(No Model.) 3 Sheets—Sheet 1.

E. E. RIES.

ELECTRIC RIVETING APPARATUS.

No. 452,042. Patented May 12, 1891.

Fig. 1a

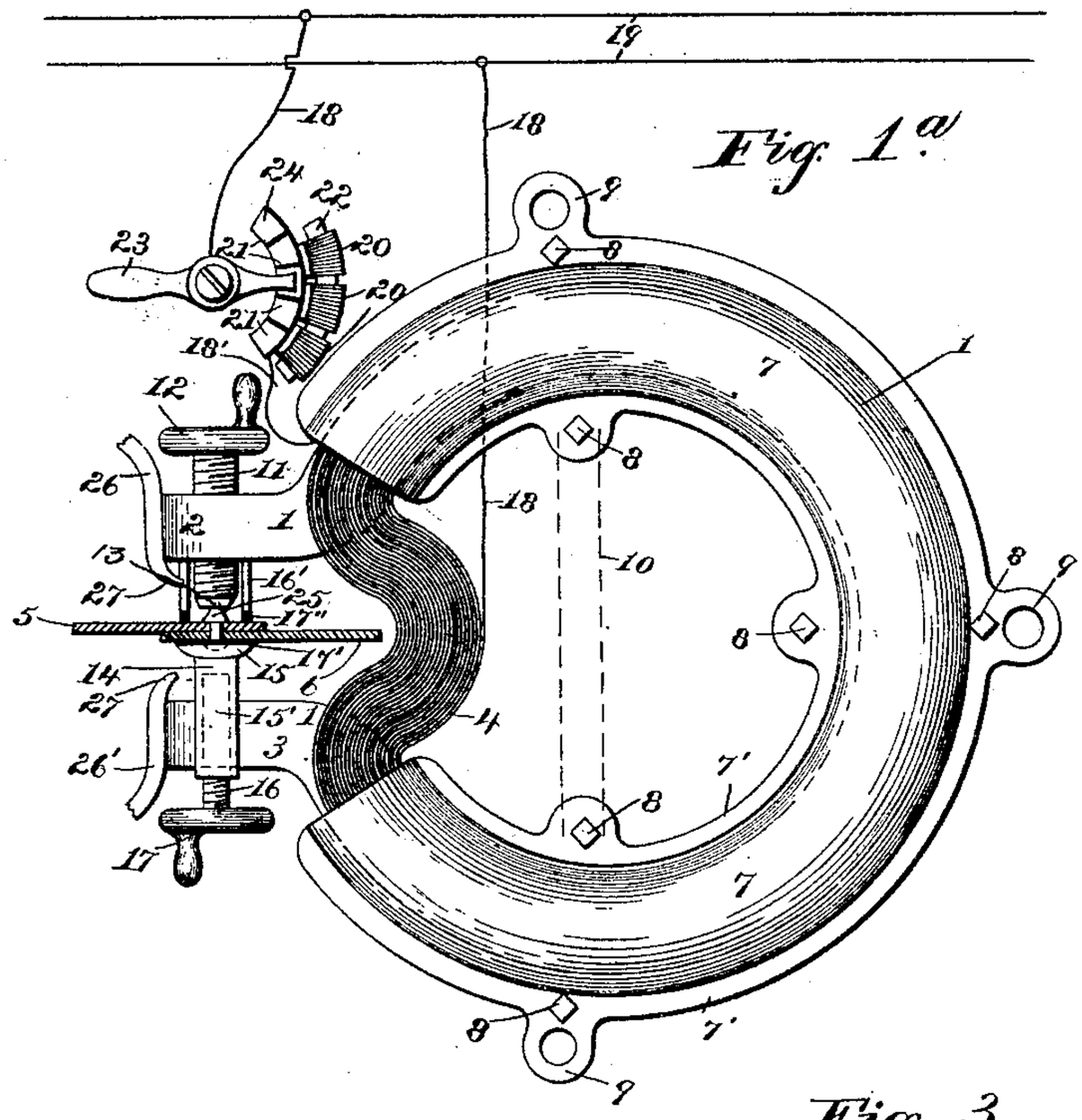


Fig. 4.

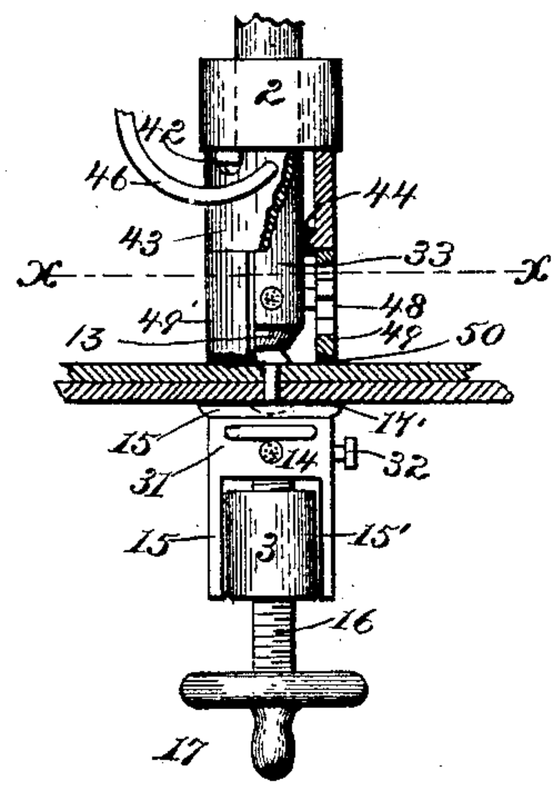
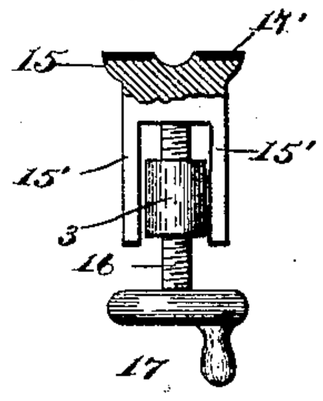


Fig. 3.



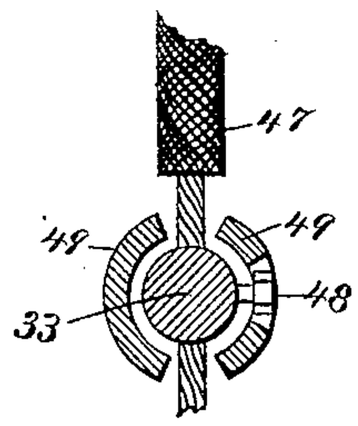


Fig. 5.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

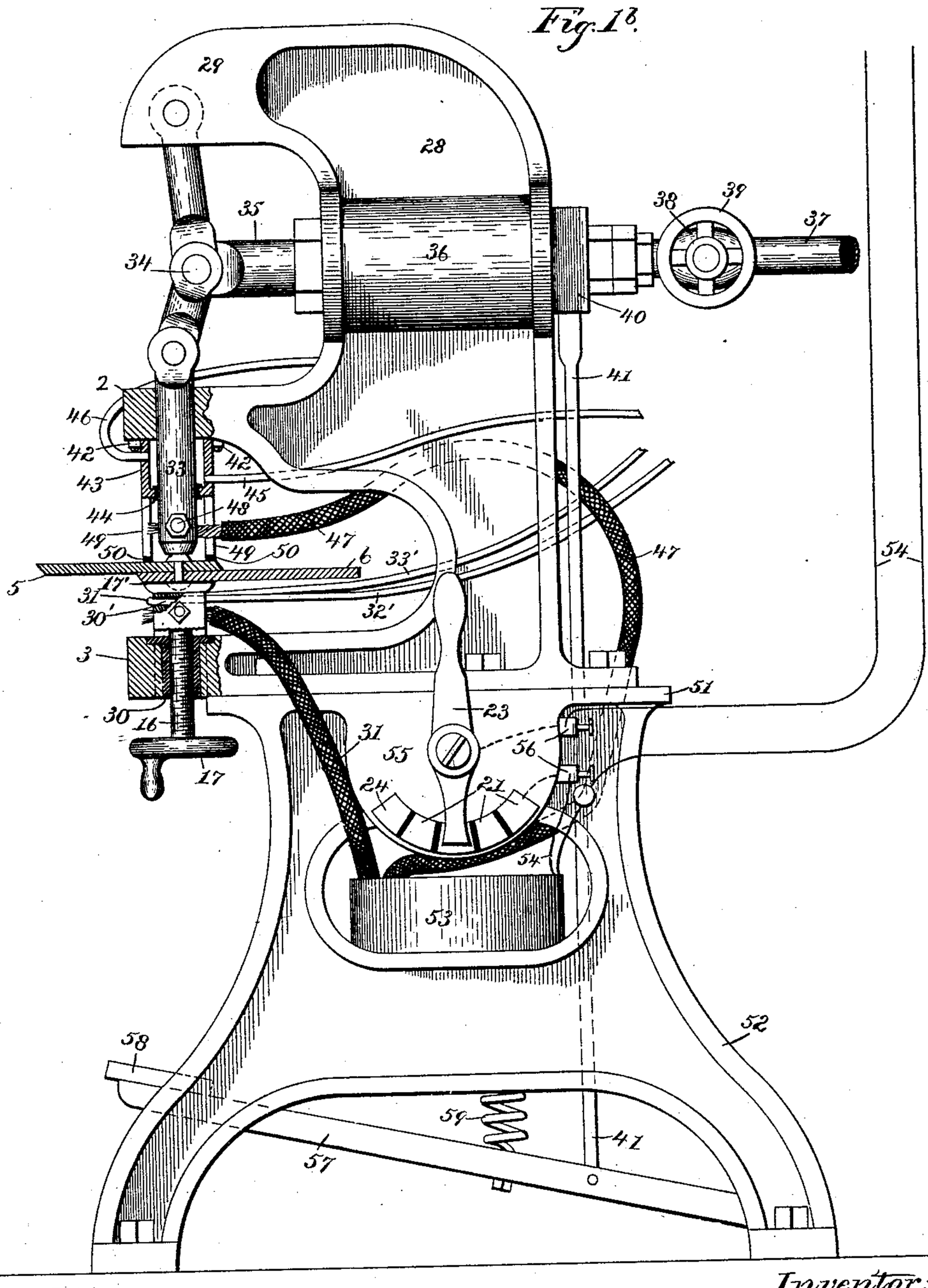
(No Model.) 3 Sheets—Sheet 2.

E. E. RIES.

ELECTRIC RIVETING APPARATUS.

No. 452,042. Patented May 12, 1891.

Fig. 1b.



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(No Model.) 3 Sheets—Sheet 3.

E. E. RIES.

ELECTRIC RIVETING APPARATUS.

No. 452,042. Patented May 12, 1891.

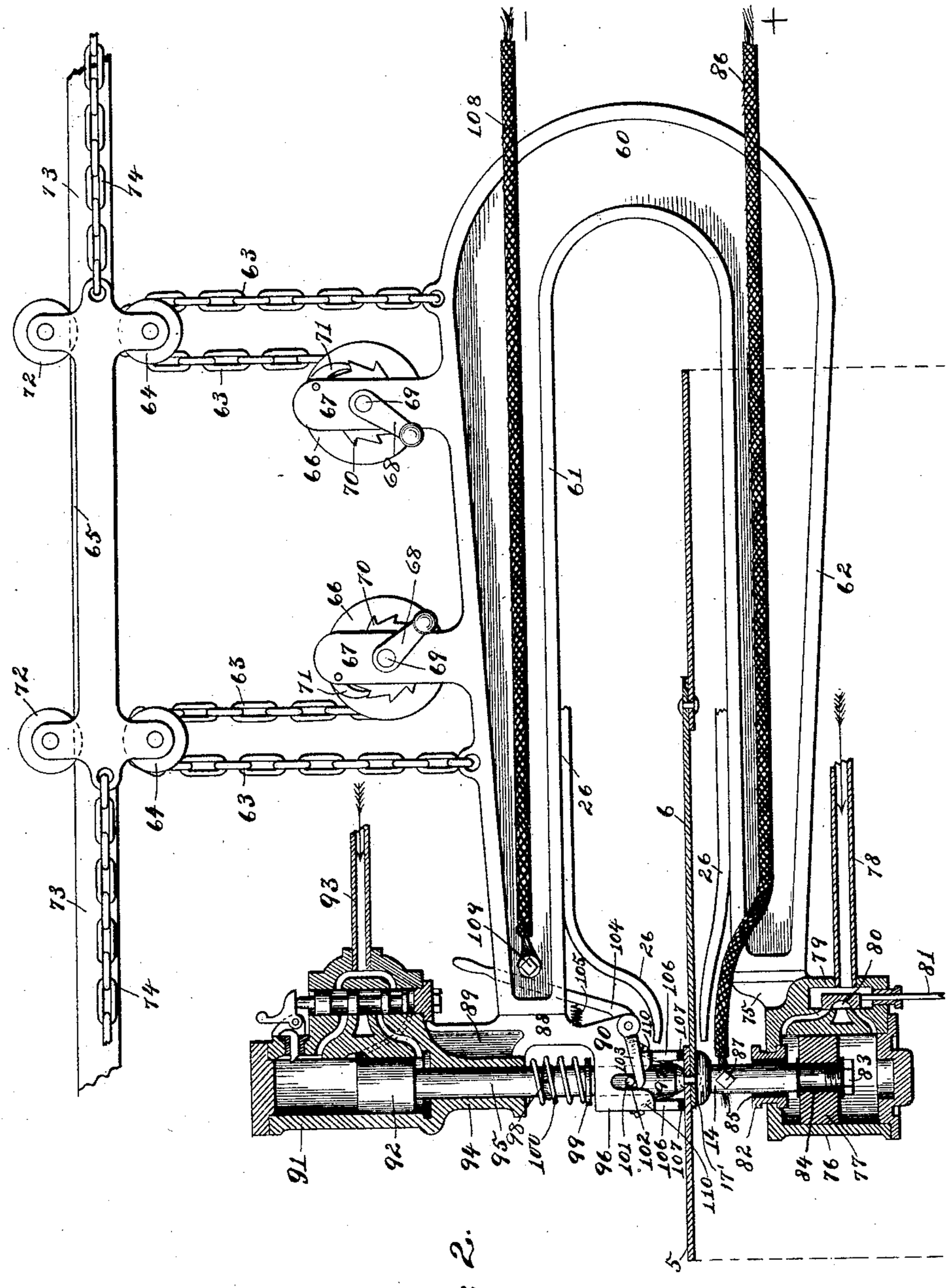

Fig. 2.

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UNITED STATES PATENT OFFICE.

ELIAS E. RIES, OF BALTIMORE, MARYLAND, ASSIGNOR TO RIES & HENDERSON, OF SAME PLACE.

ELECTRIC RIVETING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 452,042, dated May 12, 1891.

Application filed June 25, 1889. Serial No. 315,473. (No model.)

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, and a resident of Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Electric Riveting Apparatus, of which the following is a specification.

My invention has reference to machines or apparatus for riveting by the aid of electricity in the manner set forth in my application, No. 285,555, filed September 15, 1888, and claimed in my application, No. 293,069, filed December 10, 1888, and also in my patent, No. 403,374, dated May 14, 1889; and the object of the present invention is to provide improved practical means by which the electrical riveting process may be effected with ease and dispatch.

The invention may assume a great variety of forms, and while I have shown in the drawings forming part of this specification certain organized machines embodying the invention, I am in no manner confined to the identical construction shown. All this will more fully appear from the following detail description with reference to the accompanying drawings, in which—

Figure 1ª is a side elevation of one form of riveting-machine embodying my invention, in which a generator or inductional transformer forms an integral part of the frame of the machine. Fig. 1ᵇ is a side elevation of another form of riveting-machine embodying features of my invention. Fig. 2 is a side elevation, with parts in section, of still another form of riveting-machine embodying features of my invention and designed more especially for large work. Fig. 3 is a front view of the anvil and its supporting-bracket shown in Fig. 1ª. Fig. 4 is an enlarged front view, partly in section, of the anvil and heading-die with adjacent parts shown in Fig. 1ᵇ, and Fig. 5 is a section on the line *x x* of the heading-die shown in Fig. 4.

Like numerals of reference indicate like parts throughout all the drawings.

Referring more particularly to Fig. 1ª, there is shown a heavy bar 1, of copper or other good conductor of electricity, bent to a circular shape, as indicated by dotted lines, with the free ends turned outward and parallel, forming two brackets 2 3, one above the other, to support a riveting mechanism composed of an anvil and heading-die, hereinafter referred to. The bar 1 constitutes the secondary conductor of an inductional transformer, the primary coil 4 of which is composed of fine wire, which is placed parallel with and against the bar 1. The primary coil is bent into a loop between the two brackets 2 3, as shown, so as to leave additional room for the work, which latter is shown in the form of two plates 5 6 to be riveted together. A shell or shield 7, of magnetic material, and composed of two similar castings, (one only being shown,) which are provided on the inner end and outer edges with flanges 7′, through which pass bolts 8 for securing the two castings together, incloses the circular portion of both the primary and secondary of the transformer, and serves to concentrate the magnetic lines of force within the transformer and thereby increases its efficiency. The shell sections are provided with ears 9, projecting from the outer flanges 7′, for attaching the transformer to a suitable frame or for supporting it in any desired position. If found desirable, the rigidity of the transformer may be increased by a tie-rod 10. (Indicated in dotted lines.) The bracket 2 supports a heading die or tool 11, which in this instance consists of a bolt with a threaded shank extending through a suitable nut in the said bracket, and a hand-wheel 12 or other suitable device, whereby the bolt may be turned and thus elevated or depressed. The lower end of the die is frusto-conical in shape, as shown at 13, and has a cavity of suitable shape formed in its face to receive and mold the free end of the rivet-shank. The bracket 3 carries an anvil, which, as shown in Figs. 1ª and 3, consists of a block or body 14, having an expanded upper end or head 15 with a broad flat face, in which is a cavity to receive or mold the head on one end of the rivet, and on the said face is a layer 17′ of insulating material, not, however, extending into the cavity provided for the reception of the rivet-blank head. This facing may be made of asbestus cloth, soapstone, obsidian, agate, mica, or other insulating and refractory substance. Extending through a nut in the bracket 3 is a screw-

threaded rod 16, with its upper end engaging the under side of the body 14 of the anvil and supporting the latter. The rod 16 is turned by means of a hand-wheel 17 on its lower end to elevate or lower the anvil. On the body 14 of the anvil are depending side wings 15′, straddling the bracket 3 to prevent the said body from turning when moved by the rod 16. It will be understood, however, that other forms of die and anvil and means for adjusting and actuating them—such, for instance, as shown and hereinafter described in connection with the other figures of the drawings—may be used. Depending from the bracket 2 are fixed legs 16′ at the sides of the heading-die, and provided at their lower ends with insulating material 17″ of the kind described with reference to the facing 17′. If now the plates to be riveted together be placed on the head 15 of the anvil with the shank of a rivet-blank in the rivet-holes in the plates and its head in the cavity in the anvil, then the anvil may be elevated by manipulating the screw-rod 16 until the said plates are clamped between the expanded head 15 of said anvil and the legs 16′ depending from the bracket 2. The fine-wire primary coil 4 receives alternating high-tension electrical currents by wires 18 18 from a suitable source—such as a dynamo—connecting with conductors 19 19. One wire 18 includes a suitable current-regulator within easy reach, and, as shown, this regulator is a reaction rheostat composed of a series of resistance-coils 20, a series of contact-plates 21, to which the terminals of the coils are connected, a soft-iron core 22 within the coils, and a switch-lever 23 arranged to make contact with the plates 21 and with an idle contact-plate 24. The wire 18 is connected with the switch-lever and a continuation 18′ of said wire leading to the coil 4 is connected to the end plate of the series of contact-plates 21.

The operation of riveting with a machine constructed as shown in Fig. 1ª will now be understood. A rivet 25 is placed with its head, or, if there be no head, with one end of its shank, in the cavity in the face of the anvil, and the shank itself engaging the rivet-holes in the plates 5 6. The operator then manipulates the rod 16 to elevate the anvil, together with the plates and rivet thereon, until the said plates are clamped against the lower ends of the legs 16′ and held firmly thereto during the entire operation of riveting. The heading-die is then screwed downward until in contact with the upper or free end of the rivet-shank, and the switch-lever of the current-regulator is turned from the idle contact-plate onto the other plates, and from one to the other of the latter until the requisite current is passed through the rivet to bring it to the desired degree of incandescence, as fully explained in my aforesaid applications, after which the heading-die is further depressed to upset the softened end of the rivet-shank and form a head thereon, which is molded by the cavity in said die. The current may be maintained throughout the riveting operation, or it may be regulated as desired, or be turned off at any time during the operation of riveting, as the character of the work may require.

In the machine thus far described the frame-work constitutes the proximate source of the heating-current, being, in fact, an inductional transformer, the induced or secondary circuit of which is composed of a single heavy bar of copper or other good conductor of heat and electricity. The machine may thus be transported and set up at any place without in any way or manner disturbing its electrical connections, except that the two feeding-conductors 18 18 must be disconnected from and then again connected with the main charging-circuit 19 19. In addition to this advantage, there is the further advantage of utilizing the material unavoidably used for the frame-work of the machine for the important purpose of transforming the currents of high tension furnished by the primary source—such as a dynamo—into currents of the requisite low tension. After the riveting operation has been repeated a number of times the heading-die and anvil become heated, partially from the passage of the heating-current through their contiguous ends and partially from contact with the incandescent rivets. The heating of the die and anvil is very objectionable and renders the operation of riveting inconvenient and uncomfortable, and to overcome this objectionable feature I apply a cooling medium to the said die or anvil, or to both of them, in any suitable manner. In Fig. 1ª there is shown a pipe 26, leading from a source of cold-air supply, (not shown,) and provided with a nozzle 27, constructed to direct an air-jet against the lower end of the heading-die; and there is also shown another pipe 26′, leading from the same source of air-supply and provided with a nozzle 27′ for directing an air-jet against the upper end or head of the anvil. It will be understood that I am in no manner confined to the use of air-jets for cooling the heading-die or anvil, and in lieu thereof I may use such means as are hereinafter described in relation to other forms of riveting-machines, or I may use any other means for the purpose, since my invention in this particular is designed to prevent undue heating of the heading-die or anvil.

Referring now more particularly to Fig. 1ᵇ, together with Figs. 4 and 5 of the drawings, there is shown a casting 28, provided with projecting arms or brackets 2, 3, and 29, one above the other. The arm 3 carries an anvil 14, similar to the anvil shown and described in relation to Fig. 1ª—that is, it has an expanded head 15, with an insulating-facing 17′ and a cavity for receiving a rivet-head, depending side wings 15′ straddling the bracket 3, and an adjusting screw-rod 16,

with its hand-wheel 17 for raising and lowering the anvil. In the present instance, however, the anvil is insulated from its support by a bushing 30 of insulating material seated in the bracket 3, and through a nut in said bushing the screw-rod 16 extends, and the inner faces of the wings 15′ are covered with insulating material, as indicated by heavy lines. The anvil is provided below the head 15 with a perforation for the reception of the end of a conductor 31, and a set-screw 32 entering said perforation serves to bind the conductor firmly in the said perforation in the anvil. As stated before with reference to Fig. 1ª, any suitable means may be employed to cool the anvil during the operation of riveting, and in the apparatus shown in Fig. 1ᵇ the anvil is provided for this purpose with two perforations 30, connected together at one end by a coupling-pipe 31′ and at the other end connected, respectively, to an inlet-pipe 32′ and an outlet-pipe 33′. A cooling agent—such as water or ammonia—coming from a reservoir not shown, is made to flow through the pipe 32′, from whence it will pass through one of the perforations 30′, and by means of the coupling 31′ to the other perforation 30′, from which it will escape through the pipe 33′. The cooling agent will absorb heat from the anvil and will maintain the latter at a moderate temperature during the operation of riveting. The arm or bracket 2 serves as a guide for a reciprocating heading-die 33, reduced at its lower end to a frusto-conical form, and there provided with a cavity for molding a rivet-head similar in this respect to the heading-die 11 shown in Fig. 1ª, and at the upper end the heading-die is attached to one link of a toggle 34, the other link of which is pivoted to the arm or bracket 29 of the casting 28. The toggle is connected for operation with a piston-rod 35, driven by a suitable piston within a cylinder 36, formed in the casting 28. Steam or compressed air is admitted to the cylinder through a pipe 37, having a valve 38 of the familiar globe type, and provided with a hand-wheel 39. In the pipe 37, between the cylinder and the valve 38, is another valve 40, constructed to admit steam in front of or behind the piston when actuated by a valve-rod 41. Depending from and secured to the bracket 2 by bolts or screws 42 is a jacket 43 surrounding and inclosing a portion of the heading-die, and having a perforation in the bottom through which the die passes, and at which point the jacket is provided with a gasket 44 to form a fluid-tight connection between the said jacket and die at the perforation. A cooling agent—such as water or ammonia—is introduced into the jacket by means of a supply-pipe 45 coming from a reservoir or pump (not shown) and entering the jacket near the bottom, and after circulating around the portion of the die inclosed by the jacket the fluid escapes through a pipe 46, from which it is returned to the said reservoir or pump or is allowed to waste. It will be readily understood thai the cooling agent constantly flowing through the jacket will absorb the heat generated in the die during the operation of riveting, and the die will thereby be maintained at substantially the normal temperature. I may with advantage use air-jets, hereinbefore described in the machine shown in Fig. 1ᵇ, in place of the liquid-circulating devices, or I may use any other suitable means for the purpose. Near the lower end of the heading-die is a perforation for the end of a conductor 47, which is held therein by a set-screw 48. Embracing the lower end of the heading-die are two laterally-curved legs 49, having their lower edges coated with insulating material 50. These legs do not entirely encircle the die, there being a space between their opposing edges for the passage of the conductor 47, as clearly shown in Fig. 5, and the said legs extend downward from the bottom of the jacket 43, being either integral therewith, as shown, or attached thereto in any suitable manner. The casting 28, together with the anvil and die carried thereby, is secured on the top of a suitable table 51, one of the end supports or legs 52 of which are shown. Supported between the legs of the table is an inductional transformer 53, from the thick-wire secondary coil of which extend the conductors 31 and 47, and the fine-wire primary coil of the transformer receives the current from the derived circuit-wires 54 54, leading from the main dynamo-circuit 19, or in any other suitable manner. One of the wires 54 includes a current-regulator, which may be identical with that shown in Fig. 1ª, and is supported by a plate 55, depending from the end of the table 51. On the face of this plate is mounted the switch-lever 23 and the series of contact-plates 21, which latter are connected with resistance-coils mounted on the inner face of the plate 55 and hidden from view thereby. The regulator is provided with an idle contact-plate 24, and the lever 23 and contact-plates 21 are in circuit with one of the feeding-wires 54 and its continuation 54′, leading to the transformer, respectively. Binding-posts 56 on the leg 52 and plate 55, and forming the terminals of the regulator and one of the terminals of the transformer, are provided for convenience in attaching the feeding-wires. Below the transformer and within convenient reach is a pedal 57, pivoted at one end between the legs 52 of the table 51 in any suitable manner, (not shown,) and at the other or free end provided with a step 58. This pedal is connected to the valve-rod 41, controlling the valve 40, and is held normally elevated by a spring 59, attached to some fixed portion of the frame of the machine. When the treadle is elevated, the valve 40 is in a position to admit steam in front of the piston, in which case the toggle will be actuated to elevate the heading-die, and when the treadle is depressed the valve 40 is moved to admit steam behind the piston, in which case the

toggle will be actuated to depress the heading-die.

The operation of the machine shown in Fig. 1[b] will now be understood. The plates 5 6 to be riveted together, with the rivet-blank in position, are placed on the anvil and elevated with the same by turning the hand-wheel 17 until clamped against the lower insulated ends of the legs 49 in the same manner hereinbefore described with reference to the operation of the machine shown in Fig. 1[a] of the drawings. The treadle is now slightly depressed and moves the valve 40 in a direction to admit sufficient steam or compressed air behind the piston to actuate the toggle and depress the heading-die until in contact with the free end of the rivet-blank. The circuit now being completed through the secondary coil of the transformer, conductors 31 and 47, the anvil, heading-die, and rivet-blank, the circuit through the primary coil of the said transformer being preferably maintained closed, a heating-current of electricity is passed through the rivet-blank in the manner hereinbefore described, and also described in my aforesaid applications and patent. When the rivet-blank has been raised to the desired temperature or degree of incandescence, the treadle 57 is further depressed to admit more steam behind the piston, so as to forcibly move the heading-die down upon the softened rivet-blank and upset the latter, the cavity in the die molding a head on the end of said blank, while at the same time the shank of the rivet is upset to completely fill the rivet-holes in the plates 5 and 6, the entire operation being usually completed by one stroke of the die. If the heading of the rivet is not completed by such operation, the die may be raised and again forcibly depressed by a suitable manipulation of the treadle, and repeated, if necessary, until the heading of the rivet is satisfactorily accomplished. During the operation the current may be regulated, as hereinbefore stated, or the current may be discontinued by moving the switch-lever to the dead-contact, or in any other desirable manner. As stated above, the circuit through the primary coil is preferably maintained always closed through the coils of the regulator. Current begins to flow through the rivet the moment contact is completed with the dies, and the secondary current is then increased by moving the switch-lever to cut out the regulator-coils, thus reducing the counter electro-motive force generated thereby and permitting more current to flow through the primary coil, which, of course, increases the current in the secondary. The regulating-switch may also be set to a certain point for given-sized rivets and the entire heating operation be left to itself. As the ends of the rivets make better contact with the dies as they assume the proper shape, the resistance is gradually diminished and the current automatically increased.

Referring now more particularly to Fig. 2 of the drawings, there is shown a riveting-machine adapted for heavy work, such as riveting steam-boiler plates and the like. There is a heavy U-shaped frame 60, with legs 61 62, normally extending in a horizontal position, and this frame is suspended by chains 63, secured to the upper leg 61, and passing around pulleys 64, mounted in a truck-frame 65, from whence the chains are returned to winding drums or windlasses 66, journaled between standards 67, rising from the said upper leg 61 of the frame 60. Each drum is rotated by means of a crank 68 on one of the ends of the drum-shaft 69, and is held against a reverse movement by a ratchet-wheel 70 on the said drum-shaft, and a pawl 71 on the adjacent standard 67. The truck-frame 65 has the pulleys 64 mounted on its under side near the ends, and directly above said pulleys and on the upper side of the frame are mounted truck-wheels 72, constructed to move on a rail or rails 73. Chains 74 are attached to the ends of the truck-frame 65 and extend to some convenient point where power may be applied to move the truck-frame, together with the frame 60, along the track in either direction to the desired position.

It will be understood that the drums 66 may be manipulated to raise or lower the frame 60 or incline it to any desired angle within the vertical plane marked by the chains 63 and by the two legs of the frame 60. To the free end of the lower leg 62 is secured a bracket 75, carrying a cylinder 76, in which is a piston 77, fitted for reciprocation therein. The piston is actuated by steam or compressed air admitted through a pipe 78 into a valve-chamber 79, from whence it is directed above or below the piston by a slide-valve 80, controlled by a valve-rod 81, which may be manipulated by hand or otherwise. The cylinder, together with the piston and means for admitting steam to the cylinder, being of common and well-known construction, no further description thereof is necessary. The anvil 14 in this machine is cylindrical in form and constitutes the piston-rod entering the cylinder 76 through a stuffing-box 82, and at its lower end being reduced and passed through the piston and clamped thereto by a nut 83, which latter is screwed onto the lower end of the anvil-stem, which is screw-threaded, as shown, for the purpose. The anvil is insulated from the frame 60 by a bushing 84 of insulating material interposed between the reduced end of the anvil and the piston through which it passes, and by another bushing 85 of insulating material, which may also serve as packing surrounding the anvil-stem where it passes through the stuffing-box. The upper end of the anvil has formed on it an expanded head 15′, having a facing 17′ of insulating material and a cavity for the head or end of a rivet-blank, similar to and for the same purpose as hereinbefore described with reference to the anvils shown in Figs. 1[a] and 1[b]. Below the head 15′ the anvil is provided with a perforation for the recep-

tion of the end of a conductor 86, leading from a source of electricity capable of producing a low-tension current of great quantity, and which may be a transformer similar to either of those shown in Figs. 1[a] and 1[b], or of any other suitable form, or a suitable dynamo or secondary battery. The conductor is clamped to the anvil by a set-screw 87 entering the aforesaid perforation in the anvil. To the free end of the upper legs 61 of the frame 60 is secured a bracket 88, having an upwardly and a downwardly projecting arm 89 and 90, respectively. The arm 89 of the bracket 88 carries a steam-cylinder 91, constructed to cause the automatic reciprocation of a steam-hammer 92, forming the piston and piston-rod, when steam or compressed air is admitted to the cylinder 19 through a pipe 93.

It is not necessary to describe in detail the construction of the steam-hammer, since the same forms no necessary part of my invention, for the purposes of which it is of no consequence how this steam-hammer is constructed, so long as it is reciprocated under the action of the steam or compressed air admitted by the pipe 78. I have therefore shown in the drawings a steam-hammer of ordinary construction, which may be changed in various ways without affecting the principle of operation which forms the basis of my invention. The steam-hammer cylinder 91 is provided with a neck 94, through which extends the rod 95, forming a part of the hammer, and the free end of which constitutes the hammer-head. The arm 90 of the bracket 88 is provided with a horizontal extension 96, having a vertical passage for a heading-die 97, the latter consisting of a cylindrical body reduced at the lower end to a frusto-conical shape and there provided with a head-molding cavity, (indicated by dotted lines,) and at the upper end, above the extension 96, the said die is provided with a buffer 98, of rawhide or other noise-deadening material, in line with the head of the hammer 92. Below the buffer 98 the die is encircled by a collar or flange 99, against the top of which bears the lower end of a coiled spring 100, encircling the said die and bearing at its upper end against the lower end of the neck 94, the said spring tending at all times to depress the die. Projecting from one side of the die, near its lower end, is a pin 101, extending through a slot 102 in the side of the extension 96 of the bracket-arm 90 and in the path of the shorter arm 103 of an angle-lever 104, pivoted to the said arm 90, and constructed to be manipulated by hand. The lever 104 is held with its shorter arm in a normally-depressed position by a retractile spring 105, as shown. It will be evident that when the longer arm of the lever is depressed the shorter arm will be raised, and, acting upon the pin 101, will elevate the heading-die against the action of the spring 100 and above the position shown in the drawings. Depending from the extension 96 of the bracket-arm 90 are two legs 106, each with a facing 107 of insulating material on their lower ends. These arms constitute the fixed member of a clamp, the movable member being the anvil before described, and it will now be understood that two plates 5 6 to be riveted together may be placed over the anvil with a rivet-blank in place in matched rivet-holes in the said plates, and that steam or compressed air may be introduced into the cylinder 76 below the piston 77, when the anvil will be raised and force the said plates against the insulated lower ends of the legs 106, and thereby clamp them firmly together between the said anvil and legs. A conductor 108, leading from a transformer or other source of electric energy from which the conductor 86, before mentioned, leads, is connected to the upper leg 61 by a set-screw 109, or otherwise. To insure good electric connection between the movable heading-die and the portion of the bracket 88 through which it is passed, and which is in circuit with the conductor 108, there are contact-brushes 110, secured to the bracket-extension 96 at the sides of the heading-die, and bearing at their free ends directly on the said heading-die, so as to have a sliding contact therewith when the heading-die is moved in a longitudinal direction.

The operation of a riveting-machine constructed as shown and described with reference to Fig. 2 is as follows: The entire apparatus is first adjusted by means of the supporting-truck and the windlasses, in the manner before described, until the anvil is below matched rivet-holes in the plates in which a rivet-blank is inserted. The heading-die is then elevated by manipulating the lever 104, after which steam or compressed air is admitted into the cylinder 76, below the piston 77, and the anvil is raised, thereby clamping the plates firmly against the insulated lower ends of the legs 106. The lever 104 is now moved to its normal position and the heading-die is forced downward by the spring 100 into intimate contact with the upper or projecting end of the rivet-blank. When the parts are in the position just described, there is an electric connection from the conductor 86 to and through the anvil, rivet, and heading-die, and by the contact-brushes 110 to the upper leg 61 and the conductor 108. The current is now turned on and controlled by a suitable regulator, (not shown,) which may be constructed in the same manner as those described with reference to Figs. 1[a] 1[b], until the rivet is heated to the desired state of incandescence. Steam or compressed air is now admitted through the pipe 93 to the cylinder 91, the hammer is automatically reciprocated in a manner well understood, and a rapid succession of heavy blows is struck on the upper end of the heading-die, thus upsetting the softened rivet-blank and forming a head thereon. In order to maintain the heading-die and anvil at an approximately normal

temperature, air-jets are directed against them by pipes 26 26′, respectively, which may be similar to those described with reference to Fig. 1ª of the drawings, and are provided with nozzles adjacent to the said die and anvil; but I may use any other suitable means for the purpose of cooling the anvil and die, and I am, therefore, not confined to the use of air-jets in connection with the machine illustrated in Fig. 2.

It will be observed that in each machine hereinbefore described the face of the anvil and the lower ends of the legs, forming the two members of the clamp for holding the plates together, are shown with a facing of insulating material, which, however, may be applied directly to the plates around the rivet-holes, a coating of mineral paint or other similar substance giving good results. By this means the current passing between the anvil and heading-die is confined to the rivet, and the plates, therefore, remain comparatively cold during the operation of riveting, and are not compressed or distorted when the rivet-blank is upset.

In the use of the different forms of apparatus hereinbefore described, the anvil and heading-die, being used at the same time as the terminals of the circuit-carrying current of great quantity for heating the rivet, are themselves readily heated, and unless provision were made for cooling these dies and anvils they would soon soften to such an extent as to render their continued use impracticable. For this reason the heat-abstracting or refrigerating devices hereinbefore described are used; and it will be understood that I am not at all confined to the use of the refrigerators shown in this case, since any other means for abstracting the heat from the dies and anvils may be employed.

In order to prevent as much as possible the heating of and to more readily abstract the heat from the working ends of the dies and anvils, the same are preferably made of a metal of high conductivity for both heat and electricity, and especially, when possible, of greater conductivity for heat and electricity than the rivets employed. If iron rivets are used, the working ends of the die and anvil may be made with advantage of phosphor-bronze, aluminium bronze, or any other suitable alloy of copper, and in all cases the cross-sections of both the die and anvil are made much larger than that of the rivet.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. In an electric riveting apparatus, the combination, with a heading-die, of an anvil adjustable to and from the die and an electric circuit including said die and anvil, substantially as described.

2. In an electric riveting apparatus, the combination, with a heading-die and anvil, of a clamp for the articles to be riveted and an electric circuit including the said die and anvil, substantially as described.

3. In an electric riveting apparatus, the combination, with a heading-die, of an anvil adjustable to and from the die, a clamp for the articles to be riveted, one jaw of which clamp is formed by the anvil, and an electric circuit including said die and anvil, substantially as described.

4. In an electric riveting apparatus, the combination, with a heading-die, of a clamp for the articles to be riveted, one jaw of the clamp consisting of legs at the sides of the die, an anvil adjustable to and from the die constituting the other jaw of the clamp, and an electric circuit including said die and anvil, substantially as described.

5. In an electric riveting apparatus, the combination, with a heading-die, of an anvil, a clamp for the articles to be riveted, one jaw of which clamp is formed by the anvil, a layer of insulating material interposed between the working-faces of the clamp-jaws and the articles clamped, and an electric circuit including the die and anvil, substantially as described.

6. In an electric riveting apparatus, the combination, with a heading-die, of an anvil, a clamp for the articles to be riveted, one jaw of which is formed by the said anvil and provided with a layer of insulating material on the working face of each jaw, and an electric circuit including the anvil and die, substantially as described.

7. In an electric riveting apparatus, the combination, with a heading-die and anvil forming the terminals of an electric circuit, of a refrigerator for cooling said die and anvil, substantially as described.

8. In an electric riveting apparatus, the combination, with a heading-die and anvil forming the terminals of an electric circuit, of pipes provided with nozzles for directing a cooling agent against the working ends of said die and anvil, substantially as described.

9. In a machine for heating metals electrically preparatory to shaping the same, the combination of a ring-shaped bar constituting the supporting-frame of the machine and also the secondary of an inductional transformer, with the primary of such transformer applied to said bar, and a shell or envelope of magnetic material for said transformer, substantially as described.

10. In an electric riveting apparatus, the combination, with an inductional transformer constituting the frame-work of the apparatus, of an anvil and heading-die forming the terminals of the secondary conductor of said transformer, substantially as described.

11. In an electric riveting apparatus, the combination, with an inductional transformer constituting the frame-work of the apparatus, and consisting of a fine-wire primary coil and an open frame forming the secondary conductor, of an anvil and heading-die forming

the terminals of said secondary conductor, substantially as described.

12. In an electric riveting apparatus, the combination, with an inductional transformer constituting the frame-work of the apparatus, and consisting of a fine-wire primary coil, an open frame forming the secondary conductor, and a shell of magnetic material for the said primary and secondary, of a heading-die and anvil forming the terminals of said secondary conductor, substantially as described.

13. In an electric riveting apparatus, the combination, with an inductional transformer composed of a fine-wire primary coil and a secondary conductor with adjacent projecting ends, of an anvil and heading-die carried by said ends and a clamp for the articles to be riveted, one jaw of which is formed by said anvil, substantially as described.

14. In an electric riveting apparatus, the combination, with an inductional transformer constituting the frame of the apparatus and provided with a secondary conductor having adjacent projecting ends, of a heading-die and adjustable anvil carried by said ends and a clamp for the articles to be riveted, one jaw of which is formed by the said anvil, substantially as described.

15. In an electric riveting apparatus, a heading-die and anvil constituting the terminals of an electric circuit, composed of an alloy of copper having higher specific conductivity than the metal of the rivet operated upon, substantially as described.

16. In an electric riveting apparatus, the combination of a heading-die and anvil composed of a metal of higher specific conductivity than that of the rivet operated upon, with guides and supports for the anvil and die, composed of a metal of inferior electric conductivity, substantially as described.

17. In an electric riveting apparatus, a heading-die and anvil composed of aluminium bronze having higher specific conductivity than the metal of the rivet operated upon, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ELIAS E. RIES.

Witnesses:
JNO. T. MADDOX,
LEOPOLD RIES.