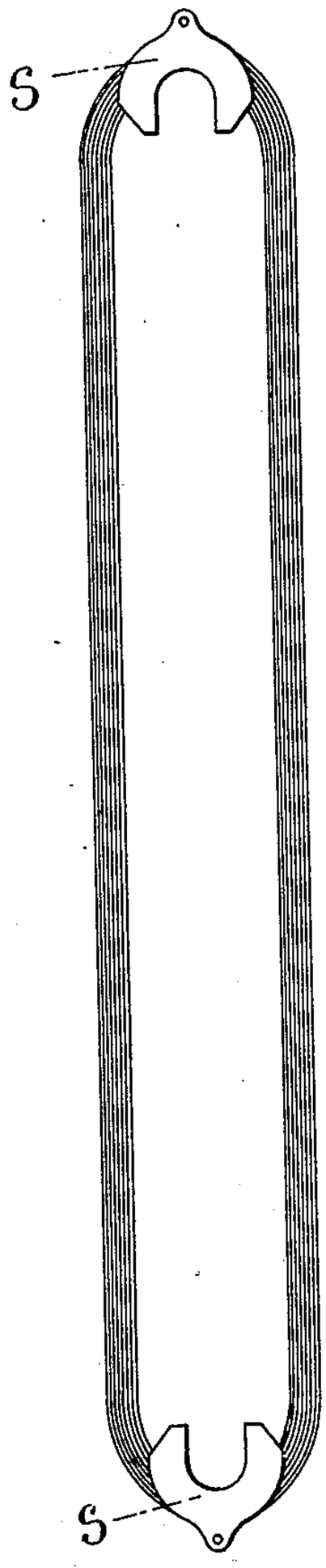

Fig.9.

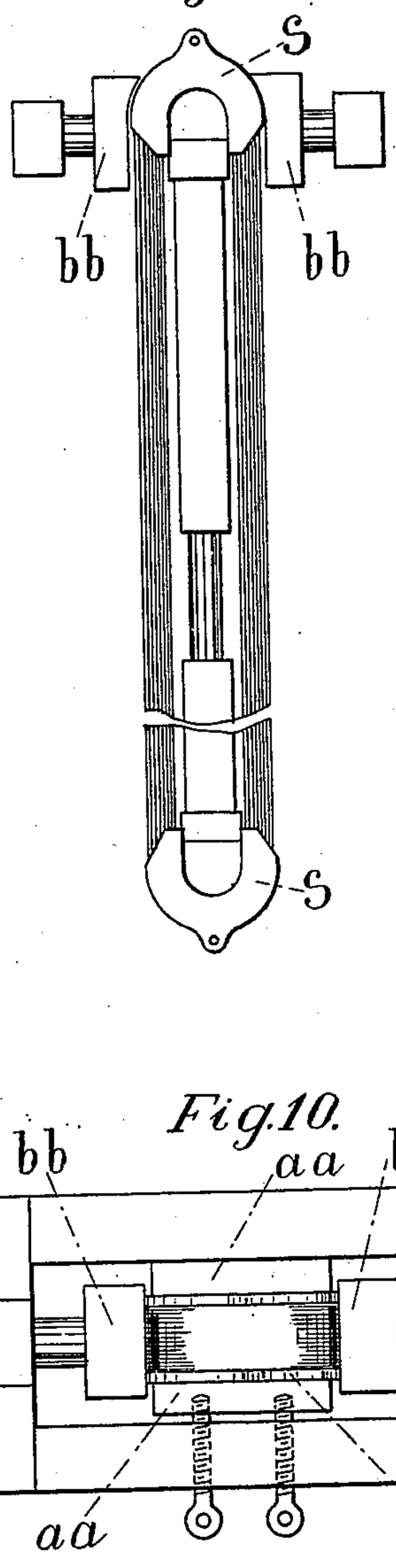

Fig.11.

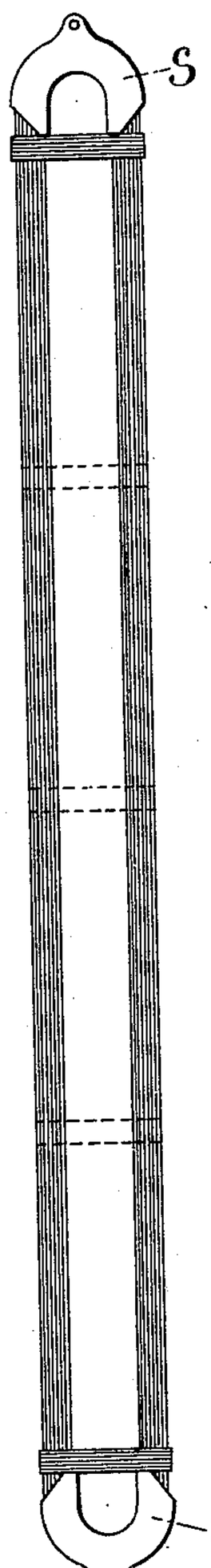

Fig.10.

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UNITED STATES PATENT OFFICE.

GUSTAV LINDENTHAL, OF NEW YORK, N. Y.

APPARATUS FOR THE MANUFACTURE OF WIRE LINKS FOR BRIDGES.

SPECIFICATION forming part of Letters Patent No. 673,437, dated May 7, 1901.

Application filed June 28, 1897. Renewed October 5, 1899. Serial No. 732,733. (No model.)

To all whom it may concern:

Be it known that I, GUSTAV LINDENTHAL, a citizen of the United States, and a resident of New York, county and State of New York, have invented certain new and useful Improvements in Apparatus for the Manufacture of Wire Links for the Construction of Tension Members in Bridges and other Similar Structures, of which the following is a full, clear, and exact specification, reference being had to the accompanying drawings, wherein—

Figure 1 is an elevation of my improved apparatus for winding of wire links; Figs. 2 and 3, sectional views thereof on lines 2 2 and 3 3, respectively, indicated in Fig. 1. Fig. 4 is an enlarged detail of the sectional view Fig. 3, showing the rack filled with the strands of wire. Fig. 5 is an elevation of the coil removed from the winding apparatus and provided with temporary lashes. Fig. 6 is an enlarged sectional view on line 6 6, indicated in Fig. 5. Fig. 7 is an elevation showing the coil in the first stage of stretching with the stretching-ram in action. Fig. 8 is an elevation of a stretched wire link. Figs. 9 and 10, front and top views, respectively, show the hydraulic apparatus for compressing the link ends into the shoe and in operation upon one head of the link; and Fig. 11 is an elevation of the wire link stretched to its exact length and finished for use.

Wire links heretofore produced by winding the wire around shoes or half-round bearings and used as tension members in the construction of bridges and similar structures are faulty because the tension in all the wires of such link is not equal, the inner wires being less strained than the outer ones. The cause for it is to be found in the elastic compressibility of the iron frame on which the shoes during the winding process must be fastened. As the number or layer of wires increases the force compressing the iron frame between the bearing points or shoes increases and the iron under the increasing pressure shortens, thus releasing the tension on the inner wires as compared with the outer wires, and thereby the capacity of the wire link as a tension member is impaired.

The object of my invention is an apparatus for manufacture of such wire links wherein all strands or wires are equally strained for any value of force or tension.

With this end in view my invention consists of the hereinafter-described apparatus for manufacture of wire links adapted for tension members in bridges and other similar structures.

The apparatus consists of a winding-reel, adjustable as to diameter, a device for regulating and maintaining a slight tension upon the wires or strands during the winding, and of devices for shaping the link.

The reel consists of a hub or disk M, preferably provided with round or slotted bolt-holes *b*, arranged in rows radiating from the center, arms P, adapted to carry shoes S, and arms N and N′, to which reeds R and saddles X are secured. The arms may be secured to the disk M by bolts *b*′ through holes corresponding with the holes provided in the disk M to permit the adjustment of the periphery of the reel. The reel rotates on shaft O, being driven by friction, sprocket, or other suitable gearing.

The arms N, N′, P, and P′ of the winding-reel are extended according to the required length of the links to be produced. For instance, if links are to be produced sixty-five feet long (from center to center of the bearing-pins) the arms of the winding-reel must be extended to a diameter of exactly forty-three feet. On this basis the necessary extension for any given length of a link may be readily calculated. As shown in the drawings, arms N, N′, P, and P′ are secured to disk M by bolts. The manner of securing these arms to the disk is a minor detail of construction and may be varied to suit the purpose or facilitate a more speedy adjustment of the arms at varying lengths. They may be inserted in dovetailed grooves and secured to the disk in adjusted position by two or more set-screws or they may have their ends slotted and bolts set in the disk in the same manner as shown in the drawings, projected through the slots.

Reeds R (shown in enlarged detail in Fig. 4) are composed of a U-shaped rack secured to or made in one piece with the arms N and of a number of blades *r*, set between the side bars of the rack. Blades *r* form a number of intermediate splits or dents, into which the wire is laid during winding, guiding it in

spiral turns to form closely-laid layers of wire. The shape of the reeds R corresponds with the shape of the bearing-surface of the shoes and with the cross-section of the link to be produced. Fig. 4 shows a sectional view of a reed, and Fig. 6 a sectional view of a shoe with the wires of the coil embedded therein. Saddles X are integral with or secured to arms N′ in the same manner as the reeds R. They aid in supporting the wires during the process of winding. In the apparatus shown in the drawings the saddles alternate with the reeds and shoes. This arrangement may, however, be varied, as desired. Also the shape of the rack and of the saddles may be varied, as explained before, and the manner of their securing to the radiating arms. More than one of them may be secured to each of the arms N, N′, P, and P′, and the apparatus may be made thus to serve for winding of two or more links, either of the same or different sectional area, at the same time. The winding operation does not require any considerable power, and therefore two or more links may be wound at the same time upon the same reel.

The device for regulating and maintaining a slight tension upon the wires or strands while they are being wound on the reel is shown in elevation in Fig. 1 of the drawings. It consists of two or more friction-rollers *d* and *d′*, provided with grooves *e* of slightly-less depth than half the thickness of the wire, and the pressure upon which may be varied by any suitable device for regulating the tension upon the passing wire. In the device shown in the drawings the pressure of the rollers upon the wire is regulated by screw *l*, and by setting the weight *i* upon lever *g* brake-block *h* is pressed upon the rollers *d* and *d′*, as desired.

The devices for shaping the links are shown in Figs. 7, 9, and 10. They comprise a ram, preferably a hydraulic ram, for stretching the link, and a vise, preferably a hydraulic vise, for compressing its heads (ends of the link) and setting them into the shoes. The ram (shown in Fig. 7) consists of a hollow cylinder *n* and of a plunger *p* fitted therein. Cylinder *n* and the plunger *p* are provided with heads *p′*, snugly fitted into the bearing of shoes S. The ram may also be composed of two hollow cylinders connected by a common plunger, as shown in Fig. 9, which construction is more suitable for the adjustments in length during the last stages of the operation. The vise is shown in Figs. 9 and 10 in elevation and plan view, respectively. It consists of a rigid frame with two blocks *a a*, set opposite each other, one of them being preferably stationary and the other adjustable by means of set-screws. The gripping-faces of jaws *b b* conform to the shape of the heads of the link and are connected to a hydraulic apparatus in such manner that when the power is applied these jaws *b b* are driven forcibly together. This vise is always used in combination with one of the stretching devices shown in Figs. 7 and 9, respectively, and described above.

The apparatus is used for manufacture of wire links in following manner: The links to be used in the manufacture are first straightened in suitable machines and the ends of the coils thereof are united, preferably by so-called "brazed joints," into one continuous wire until the required length of the wire is obtained. The wire so prepared is wound on an ordinary wire-reel, (shown in Fig. 1 of the drawings,) which must be of such a diameter as to prevent permanent bending (set) of the wire. One end of the wire is then passed through the tension device (also shown in Fig. 1 of the drawings) and fastened to one of the shoes mounted on the winding-reel. The winding-reel is then set in motion and the tension device is adjusted to hold the wire down upon the reel with only such force as required to keep the wire in its proper place on the winding-reel and to prevent any looseness in the coil. During the winding of round wire bearing-strips *c*, described in my Letters Patent of United States No. 608,690, dated August 9, 1898, are secured in position upon the bearing-surface of the shoes. These bearing-strips are slightly bent to prevent their interfering with the wire in the course of winding and lubricated to facilitate the gliding of the wires thereon during the subsequent operations in shaping the link. Additional bearing-strips are inserted in the shoes as each row or layer of wires is wound upon the reel until the required number of layers is obtained in the coil. For square or flat wires no bearing-strips are required. Thereupon the coil (or ring) so produced is tied by temporary lashings *r r*, the shoes are secured in their places by the lashings *r s*, as shown in Fig. 5, and the coil is taken off the reel by loosening some of the adjustable arms N for easier manipulation in removal. Next a ram, such as illustrated in Fig. 7 or such as shown in Fig. 9, is set between the shoes of the coil and power applied thereto, so as to elongate the ring. The elongation of the link by means of the ram is continued until the coil obtains the shape shown in Fig. 8, whereupon the ends of the link, or "heads," as they will be called hereinafter, are compressed into the shoes. For this purpose the head of the link is placed between blocks *a a* of the vise (shown in Figs. 9 and 10) and then compressed between the jaws *b b*, operated, preferably, by hydraulic pressure. Power is then applied to the ram and to the vise simultaneously. By this coöperation of the vise and the ram the wires and bearing-strips are bent into their final shape, forced into the shoe, and compressed therein. Clamps or wire lashings are then placed around the link close to the shoe, and the link is then ready for the final operation upon the drilling-bench, where preferably a hydraulic ram is applied to it in the manner shown in Fig. 9. The pressure

exerted by this ram upon the link is regulated according to the number of wires of which the link consists, with the object of having each wire under the same tension during the boring out of the shoes to finished length. If, for illustration, the link be composed of one hundred and sixty wires, (eighty turns,) with a tension on each wire of five hundred pounds during the boring operation, then the pressure applied will be $160 \times 500 =$ 80,000 pounds. If the wire link be composed of six hundred wires, (three hundred turns,) then the pressure applied would be $600 \times 500 =$ 300,000 pounds. During the application of this regulating-pressure the heads of the rams are keyed up to a fixed bearing, so that any leakage of the ram may not change the length of the wire link during the boring operation. While the link is under this fixed tension both shoes are bored out simultaneously to the exact length which the link is to have. Temporary lashings, as many as may be required, are then fastened at proper intervals around the link and wooden bracings and packing are applied for protecting it during transportation and erection.

Having thus described the object and nature of my invention and the means for practicing the same, I claim and desire to secure by Letters Patent—

1. A winding apparatus for the manufacture of wire links for tension members of bridges and similar structures, consisting of a hub or disk mounted on a shaft pillowed in bearings on suitable standards, extensible arms, adjustably secured to the disk, saddles and reeds secured to the arms, arms adapted to carry the shoes adjustably secured to the disk diametrically opposite each other, means for securing the shoes to the arms, means for rotating the apparatus upon the shaft and means for feeding the wire to the apparatus under uniform conditions of tension and adjustment.

2. A reel for an apparatus for manufacture of wire links for tension members of bridges and similar structures comprising a shaft mounted on suitable standards; a disk mounted on the shaft; arms adjustably secured to the disk; shoes, saddles and reeds secured to the arms and means for rotating the disk.

3. An apparatus for manufacture of wire links for tension members of bridges and similar structures, consisting of a rigid frame, a stationary and a movable block set opposite each other within the frame, means for operating the movable block, jaws having gripping-faces shaped in conformity with the shoes of the link, set movably in the frame and opposite each other and means for forcing the jaws together.

4. An apparatus for manufacture of wire links for tension members for bridges and similar structures, comprising a vise for pressing the strands of wire links into the grooves of their shoes, and a stretching apparatus operating simultaneously with the vise and comprising a hollow cylinder with a head fitted in the bend of the shoe secured to the coil, a plunger fitted into the hollow cylinder and having a head fitted into the bend of the other shoe and means for driving the plunger.

In witness that I claim the improvements described in the foregoing specification I have signed my name in the presence of two subscribing witnesses.

GUSTAV LINDENTHAL.

Witnesses:
HENRY SCHREITER,
ROBERT VALENTINE MATHEWS.