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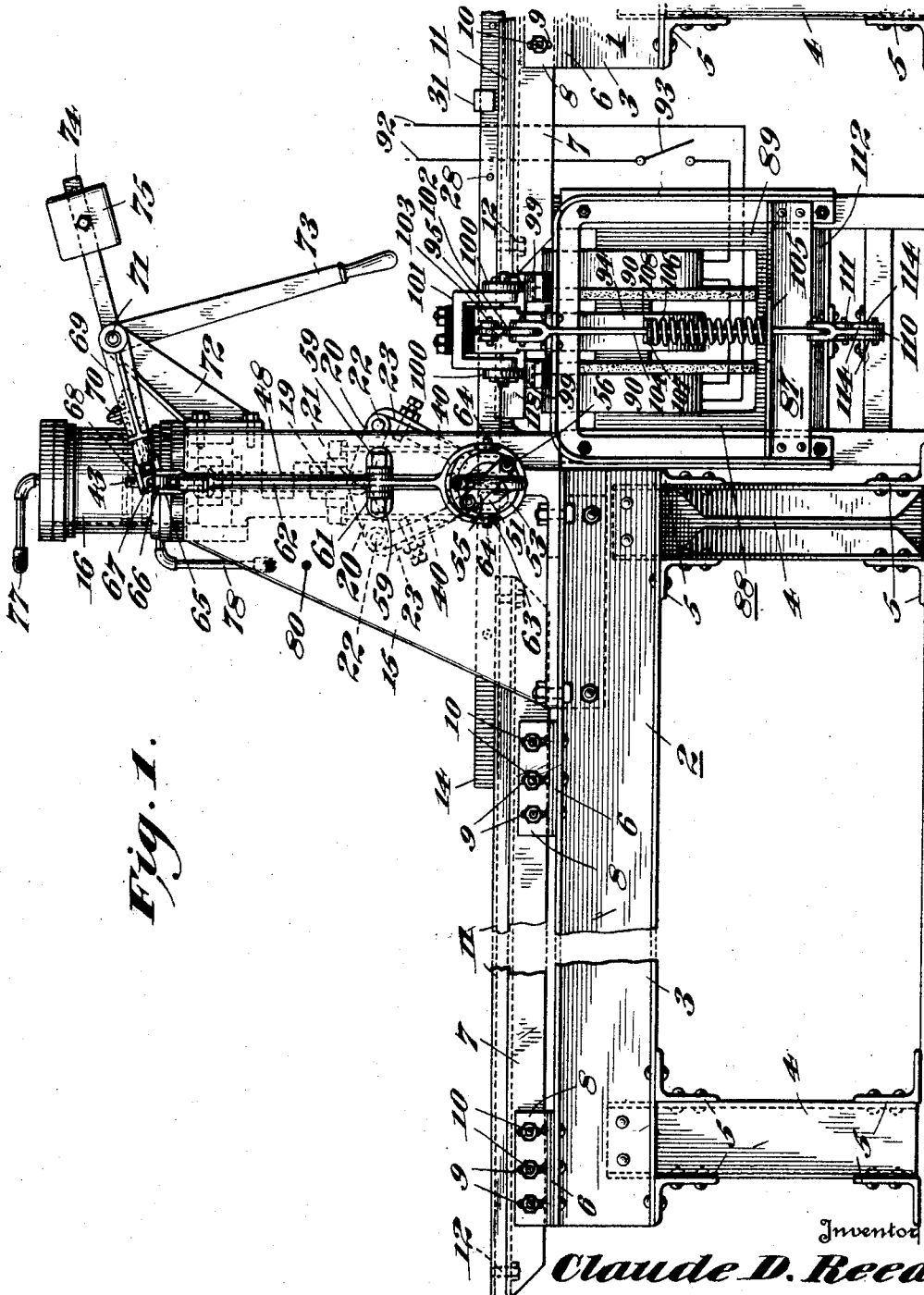
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1,901,334

APPARATUS FOR FORMING LADDERS

Filed June 11, 1930

5 Sheets-Sheet 1



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March 14, 1933.

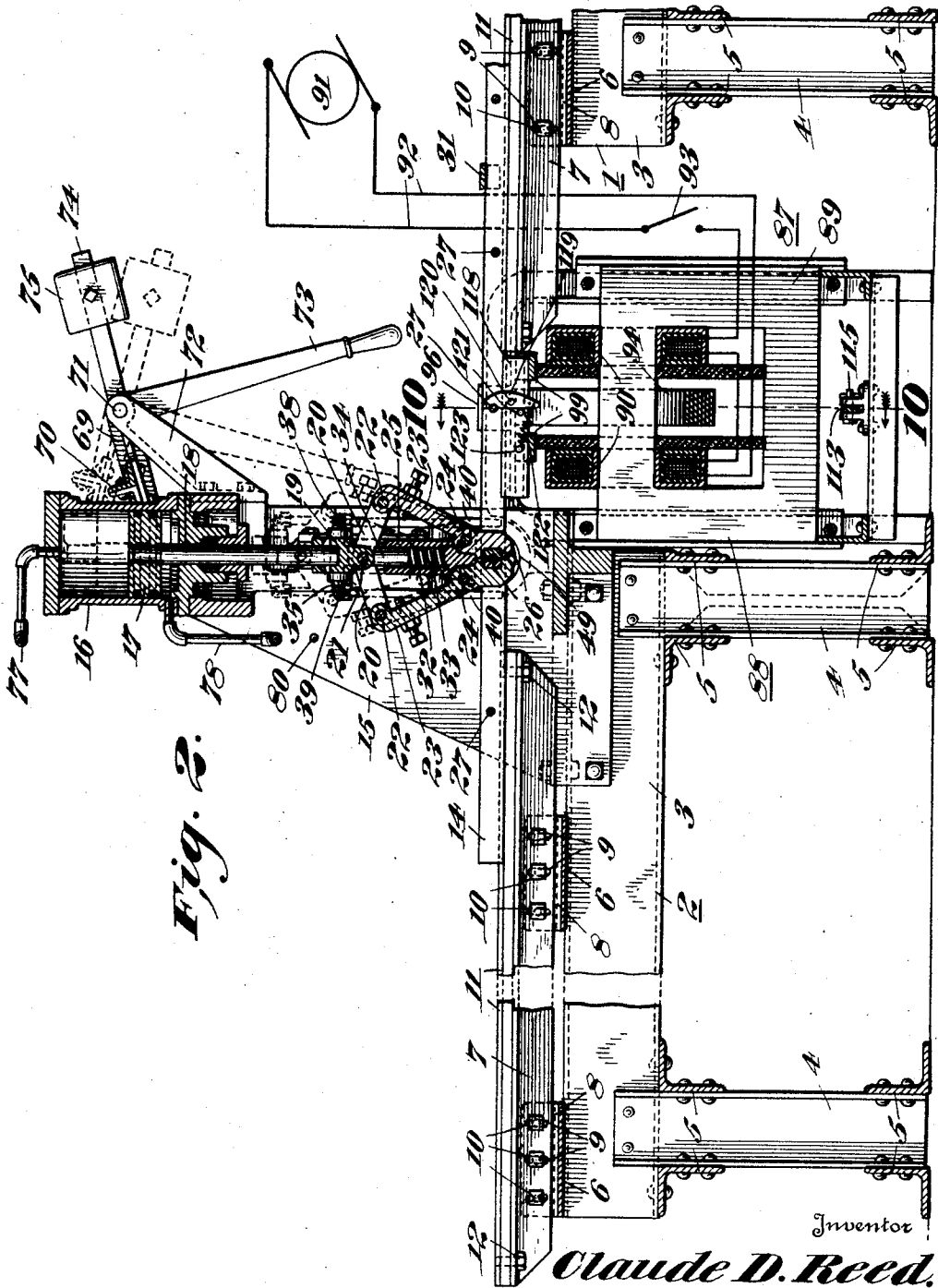
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APPARATUS FOR FORMING LADDERS

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5 Sheets-Sheet 2



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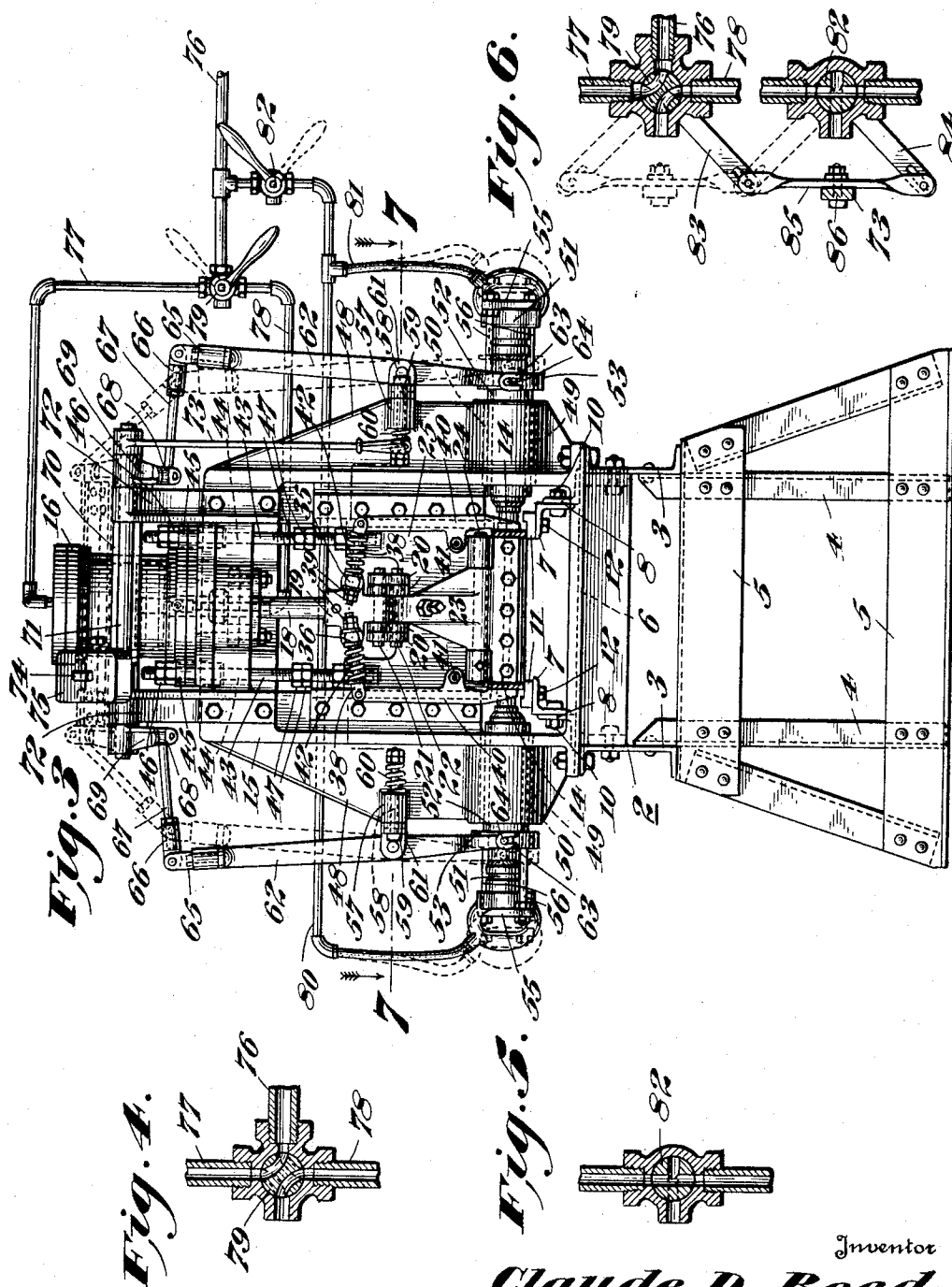
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APPARATUS FOR FORMING LADDERS

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5 Sheets-Sheet 3



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APPARATUS FOR FORMING LADDERS

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5 Sheets-Sheet 4

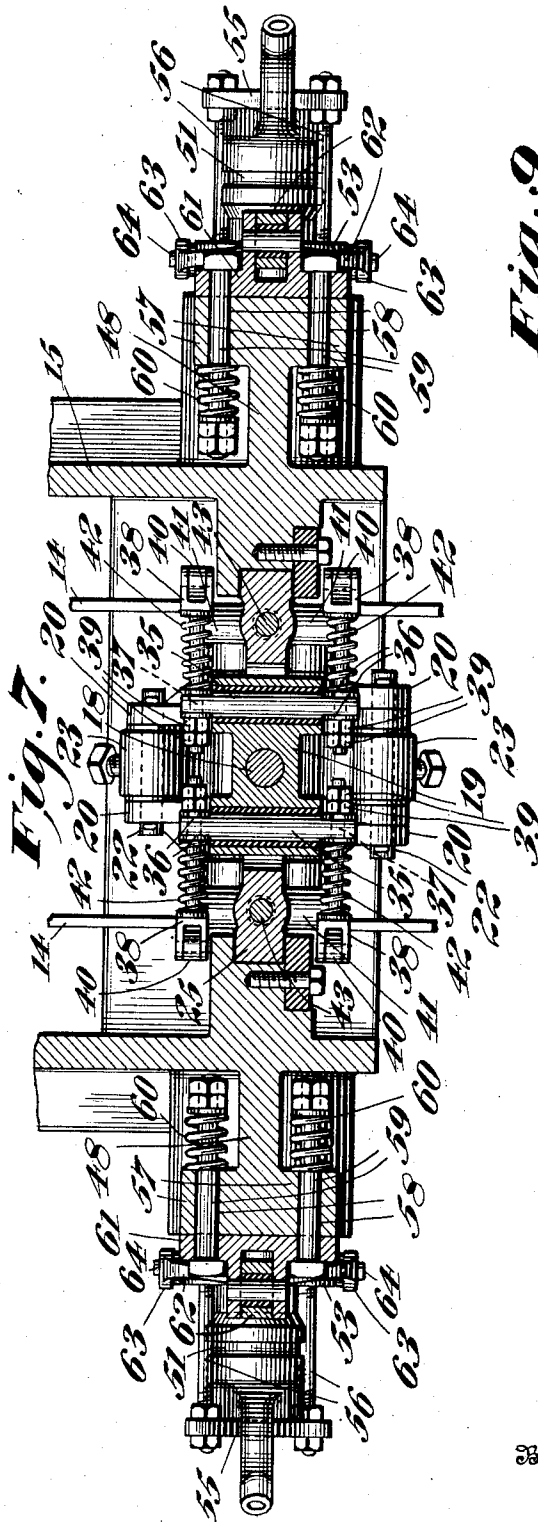


Fig. 7.

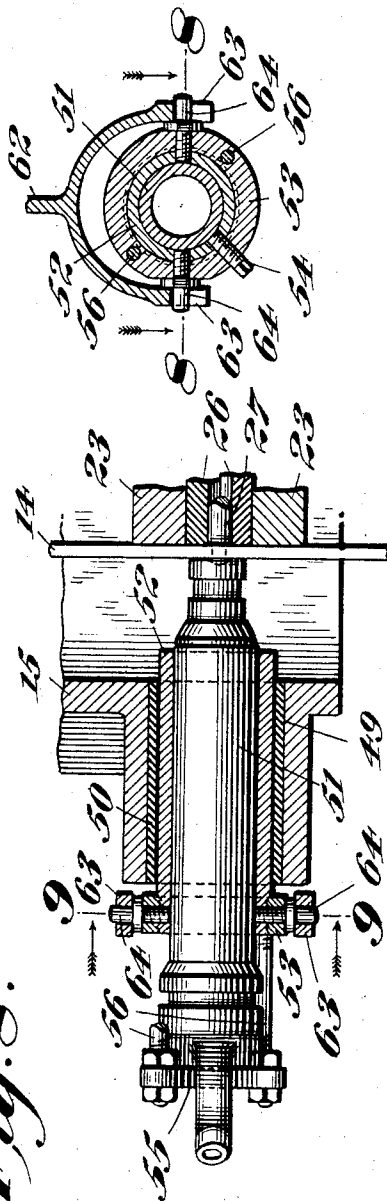


Fig. 8.

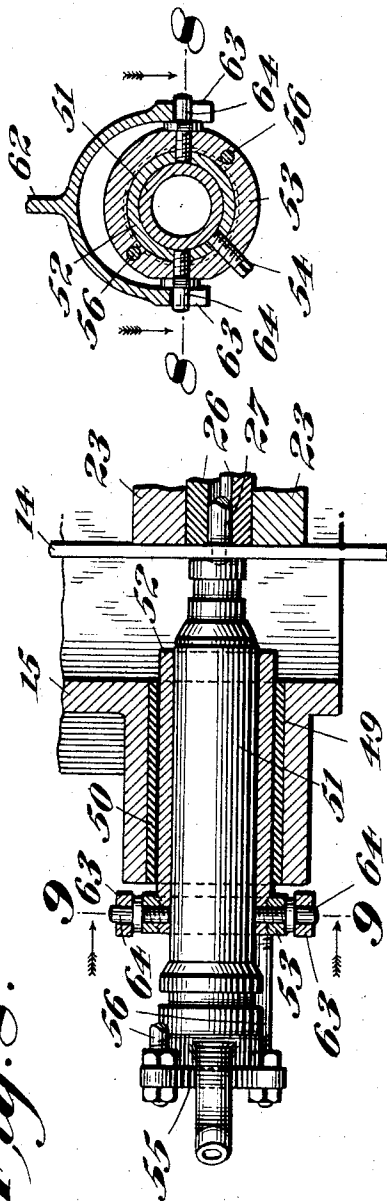


Fig. 9.

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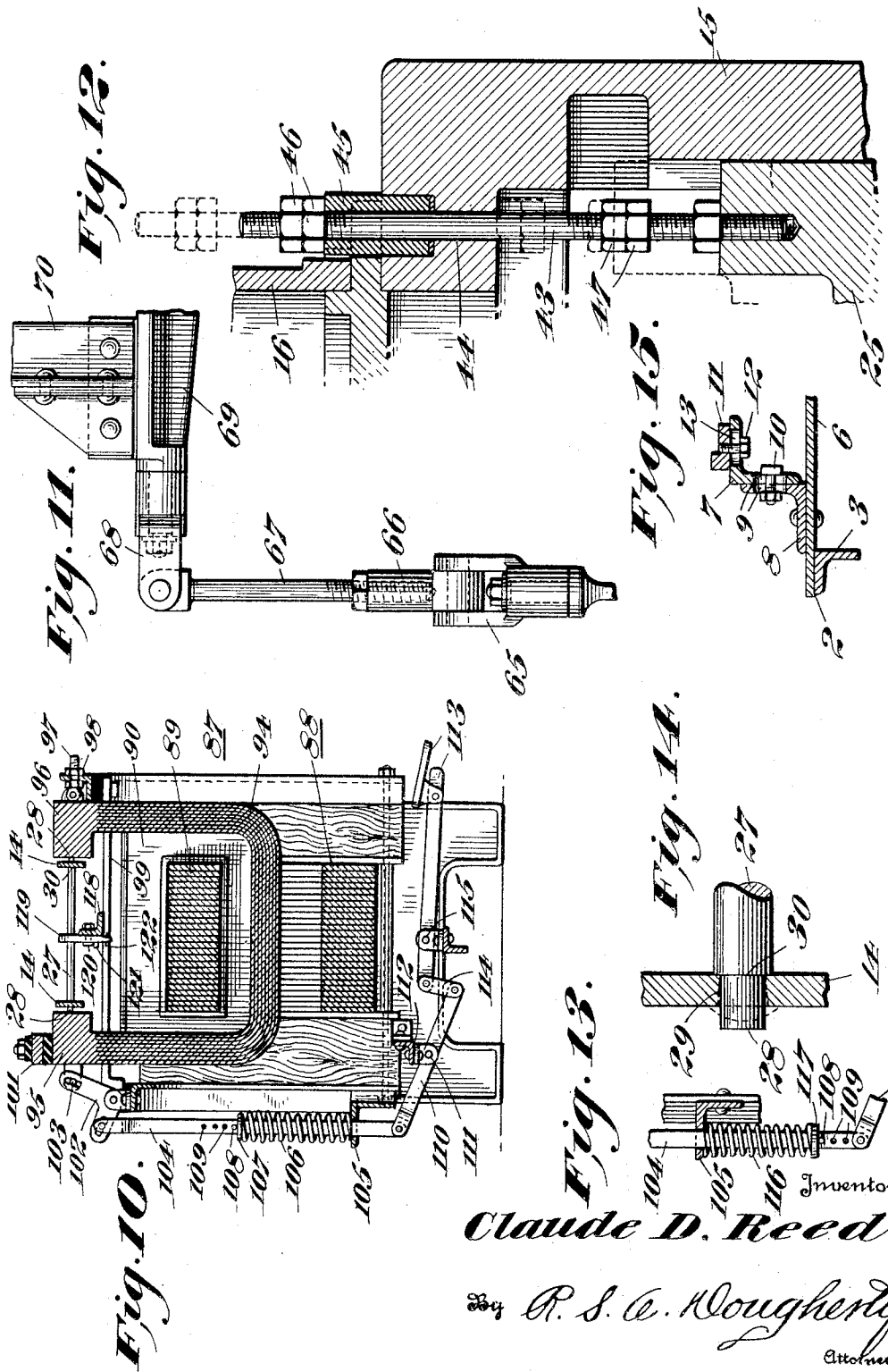
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APPARATUS FOR FORMING LADDERS

Filed June 11, 1930

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

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APPARATUS FOR FORMING LADDERS

Application filed June 11, 1930. Serial No. 460,385.

My invention relates to an apparatus for assembling or fabricating metal articles, as by riveting, and more particularly to the manufacture of ladders.

One of the objects of my invention is to provide a machine whereby the ends of the rungs or rounds of the ladder are heated and riveted to both of the side stringers simultaneously.

Another object of my invention relates to positioning and clamping of the assembled ladder during the electrically heating and riveting operations, the entire length of the rung between the stringers being enclosed thereby preventing driving back the stock in the rung, during the riveting operation.

A further object of my invention is to provide a machine for forming ladders which permits of quick and easy shifting of the incomplete ladder from the position of one rung, or one pair of rungs, the ends of which are adapted to be heated and upset, to that of another.

Another object of my invention relates to the method and means for heating the ends of the rungs, and to the mechanism operated by fluid pressure for clamping the assembled ladder during the riveting operation, which allows for quickly releasing and shifting the assembled ladder at the end of each heating and riveting operation.

Another object of my invention relates to the manner of automatically controlling the clamping and riveting mechanism.

Another object of my invention relates to the manner of adjusting the guiding bars for the stringers, and for positioning the assembled ladder during the heating and riveting operation and its passage through the machine.

Still another object of my invention relates to the manner of assembling the side stringers and rungs having reduced ends to form an assembled ladder while cold, initially securing the parts together by means of portable clamps, electrically heating both ends of one of the rungs at one operation to a semi-plastic condition, advancing the assembled ladder the distance equal to the space between a pair of rungs and then simul-

taneously upsetting both ends of the previously heated rung.

Other objects of my invention will appear hereinafter.

Having thus given a general description of my invention, I will now, in order to make the matter more clear, refer to the annexed five sheets of drawings forming a part of this specification and in which like characters of reference refer to like parts.

Figure 1 is a side elevation of my improved machine with parts of the assembling and runout tables broken away.

Figure 2 is a vertical longitudinal section taken substantially on the center line of the machine shown in Fig. 1.

Figure 3 is a front end elevation of that portion of the machine for clamping the assembled ladder and upsetting the ends of the rungs.

Figure 4 is a detail view in section of the four-way valve for controlling the fluid pressure to the cylinder for operating the clamping devices.

Figure 5 is a detail view in section of the three-way valve for controlling the fluid pressure to the riveting hammers.

Figure 6 illustrates the valves shown in Figs. 4 and 5 connected to the control lever for advancing and retracting the riveting hammers in such a manner as to allow the parts to operate simultaneously at one operation.

Figure 7 is a horizontal section drawn on a larger scale, through the clamping and riveting machine taken on the line 7—7 of Fig. 3.

Figure 8 is a detail section view taken on the line 8—8 of Fig. 9 showing the manner of mounting one of the riveting hammers.

Figure 9 is a vertical transverse section taken on the line 9—9 of Fig. 8.

Figure 10 is a vertical transverse section through the electric heater taken on the line 10—10 of Fig. 2 with the refractory sheet removed to more clearly show the manner of construction.

Figure 11 is a detail showing the manner of connecting one of the crank arms to one of the yoke levers.

Figure 12 is a detail view illustrating the manner of adjusting the stroke of the cross-head.

Figure 13 is a detail modification illustrating a spring mounted on the connecting rod for operating the movable electrode in such a manner as to normally hold the electrode away from the article to be heated.

Figure 14 is an enlarged detail view illustrating the manner of connecting the ends of the rungs to the side stringers, and Fig. 15 is a detail view illustrating the manner by means of which the guides for the side stringers on the assembling and runout tables may be adjusted.

Referring now to the characters of reference on the drawings:—The numeral 1 indicates the assembling table and 2 the runout table, each similarly constructed of structural steel having spaced channel sides 3 and legs 4 connected together by means of angles 5. The channel sides 3 are further connected together at the tops by means of spaced plates 6. Angular guide supports 7 are attached to each side of the top of the tables and secured to plates 6 by means of angular brackets 8. The vertical legs of the brackets 8 and guide supports 7 are slotted as at 9, which allows for vertical adjustment of the guide supports 7 by means of the bolts 10. Guides 11 are mounted on the top of the horizontal legs of the guide supports 7 and are secured by means of set bolts 12 passing through slots 13 whereby lateral adjustment of the guides may be obtained. The upper surface of the guides are stepped or formed with a short flange along their outer edges in order to hold the side stringers 14 of the ladder in proper alignment. Mounted on the inner end of the runout table 2 and secured to, and connecting the side channels 3 together is the frame 15 of the clamping and riveting machine, having a fluid pressure cylinder 16 centrally mounted thereon, in which reciprocates the piston 17 having a piston rod 18, to the lower end of which is keyed a wrist block 19, having the inner ends of links 20, pivoted thereto as at 21, the opposite ends of said links being pivoted as at 22 to the upper ends of gripping arms 23, which are fulcrumed as at 24 to the cross head 25. The inner faces of the lower portions of the gripping arms 23 have gripping jaws 26 attached thereto, the grooved inner faces of which are adapted to surround and engage the rungs 27 of the ladder. These rungs 27 are formed with reduced ends 28 adapted to be inserted in holes 29 formed in the side stringers 14 and are held firmly against the shoulders 30 of the rungs by means of one or more portable clamps 31. A socket 32 is formed centrally in the cross-head 25 for receiving a spring 33 adapted to project a cylindrical plunger 34 against the lower face of the wrist block 19. Wrist pins 35 are jour-

naled in the wrist block 19 the extending ends of which have flattened side faces 36 with perforations 37 formed therein for receiving the threaded ends of clevis bolts 38 having adjusting nuts screwed thereon as at 39.

Side gripping levers 40 are fulcrumed on the cross-head as at 41, the upper end of each side gripping lever being pivoted to the bifurcated heads of the clevis bolts 38, and a spring 42 is mounted on the shank of the clevis bolts to normally project the upper ends of the side gripping levers 40 outwardly and forming a toggle connection between the wrist block 19 and the gripping levers 40.

To limit the vertical movement of the cross-head 25, are rods 43, each having its lower end threaded and secured to each side of the top of the cross-head and extending upwardly therefrom through holes 44 in the top portion of the frame 15. Said holes being enlarged at their upper portions to form sockets for cylindrical bumper blocks 45.

The upper portions of the rods 43 have adjustable nuts 46 threaded thereon adapted to engage the top ends of the cylindrical bumper blocks 45 and limit the downward movement of the cross-head 25, while adjustable nuts 47 are threaded on the intermediate portions of the rods and engage the lower face of the top portion of the frame 15, and limit the upward movement of the cross-head.

The frame 15 has outwardly extending vertical side flanges 48, each having a cylindrical bearing opening 49, with liners or bushings 50 secured therein and in the side frame in horizontal alignment with each other for receiving and supporting pneumatic riveting hammers 51, which may be of any well known construction. A sleeve 52 is attached to the barrel or casing of each pneumatic hammer having a collar 53 extending outwardly around its outer end. The sleeves may be shrunk on the casings of the pneumatic hammers and further held in position by means of a set screw 54, clamp bars 55 and bolts 56.

Extending outwardly on each side of the outer edge of the flanges 48 above the bearing openings 49 are lugs 57, having holes formed therein as at 58 for receiving bolts 59, having relief springs 60, retained in position by means of nuts on the inner ends for movably securing bracket clips 61 to which is pivotally attached at an intermediate point a yoke lever 62, the lower bifurcated ends 63, engaging studs or trunnion extensions 64, attached to the opposite sides of the collars 53 and sleeves 52.

The set of relief springs 60, on the bolts 59 are adapted to relieve the excessive vibrating blows on the housings or frame of the machine caused by the hammers and at the same time allow for any displacement in moving the hammers against the work.

The upper end of each of the yoke levers

62 have mounted thereon a swivel jaw 65, pivoted to a link adjuster 66, which is attached to the threaded end of an eye bolt 67, the head of which is pivoted by means of a swivel jaw 68 to the outer end of crank arms 69, which are connected together by means of an angular brace 70, and mounted on the outer ends of an operating shaft 71, and journaled in brackets 72 secured to the frame 15, in which manner a universal connection or coupling is formed between the upper ends of the yoke levers 62 and the operating shaft 71. A control lever 73 is keyed to the outer end of the operating shaft and in order to assist in holding the heading tools of the pneumatic hammers against the work being riveted and to facilitate in the case of operating the machine a lever 74 is also mounted on the operating shaft having an adjustable counterweight thereon as at 75. The main fluid supply pipe is indicated by the numeral 76, the supply of which to the cylinder 16 through pipes 77 and 78 is controlled by means of a four-way valve 79, while the supply of fluid pressure to the pneumatic hammers 51, is controlled through pipes 80 and 81, by means of a three-way valve 82. The control lever 73, three-way valve 82 and four-way valve 79 may be operated separately as illustrated in Fig. 3 or simultaneously as indicated in Fig. 6, in which the handles 83 and 84, attached to the stems of the four-way and three-way valves respectively are connected by means of a link 85 which is pivoted centrally as at 86, to the control lever 73. It will be noticed however, that in Fig. 6, the entrance ports in the four-way valve casing for the pipes 76 and 77 are made of larger diameter in order to allow the passage of fluid pressure to the cylinder 16 and operate the clamping arms so the jaws will engage and clamp the rungs of the ladder before the riveting hammers 51 are brought into action. These valves may be otherwise arranged or adjusted if desired in order to vary or give a greater space of time between the opening and closing of the valves in relation to each other.

An electric heater 87 is provided between the assembling table 1, and the runout table 2, comprising a transformer 88, having a soft steel or iron core 89, of laminated structure, upon one side of which coils 90 in the primary circuit are mounted, and supplied with an electric current from a generator 91, through the circuit 92 which may be controlled by means of a switch 93. The secondary circuit is formed by means of a plurality of flat copper strips 94 of metal bent U-shaped the laminated structure extending through the center of the core 89, the ends extending upwardly therefrom, and having solid electrodes 95 and 96 of copper formed integral therewith. Electrode 96 is stationary and secured to the frame of the heater by means of an eye bolt 97 and nuts 98, while

electrode 95 is movably mounted and supported on the tracks 99 by means of rollers 100, the axles of which extend from the inverted legs of a U-shaped yoke 101, attached centrally to the movable electrode. A bell-crank lever 102 is pivoted centrally to the top of one of the side frames of the electric heater, one leg of which extends upwardly and is pivoted to the movable electrode 95 as at 103, while the other leg of the bell-crank lever 102 extends horizontally outwardly and is pivoted to the top end of a connecting rod 104 which extends downwardly through an opening in an angle 105 of the side frame, said rod having a spring 106 interposed between the angle 105 and a washer 107, which is adapted to be adjusted by means of a pin 108, inserted in one of the spaced holes 109 formed in the connecting rod 104. The lower end of the connecting rod 104 is pivoted to bar 110, the intermediate portion of which is fulcrumed as at 111 to an angle 112 and the inner end is connected to a treadle 113 by means of short links 114. The treadle 113 is fulcrumed at an intermediate point as at 115 and is adapted when foot pressure is applied to the treadle to move the electrode 95 outwardly and break the contact with the work being heated, and when the foot pressure is released, the spring 106 on the rod 104 projects the movable electrode 95 inwardly to engagement with the work to be heated when the switch 93 is closed and the electric current turned on.

In order to more fully protect the coils 90, refractory sheets of asbestos or the like substance, are inserted between the coils and the laminated strips 94 forming the secondary circuit.

In Fig. 13 I have illustrated the spring 116 and washer 117 on the rod 104 as mounted on the opposite side of the angle 105. In this manner of mounting the spring on the rod 104 the movable electrode 95 will be normally held out of the engagement with the work to be heated. When this construction is used the links 114 will be dispensed with the bar 110 being made longer and pivoted at an intermediate point at 115 and the foot member attached to the opposite end. In this manner when foot pressure is applied to the treadle 113 it will advance the movable electrode 95 inwardly into engagement with the work to be heated.

A short angle 118 is secured centrally on the tracks 99, having a latch 119 pivoted thereto as at 120, and is adapted to be normally held vertically against a stop 121 by means of a spring 122, having one end connected to the lower end of the latch 119 and its opposite end attached to a pin 123, secured to the angle 118.

Having thus given the foregoing general and detailed description of my machine, I will now describe the operation thereof which

is as follows:—The side stringers 14 and rungs 27 are first assembled on the assembling table 1, the reduced or turned ends 28 of the rungs being inserted through holes 29, in the side stringers 14, until the shoulders 30 on the rungs come in contact with the inner faces of the side stringers 14, with the ends of the rungs extending a short distance beyond the outer faces of the stringers as illustrated more clearly in Figs. 10 and 14. One or more portable clamps 31 are then secured to the stringers, for initially holding the assembled parts of the ladder together. The operator places his foot on the treadle 113 and retracts the movable electrode 95 and then advances the ladder by sliding it manually until the first rung passes over the latch 119. The ladder is then retracted slightly until the rung engages the grooved side of the latch 119 to the proper aligned position for the electrodes 95 and 96 to engage the ends of the rungs, the treadle is then released and the switch 93 in the primary circuit closed.

With resistance heating it requires only a few seconds to heat the reduced, or turned end portions of the rungs to approximately 1700 degrees Fahrenheit. The current is then turned off by opening the switch 93, the treadle depressed to retract the movable electrode 95, and immediately the ladder advanced the width of the space between a pair of rungs, and positioned between the electrodes in the proper alignment and the current switched on, and off, as above described, at the same time while the ends of the second rung are being heated, the first rung will be in alignment with the gripping and riveting mechanism.

The operator then turns the four-way valve 79, which controls the supply of fluid pressure to and from the cylinder 16, into the position indicated in full lines in Figs. 3, and 4 whereby fluid pressure will be admitted into the top of the cylinder 16 to advance the piston 17 and cross-head 25 in the down stroke, whereby the rung is clamped between the gripping jaws 26, which are carried by the gripping arms 23 between the side stringers 14.

This same downward movement of the cross-head 25, operates the two pairs of side gripping levers 40, producing a clamping action on the outside of the side stringers 14, and is adapted to hold the inside of the stringers thrust tight against the shoulders 30 of the rungs 27. With the rung tightly clamped in this position, the operator then pulls the control lever 73 and advances both of the pneumatic riveting hammers 51 inwardly, and applies the air by operating the three-way valve 82 heading both ends of the rung at the same time thereby producing a tight fitting joint between the stringers and the rungs.

The parts of the riveting and gripping machine, during this operation will then

be in the positions indicated in full lines in Figs. 1, 2 and 3.

When the control lever 73 is swung into the position indicated in dotted lines in Fig. 2, and the three-way valve 82, and four-way valve 79 are rotated into the position, as indicated in dotted lines in Figs. 3, 4, 5 and 6, the cross-head 25 will be raised, and the rungs and side stringers will be released and the pneumatic riveting hammers 51 retracted.

A continuation of the above sequence of operation is produced on each rung until the ladder is completed.

The heating and riveting operations may be carried on simultaneously or separately if desired.

In Fig. 3 I have indicated the three and four-way valves and control lever as operated separately but as indicated in Fig. 6 these parts may be connected together to operate simultaneously at one operation by movement of the control lever 73.

It will be noticed that the stroke of the cross-head 25 is limited by the nuts 46 and 47 on the rods 43, which allows the excess stroke of the piston to produce the toggle action in gripping the rungs, with the release arranged by the weight of the cross-head and a spring 33, to allow the cross-head to move down before the toggles act. On the back stroke, the toggles will be operated to open the gripping jaws before the cross-head moves up.

The reason for this grip is to firmly hold and center the rung between the side stringers and prevent driving back the stock in the rung in riveting, therefore, producing an absolutely tight joint between the shoulders 30 of the rung 27 and the sides of the stringers.

Although I have described and illustrated my invention in considerable detail, I do not wish to be limited to the exact and specific details thereof as shown and described, but may use such modifications in substitutions for, or equivalents thereof, as are embraced within the scope of my invention, or as pointed out in the claims.

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

1. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, electrodes for engaging and electrically heating both ends of the rungs, and means independent of the electrodes operated by fluid pressure for clamping and attaching the rungs to the side stringers by upsetting the ends of the rungs.

2. In a machine for fabricating metal ladders having a pair of spaced side stringers, spaced perforations formed therein, the perforations formed in one side stringer being assembled in alignment with the perforations formed in the other side stringer, rungs

formed with reduced end portions adapted to be inserted in the perforations and extend beyond the outside of the side stringers, electrodes for engaging and simultaneously heating the ends of the rungs, and means independent of the electrodes for upsetting the ends of the rungs on the outside of the side stringers.

3. In a machine for fabricating metal ladders having a pair of spaced side stringers connected together by rungs, perforations of smaller diameter than the rungs formed in the side stringers, the perforations in one side stringer being assembled in alignment with the perforations formed in the other side stringer, rungs formed with reduced end portions adapted to be inserted in the outside of the side stringers, electrodes for engaging and electrically heating simultaneously both ends of the rungs, and means independent of the electrodes for upsetting the ends of the heated rungs on the outside of the stringers.

4. In a machine for fabricating metal ladders having a pair of spaced side stringers connected together by rungs, perforations of smaller diameter than the rungs formed in the side stringers, the perforations in one side stringer being in alignment with the perforations formed in the other side stringer, rungs formed with reduced end portions adapted to be inserted in the perforations and extend beyond the outside of the side stringer, electrical means for simultaneously heating both ends of the rungs, gripping jaws operated by fluid pressure for enclosing and clamping the rung having the heated ends, and riveting hammers operated independently of the electrical heating means for upsetting the ends of the rungs on the outside of the side stringers.

5. In a machine for fabricating metal ladders having a pair of perforated side stringers, the perforations in one side stringer being assembled in alignment with the perforations formed in the other side stringer, rungs having their ends extending through the perforations and projecting beyond the outside faces of the side stringers, electrical means for simultaneously heating both ends of the rungs without substantially heating the body of the rungs, gripping jaws operated by fluid pressure for enclosing and clamping the rungs between the side stringers, and independent means when the rungs are clamped for simultaneously upsetting both ends of the rungs on the outside of the side stringers.

6. In a machine for fabricating metal ladders comprising an assembling table, means operated by fluid pressure for initially holding an assembled ladder together, guides for supporting an assembled ladder having side stringers and rungs, electrodes for engaging and simultaneously heating both ends of the rungs in sequence, and means independent of the electrodes for simultaneously riveting

both ends of the rungs to the side stringers in sequence after the heating operation.

7. In a machine for fabricating metal ladders, comprising an assembling table, guides on the table for supporting an assembled ladder having side stringers and rungs, electrodes for engaging and simultaneously electrically heating both ends of the rungs of the ladder in sequence, means operated by fluid pressure for clamping the rungs between the side stringers after the heating operation, and means actuated independent of the electrodes for simultaneously riveting both ends of the rungs to the side stringers in sequence after the heating operation.

8. In a machine for fabricating metal ladders, comprising an assembling table and a run-out table, guides on the tables for supporting an assembled ladder having side stringers and rungs initially clamped together, electrodes for engaging and electrically heating simultaneously both ends of each of the rungs of the ladder in sequence, means operated by fluid pressure for clamping the rungs between the side stringers after the heating operation, and a pair of slidably mounted riveting hammers operated by fluid pressure independently of the electrodes for riveting both ends of the rungs to the side stringers in sequence after each heating operation.

9. In a machine for fabricating metal ladders, comprising an assembling table and a run-out table, side stringers and rungs having projecting end portions forming the ladder initially clamped together and supported by the guides on the tables, electrodes for engaging and electrically heating simultaneously both ends of each of the rungs of the ladder in sequence, clamping jaws operated by fluid pressure for clamping the rungs between the side stringers after each heating operation, riveting hammers slidably mounted independently of the electrodes and operated by fluid pressure for riveting both ends of the rungs to the side stringers in sequence after each heating operation, and a latch for holding the ends of the rungs in proper alignment with the electrodes and the riveting apparatus.

10. In a machine for fabricating metal ladders, comprising an assembling table and a run-out table, an electric heating device independently mounted between the tables, and a clamping and upsetting mechanism simultaneously operated by fluid pressure mounted laterally of the electric heating device.

11. In a machine for fabricating metal ladders having rungs and side stringers comprising an assembling table and a run-out table for supporting an assembled ladder, an electric heating device independently mounted between the tables having electrodes adapted to engage and heat the ends of each of the rungs, jaws operated by fluid pressure for grip-

ping and clamping the rungs between the side stringers after the end of each rung has been heated, and means operated independently of the electrodes for upsetting the ends of each rung when gripped by the clamping device.

12. In a machine for fabricating metal ladders, comprising an assembling table and a run-out table, adjustable guides mounted on the table for supporting and guiding an assembled ladder through the machine, said assembled ladder having side stringers and rungs initially clamped together with the ends of the rungs extending beyond the outer faces of the side stringers, an electric heating device mounted between the tables having electrodes adapted to engage and heat the ends of the rungs in sequence to a semi-plastic condition, gripping jaws operated by fluid pressure adapted to clamp the entire length of each rung between the side stringers after the ends of each rung is heated, and riveting hammers actuated independently of the electrodes for upsetting the heated ends of the rungs when the rungs are clamped between the gripping jaws.

13. In a machine for fabricating metal ladders, comprising an assembling table adapted to receive the work, an electric heating device mounted adjacent to one end of the assembling table having electrodes for simultaneously engaging and heating both of the projecting ends of the rungs of an initially assembled ladder, and means independent of the electrodes and mounted adjacent thereto for upsetting the ends of the rungs heated by the electrodes.

14. In a machine for fabricating metal ladders, comprising an assembling table adapted to receive the work, an electric heating device having electrodes mounted adjacent to one end of the assembling table for simultaneously heating both of the projecting ends of each of the rungs of an initially assembled ladder in sequence, and means actuated independently of the electrodes while both of the ends of one rung is being heated for upsetting the ends of the previously heated rung.

15. In a machine for fabricating metal ladders, comprising an assembling table for receiving an initially assembled ladder having side stringers and rungs clamped together with the ends of the rungs extending beyond the side faces of the side stringers, an electric heating device mounted adjacent to one end of the table having electrodes for engaging and simultaneously heating both ends of the rungs of the ladder in sequence as it is fed through the machine, gripping jaws operated by fluid pressure adapted to receive and surround the rungs between the side stringers after the ends of the rungs have been heated, and riveting hammers slidably mounted and operated by fluid pressure independently of

the electrodes for simultaneously upsetting both ends of the rungs.

16. In a machine for fabricating metal ladders, comprising an assembling table and a run-out table, adjustable guides mounted on the table adapted to receive the side stringers of an initially assembled ladder thereon, rungs for the ladder having their ends extending beyond the outside faces of the side stringers, an electric heating device mounted between the tables having electrodes for engaging and simultaneously heating both ends of the rungs in sequence, gripping jaws mounted adjacent to the electric heating device on a reciprocating cross-head and operated by fluid pressure adapted to receive and surround the rungs between the side stringers, side gripping levers pivoted to the cross-head and operated by fluid pressure for gripping the sides of the stringers, and means mounted in alignment with the gripping jaws and operated by fluid pressure for upsetting the heated ends of the rungs.

17. In a machine for fabricating metal ladders, comprising an assembling table and a run-out table for receiving an initially assembled ladder having side stringers and rungs, having projecting end portions, an electric heating device mounted between the tables having electrodes for simultaneously heating both ends of the rungs in sequence, a reciprocating cross-head mounted adjacent to the electric heating device, gripping jaws pivotally mounted on the cross-head adapted to surround the rungs after the ends of the rungs have been heated, levers pivoted to the cross-head for engaging the side stringers, reciprocating means mounted in alignment with the gripping jaws and operated by fluid pressure for simultaneously upsetting both ends of the rungs after the heating operation, and a latch for holding the rungs in proper alignment for engaging the electrodes and upsetting tools.

18. In a machine for fabricating metal ladders, comprising an assembling table, adjustable guides mounted on the table for supporting an initially assembled ladder having side stringers and rungs with projecting end portions, electrodes for simultaneously heating locally both ends of each of the rungs in sequence without substantially heating the rungs between the side stringers, a pair of riveting hammers mounted adjacent to the electrodes, means for positioning the assembled ladders until the heated ends of the rungs are between the riveting hammers, means for advancing and retracting the riveting hammers, a reciprocating cross-head mounted between the riveting hammers, clamping jaws carried by and operated by the reciprocation of the cross-head adapted to enclose the rungs between the side stringers, and means for limiting the reciprocating movement of the cross-head.

19. In a machine for fabricating metal ladders, an assembling table for supporting an initially assembled ladder, a stationary and movable electrode mounted adjacent to one end of the assembling table, a pair of riveting hammers mounted in spaced relation to each other at one side of the electrodes, means for simultaneously advancing and retracting the riveting hammers, a reciprocating cross-head mounted between the riveting hammers, gripping jaws pivoted to the cross-head for enclosing and clamping the rungs of the assembled ladder, and clamping levers pivoted to the cross-head for engaging the side stringers.

20. In a machine for fabricating metal ladders having rungs and side stringers, an assembling table for supporting an initially assembled ladder adapted to be intermittently fed through the machine, an electric heating device mounted adjacent to one end of the assembling table provided with an electrode on each side of the ladder, a treadle for actuating one of the electrodes, a riveting hammer mounted in the side frame on each side of the ladder adjacent to the electrodes, means for simultaneously advancing and retracting the riveting hammers, and side gripping levers and gripping jaws actuated by fluid pressure for simultaneously clamping the side stringers and rungs of the ladder.

21. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, an assembling table having adjustable guides for supporting an initially assembled ladder adapted to be intermittently fed through the machine, portable clamps for holding the parts of the assembled ladder together, an electrode on each side of the ladder arranged in alignment with each other at one end of the assembling table adapted to engage and heat the ends of the rungs, a treadle for actuating one of the electrodes, a riveting hammer mounted adjacent to the electrodes in the side frame of the machine in alignment with each other on each side of the ladder, means for simultaneously advancing and retracting the riveting hammers, fluid pressure means for actuating the riveting hammers for upsetting the ends of the rungs, and side gripping levers and gripping jaws actuated by fluid pressure for simultaneously clamping the side stringers and rungs of the ladder during the upsetting operation.

22. In a machine for fabricating metal ladders, comprising an assembling table for receiving the initially assembled ladder provided with the side stringers and rungs having projecting end portions, a pair of co-acting electrodes mounted adjacent to one end of the assembling table for engaging and heating the ends of the rungs, a pair of co-acting riveting hammers movably mounted

in the frame of the machine at one side of the electrodes for upsetting the ends of the heated rungs, a clamping device operated longitudinally of the machine between the riveting hammers for engaging the rungs, a clamping device operated transversely of the machine on each side of the riveting hammers for engaging the sides of the stringers, and fluid pressure means for simultaneously operating the clamping devices.

23. In a machine for fabricating metal ladders, comprising an assembling table, guides mounted on the table for supporting an initially assembled ladder having side stringers and rungs with projecting end portions, portable clamps for holding the parts of the initially assembled ladder together, a pair of electrodes mounted adjacent to one end of the assembling table for simultaneously heating both ends of a rung, a reciprocating cross-head mounted adjacent to the electrodes, gripping arms pivoted to the cross-head having jaws for engaging the rungs, side gripping levers pivoted to the cross-head for engaging and clamping the sides of the ladder, fluid pressure means for reciprocating the cross-head to clamp or release the assembled ladder, a pair of movable riveting hammers mounted in the frame of the machine in alignment with the gripping jaws, means for simultaneously advancing the riveting hammers into engagement with the ends of the rungs and for upsetting the ends of the rungs, and means for retracting the riveting hammers.

24. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, an assembling table for supporting the assembled parts of the ladder, clamps for initially clamping the assembled parts of the ladder together, electrodes mounted adjacent to one end of the assembling table for heating the ends of the rungs, a pair of riveting hammers mounted at one side of the electrodes for upsetting the ends of the heated rungs, jaws mounted between the riveting hammers for gripping the rungs between the side stringers, and side gripping levers pivoted to the cross-head on opposite sides of the riveting hammers for engaging the sides of the stringers during the upsetting operation and resilient means for releasing the clamping action on the ladder after the upsetting operation.

25. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, an assembling table and a run-out table for supporting the assembled parts of the ladder adapted to be advanced through the machine in a step by step movement, means for initially holding the assembled parts of the ladder together, electrodes independently mounted between the table for heating the ends of the rungs in

sequence, manual means for advancing the ladder after the ends of each rung has been heated between the electrodes, a pair of aligned slidably movable riveting hammers mounted adjacent to the electrodes adapted to upset the ends of the rungs, gripping jaws for engaging and clamping each rung in sequence between the side stringers mounted in alignment with the riveting hammers, clamping levers for engaging the outside of the side stringers on each side of the inner ends of the riveting hammers, a lever for advancing the riveting hammers, and fluid pressure means for releasing the clamping action on the ladder after the upsetting operation.

26. In a machine for fabricating metal ladders comprising side stringers and rungs having projecting end portions, means for initially assembling and clamping the parts of the ladder together, an assembling table, guides mounted on the assembling table for supporting the assembled ladder, electrodes mounted adjacent to one end of the assembling table for heating the ends of the rungs in sequence, a pair of riveting hammers mounted adjacent to the electrodes, manual means for advancing the ladder with its heated ends between the pair of movable riveting hammers in a step by step movement through the machine, fluid pressure means for actuating the riveting hammers for upsetting the ends of the rungs in sequence after each heating operation, a reciprocating cross-head mounted between the riveting hammers, gripping arms pivoted to the cross-head, jaws secured to the lower ends of the gripping arms for enclosing the rungs during the upsetting operation, a fluid pressure actuated piston having a piston rod reciprocated thereby pivotally connected to the cross-head, a wrist block attached to the piston rod and movable independently of the cross-head, a toggle connection between the wrist block and the gripping arms, levers pivoted to the cross-head for engaging the side stringers, and toggle connections between the wrist block and the levers.

27. In a machine for fabricating metal ladders comprising side stringers and rungs having projecting end portions, means for initially assembling and clamping the parts of the assembled ladder together, an assembling table, guides mounted on the assembling table for supporting and guiding the assembled ladder, electrodes mounted adjacent to one end of the assembling table for simultaneously heating the ends of the rungs in sequence to plasticity without substantially heating the body of the rungs between the side stringers, means for supplying and controlling the supply of electric current to the electrodes, a pair of riveting hammers mounted adjacent to the electrodes, manual means for advancing the ladder with its heat-

ed ends in a step by step movement through the machine between the pair of movable riveting hammers, a control lever for simultaneously advancing and retracting the riveting hammers, means for controlling the supply of fluid pressure to the riveting hammers for upsetting the heated ends of one rung while simultaneously heating by means of the electrodes the ends of another rung, a reciprocating cross-head mounted between the riveting hammers, adjustable means for limiting the movement of the cross-head, gripping arms pivoted to the cross-head, jaws secured to the lower ends of the gripping arms adapted to enclose and grip the rungs between the side stringers, a fluid pressure cylinder, means for controlling the supply of fluid pressure to the cylinder, a piston actuated therein having a piston-rod reciprocated thereby pivotally connected to the cross-head, a wrist block attached to the piston-rod and adapted to move independently and in conjunction with the cross-head, link connections between the wrist block and the gripping arms, a pair of levers pivoted to each side of the cross-head for engaging and clamping the side stringers, wrist pins journaled in the wrist block and a resilient connection between the levers and the wrist pins.

28. In a machine for fabricating metal ladders having side stringers and rungs with extending end portions, a pair of tables having guides mounted thereon for supporting and guiding the initially assembled ladder in a step by step movement through the machine, electrodes independently mounted between the tables for heating the ends of the rungs of the ladder, a reciprocating cross-head mounted adjacent to the electrodes, means for adjusting the movement of the cross-head, gripping arms pivoted to the cross-head, jaws secured to the lower ends of the gripping arms adapted to enclose and grip the rungs between the side stringers, a fluid pressure cylinder, means for controlling the supply of fluid pressure to the cylinder, a piston actuated therein by the fluid pressure having a piston-rod reciprocated thereby pivotally connected to the cross-head, a wrist block attached to the piston-rod and adapted to move independently or in conjunction with the cross-head, a pair of side gripping levers pivoted to each side of the cross-head for engaging and clamping the stringers, toggle connections between the gripping arms and the wrist block, and riveting hammers mounted in alignment with the jaws for upsetting the ends of the heated rungs.

29. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, electrodes for heating the ends of the rungs, a pair of riveting hammers movably mounted in bearings in the frame of the machine adjacent to the electrode and operated by fluid pressure, jaws

for clamping the rungs and side stringers of the assembled ladder during the riveting operation, an operating shaft, a connection between each riveting hammer and the operating shaft, a control lever mounted on the operating shaft for advancing or retracting the riveting hammers, and means for controlling the supply of fluid pressure to the riveting hammers.

30. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, tables for supporting the assembled ladder, electrodes for heating the ends of the rungs mounted between the tables, a pair of riveting hammers mounted adjacent to the electrodes and operated by fluid pressure, a sleeve having an outwardly extending collar around its outer end attached to each riveting hammer, trunnion projections extending from opposite sides of each collar, gripping devices for clamping the rungs and side stringers of the assembled ladder, a yoke lever pivoted to a bracket clip resiliently secured to the frame of the machine, a yoke at the lower end of each yoke lever for embracing the collar and having bifurcated ends engaging the trunnion projections, an operating shaft, a universal connection between each of the yoke levers and the operating shaft, a control lever mounted on the operating shaft for advancing or retracting the riveting hammers, and means for controlling the supply of fluid pressure to the riveting hammers.

31. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, an assembling table for supporting the ladder, means for initially clamping an assembled ladder together, electrodes mounted adjacent to the assembling table for heating the ends of the rungs, a treadle for controlling the engagement or disengagement of the electrodes with the ends of the rungs, a latch for holding the initially assembled ladder in the proper aligned position, gripping devices for clamping the rungs and side stringers of the assembled ladder, and riveting hammers mounted in alignment with the gripping devices for upsetting the heated ends of the rungs.

32. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, an assembling table and a run-out table, portable clamps for initially securing the assembled ladder together, adjustable guides mounted on the tables for supporting and guiding the assembled ladder through the machine, electrodes mounted between the tables for heating the ends of the rungs, a generator for supplying an electric current to the electrodes, means for controlling the electric current supply to the electrodes, a treadle for actuating one of the electrodes in one direction to engage or disengage the electrodes with the ends of the

rungs, and resilient means for actuating the electrodes in the opposite direction to that of the treadle, a latch for engaging and holding the initially assembled ladder in the proper aligned position, means actuated by fluid pressure for simultaneously clamping the rungs and side stringers of the ladder, and simultaneously movable riveting hammers mounted in the frame of the machine adapted to upset the heated ends of the rungs.

33. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, means for initially clamping an assembled ladder together, an assembling table for supporting the assembled ladder as it is fed through the machine, means mounted adjacent to the assembling table for electrically heating the ends of the rungs, a fluid pressure cylinder, a reciprocating piston having a piston-rod attached thereto mounted therein, means for controlling the supply of fluid pressure to the cylinder, a wrist block secured to the piston-rod and movable therewith, a cross-head actuated by the fluid pressure cylinder, means for adjusting the movement of the cross-head, gripping arms pivoted to the cross-head, jaws secured to the gripping arms for engaging the rungs between the side stringers, toggle connections between the wrist block and the gripping arms, clamping side levers pivoted to each side of the cross-head for engaging the side stringers, toggle connections between the wrist block and side levers, and riveting hammers movably mounted in the frame of the machine for upsetting the heated ends of the rungs.

34. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, portable clamps for initially clamping an assembled ladder together, an assembling table for supporting the assembled ladder as it is fed through the machine, means mounted adjacent to the assembling table for electrically heating the ends of the rungs, a fluid pressure cylinder, a reciprocating piston having a piston-rod attached thereto and mounted therein, means for controlling the supply of fluid pressure to the cylinder, a wrist block secured to the piston-rod and movable therewith, a reciprocating cross-head actuated by the fluid pressure cylinder pivotally connected to the wrist block and movable therewith, means for adjusting the stroke of the cross-head, gripping arms pivoted at an intermediate point to the cross-head, jaws secured to the lower ends of the gripping arms for clamping the rungs between the side stringers, link connections between the top ends of the gripping arms and the wrist block, a pair of side levers at each side of the cross-head each pivoted at an intermediate point to the cross-head and adapted to have their lower ends engaging the sides of the stringers, wrist pins journaled in

the wrist block having projecting perforated ends, a clevis bolt pivoted at one end to each of the upper ends of the side levers, the opposite ends of the clevis bolt being screw threaded and extending through a perforation formed in one end of the wrist pins and secured to the wrist pin by means of a nut, a spring on each clevis bolt interposed between the wrist pin and the head of the clevis-bolt, and riveting hammers movably mounted in the frame of the machine for upsetting the heated ends of the rungs.

35. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, means for initially clamping the parts of an assembled ladder together, an assembling table for supporting the assembled ladder as it is fed through the machine, means mounted near one end of the assembling table for electrically heating the ends of the rungs, means mounted laterally of the electrodes operated by fluid pressure for clamping the rungs and the side stringers, a pair of riveting hammers actuated by fluid pressure slidably mounted in alignment with each other in bearings on opposite sides of the machine adjacent to the clamping means for upsetting the ends of the heated rungs, means for controlling a supply of fluid pressure to the riveting hammers, an operating shaft, a connection between each riveting hammer and the operating shaft, and a control lever mounted on the operating shaft adapted when swung in opposite directions to advance or retract the riveting hammers.

36. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, means for initially clamping the parts of an assembled ladder together, an assembling table and a run-out table, guides on the tables for guiding and supporting the assembled ladder as it is fed through the machine, means mounted between the tables for simultaneously electrically heating both of the ends of the rungs, means mounted at one side of the electrodes and operated by fluid pressure for simultaneously clamping the rungs and the side stringers, a pair of riveting hammers movably mounted in alignment with each other in bearings on opposite sides of the machine adjacent to the clamping means for upsetting the ends of the heated rungs, a sleeve having a collar around its outer end secured to the casing of each riveting hammer and slidably mounted in the bearings, a trunnion projection extending from opposite sides of each collar, a yoke lever on each side of the machine, each pivoted at an intermediate point to a bracket clip resiliently attached to the frame of the machine, a yoke at the lower end of each yoke lever on each side of the machine having bifurcated lower ends engaging the trunnion projections on each side of the collars, an operating shaft journaled in brackets

attached to the frame, a universal connection between each top end of the yoke lever and the operating shaft, a control lever mounted on the operating shaft adapted when swung in opposite directions to advance or retract the riveting hammers, and a weighted lever mounted on the operating shaft adapted to facilitate the movement of the riveting hammers.

37. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, means for electrically heating both ends of the rungs, means operated by fluid pressure for simultaneously clamping the rung and side stringers, and means independent of the electrical heating mechanism for upsetting the ends of the heated rungs at one operation.

38. In a machine for fabricating metal ladders having side stringers and rungs with projecting end portions, means for simultaneously heating both ends of a rung, means operated by fluid pressure independent of the heating mechanism for simultaneously clamping the rung and side stringers and upsetting the ends of the heated rung at one operation, and resilient means independent of the fluid pressure means for releasing the clamping action on the rung and side stringers.

In testimony whereof I hereunto affix my signature.

CLAUDE D. REED.

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