

July 14, 1964

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3,140,540

METHOD FOR CONNECTING PRESEMIPLANGED RUNGS TO
PREAPERTURED SPACED LADDER RAILS

Original Filed Aug. 11, 1961

4 Sheets-Sheet 1

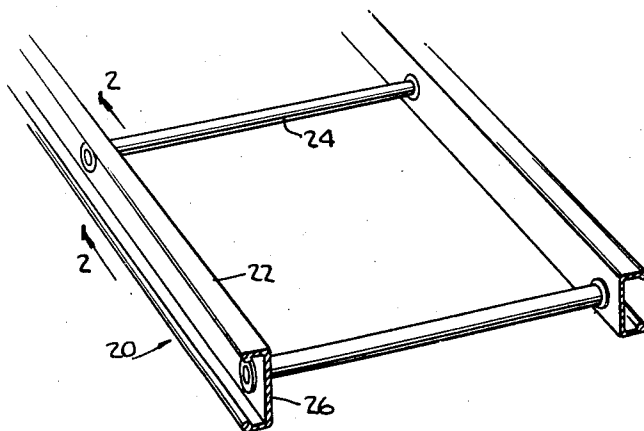


Fig. 1.

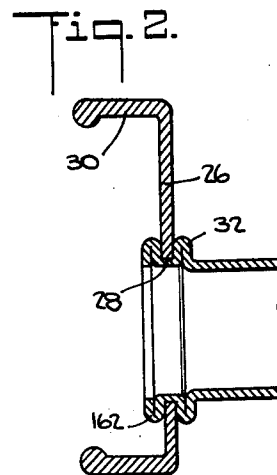


Fig. 2.

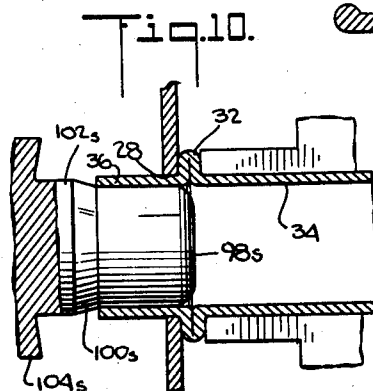


Fig. 10.

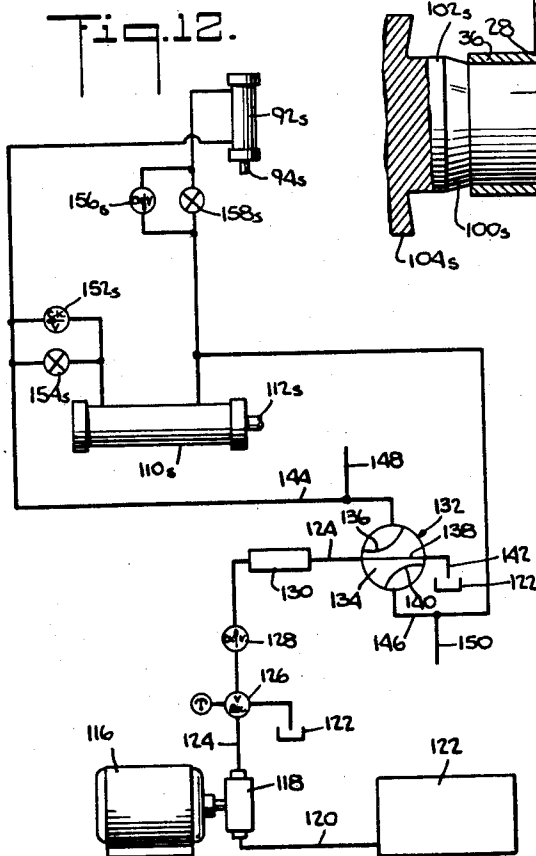


Fig. 12.

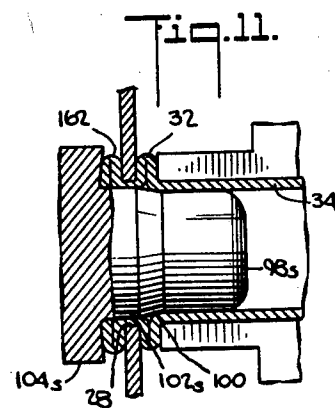


Fig. 11.

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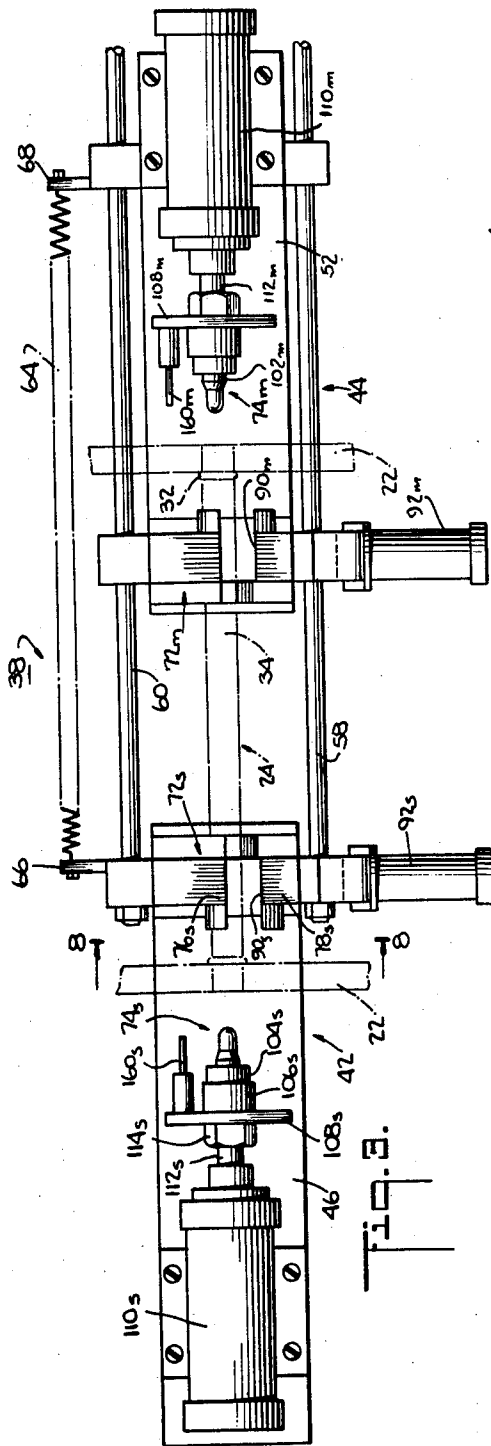


FIG. 3.

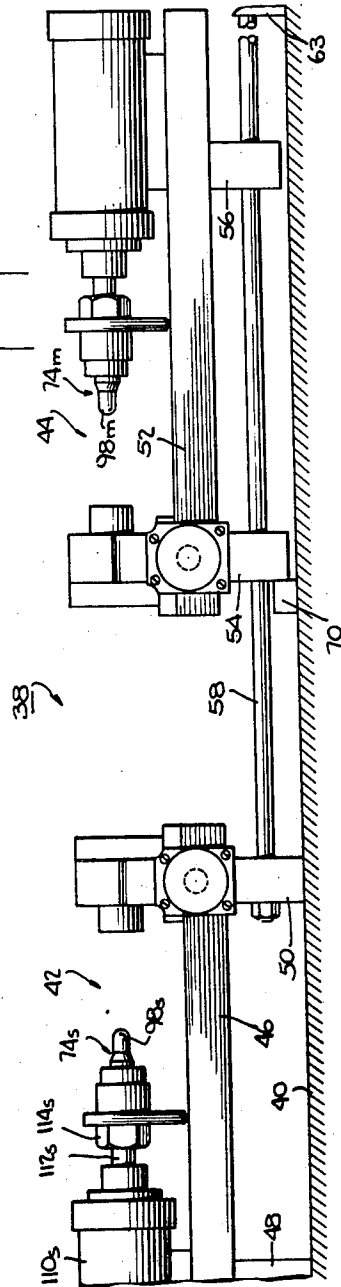


FIG. 4.

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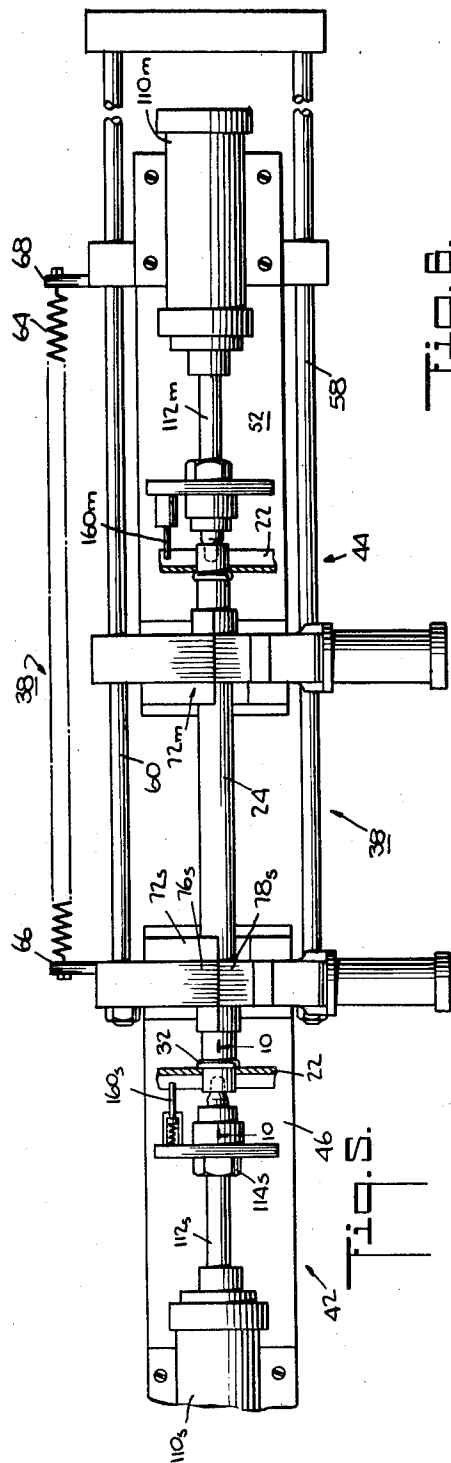
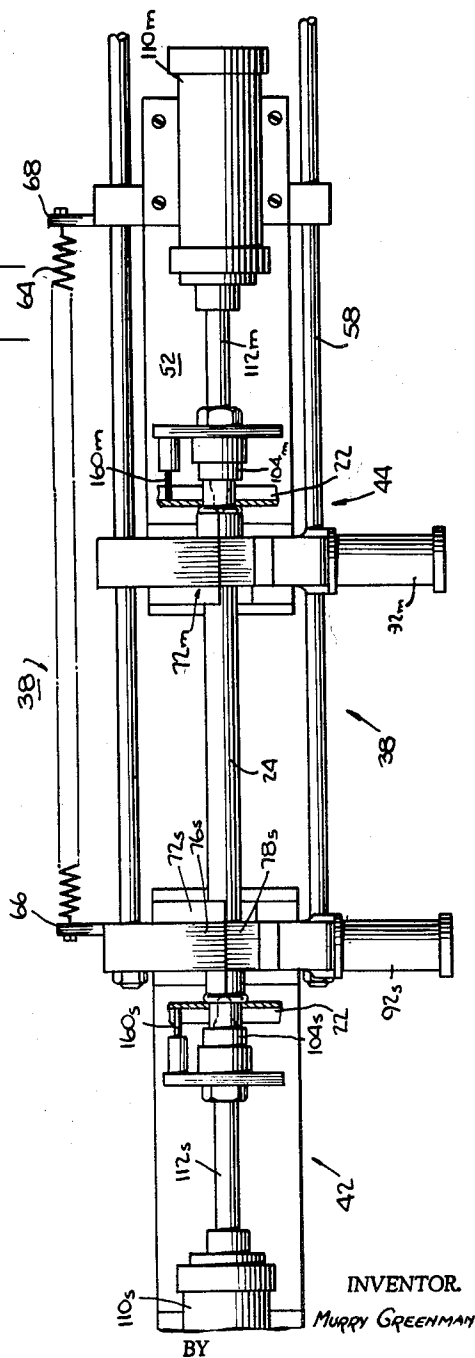


FIG. A.



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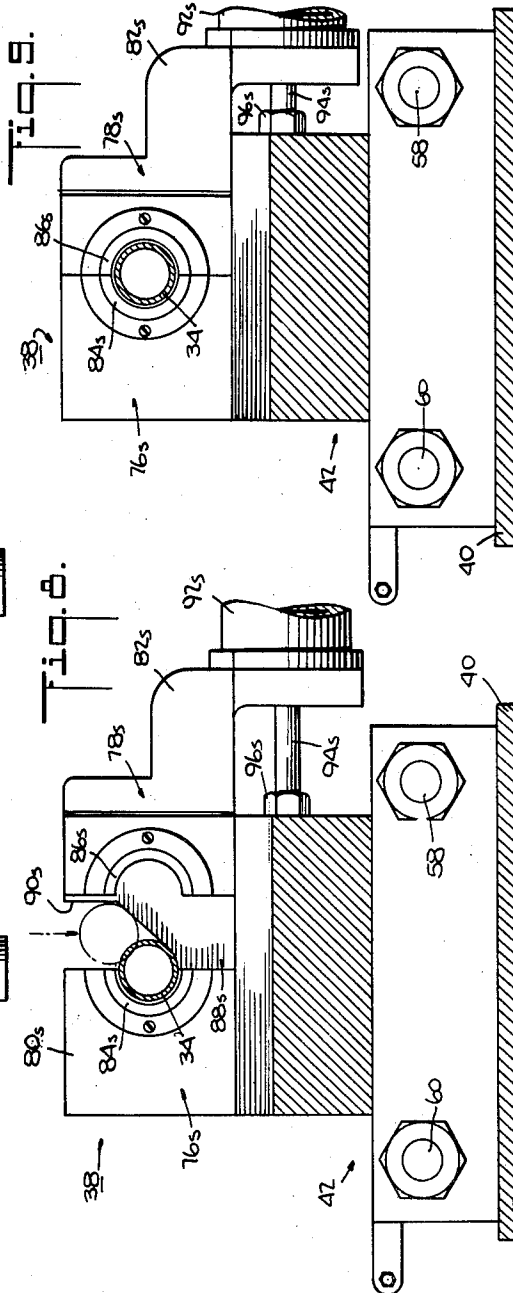
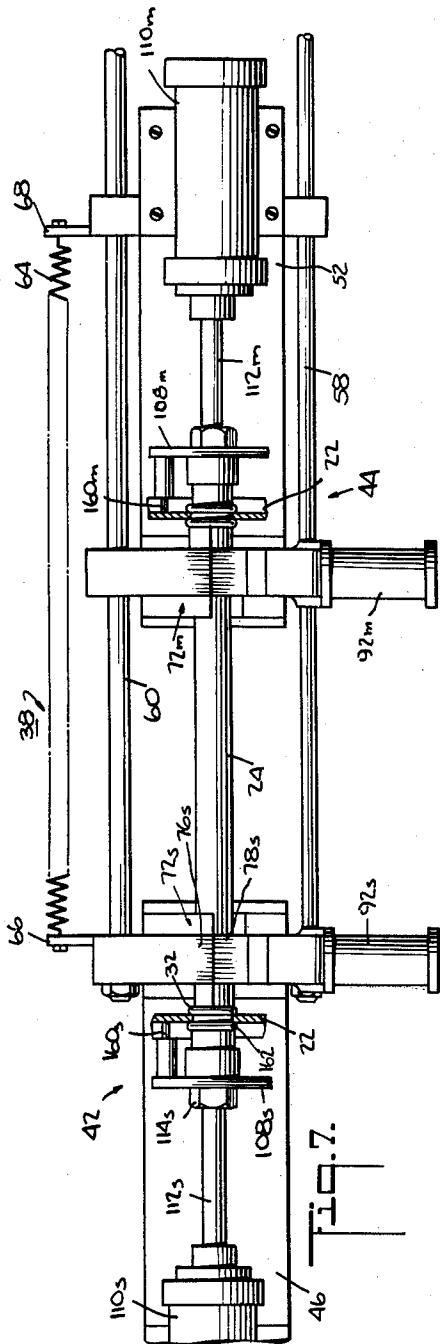
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4 Sheets-Sheet 4



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METHOD FOR CONNECTING PRESEMI-FLANGED RUNGS TO PREAPERTURED SPACED LADDER RAILS

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Original application Aug. 11, 1961, Ser. No. 131,016, now
Patent No. 3,119,435, dated Jan. 28, 1964. Divided
and this application Apr. 17, 1963, Ser. No. 273,763
1 Claim. (Cl. 29—512)

This invention relates to a method for connecting presemi-flanged rungs to preapertured spaced ladder rails.

It is an object of the present invention to provide a method of the character described which is speedy and economical in operation and which can be employed by semi-skilled labor so that small assembly plants set up at economically convenient local sites can join the rungs and rails of ladders which have been prefabricated at geographically remote factories.

It is another object of the present invention to provide a method of the character described which will efficiently and securely lock rungs to a pair of spaced rails in a fashion such that the finished ladder will be rugged, durable and attractive.

It is another object of the present invention to provide a method of the character described which will effect an unusually firm joint between the ends of the rungs and the rails whereby the rungs, even after long periods of use, will not loosen to an extent sufficient to enable them to turn and form an unsafe footing.

It is another object of the present invention to provide an assembly method of the character described which will automatically handle the manufacture of ladders having different spacings of rails whereby it is not necessary either to purchase different apparatuses for different widths of ladders or to reset the manufacturing apparatus each time that a different width of ladder has to be made.

It is another object of the present invention to provide an assembly method of the character described which will automatically handle slight variations in the lengths of the rungs so that despite minor changes in sizes of the components such as may occur in the prefabricated parts, a durable, reliable ladder nevertheless will be fashioned.

Other objects of this invention in part will be obvious and in part will be pointed out hereinafter.

The invention accordingly consists in the series of steps which will be exemplified in the process hereinafter described, and of which the scope of application will be indicated in the appended claim.

In the accompanying drawings, in which is shown one of the various possible embodiments of the invention,

FIG. 1 is a fragmentary perspective view of a ladder consisting of prefabricated rungs and rails that have been assembled by a method embodying the present invention;

FIG. 2 is an enlarged sectional view taken substantially along the line 2—2 of FIG. 1 and illustrating the finished joint connecting an end of a rung to one of the rails;

FIG. 3 is a top plan view of a machine which will carry out the method of the present invention and shown in its idle position ready for the insertion of ladder components (shown in dot-and-dash lines) to be assembled;

FIG. 4 is a front view of said machine;

FIGS. 5, 6 and 7 are views similar to FIG. 3 but illustrating successive stages in the operation of the machine, these being, respectively, when (FIG. 5) the swedging tool first engages the opposite ends of a rung, when (FIG. 6) the grip sleeves first engage the preformed inner annular beads, i.e. flanges, on the rung, and when (FIG. 7) the outer annular beads have been formed;

FIG. 8 is an enlarged sectional view taken substantially along the line 8—8 of FIG. 3 and showing the two jaws of a gripping sleeve in open (idle) position;

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FIG. 9 is a view similar to FIG. 8 but showing said jaws in closed (operative) position;

FIG. 10 is an enlarged fragmentary sectional view taken substantially along the line 10—10 of FIG. 5 and showing the relative relationship of the rung, rail, swedging tool and gripping sleeve when on the illustrated end of the rung the gripping sleeve abuts the inner flange after the swedging tool previously has engaged the adjacent unflanged end of the rung;

FIG. 11 is a view similar to FIG. 10 but showing the relative positions of the parts after the outer flange has been formed; and

FIG. 12 is a hydraulic circuit diagram for the control and operation of the actuating means of one swedging tool and its associated gripping sleeve.

Although the present invention is not so limited, one major utilization thereof is for the assembly of ladders from rungs and rails which have been prefabricated at a few widely spaced factories, or optionally only one factory, these components having been shipped to several convenient sites for assembly into finished ladders. The rails are pre-cut to various lengths and have apertures formed therein at properly spaced intervals for the reception of rungs. The rungs also are prefabricated, the same being made of hollow tubing and being supplied with a pair of annular flanges spaced inwardly from the ends thereof. The terminal portions of the rungs outwardly of said inner flanges have an external configuration which matches the configurations of the apertures in the rails and are, therefore, readily insertable into the same for quick assembly.

Thereafter in accordance with the present invention these terminal portions are flanged by buckling, i.e. by compression, so as to form outer flanges that are at the very ends of the rungs and are on the sides of the rails opposite from the preformed inner flanges, whereby the outer flanges serve permanently to secure the rungs to the rails.

Pursuant to an ancillary feature of the invention, the apertures and the rungs are of circular transverse section so that the assembly can be effected easily and speedily, it being, therefore, unnecessary to procure angular registry of a noncircular shape of rung with a matched noncircular shape of aperture. However the invention contemplates an operation upon the terminal portions of the rungs which will expand the same into the apertures so as to be seized therein and thus overcome the tendency of the circular rungs to turn in the circular apertures after fabrication of the ladders has been completed.

The assembly into finished ladders of prefabricated rungs and rails is in accordance with local demand. Rungs of various lengths are stocked to enable the assembler to make ladders of any desired widths. According to an ancillary feature of the invention the method is such that it can handle the assembly to rails of rungs of different widths without resetting the machine. That is to say, the method will automatically handle the assembly to rails of rungs of any length that may be inserted thus avoiding the necessity of stopping the process for fresh setups and of training workers in a method of rearranging the machine to handle different lengths of rungs.

Referring now in detail to the drawings, and more particularly to FIGS. 1 and 2, the reference numeral 20 denotes a ladder constructed in accordance with the present invention. Typically, such a ladder consists of a pair of spaced elongated rails 22 and a series of transverse parallel rungs 24. A conventional ladder of this type usually, although not necessarily, has the rails parallel to one another. The ladder may consist simply of a single pair of rails with an appropriate number of rungs or it may include two or more sections, each constituting a pair of rails with cross-rungs, the sections being interconnected

by conventional fittings to form an extension ladder. Whether one or more sections are to be made and whether the rails are to be parallel or convergent has no effect on the method of the present invention.

The rails as well as the rungs are made of metal having a sufficiently heavy gauge to resist deformation under the conditions of use in the field. Inasmuch as ladders of this sort usually are quite lengthy, to prevent them from being unduly heavy it is the custom to make them from lightweight metals, aluminum ordinarily being preferred and magnesium sometimes being utilized due to its additional lightness although it is considerably more costly. The metal employed usually is an alloy of either aluminum or magnesium in order that the strength thereof may be sufficiently great to safely carry the weight of a heavy person. The metal of the rungs and rails accordingly is of a standard composition such as ordinarily is used for aluminum or magnesium ladders. Such composition constitutes an aluminum or magnesium alloy which will withstand shock and has a high tensile strength. It further is characterized by its ability to be deformed (have its shape changed as by cold flow and bending) without splitting, cracking, breaking or fatiguing when subjected to very high stresses which are imposed by people standing on the rungs of the ladder. In other words the compositions of the rails and rungs, whether of aluminum or magnesium alloys, is malleable under high stress so as to be capable of being formed into new shapes that will be retained.

Although the rails may be of any suitable cross-section they generally are characterized by the presence of a main web 26 that is provided with apertures 28 for the reception of the ends (terminal portions) of the rungs 24. Usually, for the sake of reinforcing the rails, the longitudinal edges thereof are provided with rectilinear flanges 30 so that the rails are channel shaped. The flanges extend outwardly (away from the opposite rails) so as not to interfere with the footing of a person on the ladder, i.e. to maintain a maximum length of rung between the rails.

Such rails, as indicated above, are prefabricated, i.e. formed with the apertures 28 and to various suitable lengths, prior to assembly of the ladder by the method of the present invention. It will be appreciated that the spacing between the apertures is determined by trade practice and said apertures are so preformed that in matched rails they are like distances from the ends thereof whereby the spacings of the apertures in any associated pair of rails is such that they can be transversely registered.

Moreover as pointed out hereinabove the apertures 28 are circular in configuration. Nevertheless it should be mentioned that this simply is an ancillary and not an essential feature of the present invention.

The metallic composition of the rungs 24 is basically the same as that of the rails in order to prevent electrolytic decomposition. Said rungs are of hollow tubular configuration and are of generally circular transverse cross-section; however the external surfaces thereof may be longitudinally ribbed to provide an anti-slipping, i.e. anti-skidding, characteristic.

As preformed, there is provided at each end of each rung, an annular bead or flange 32 which is referred to herein as the "inner" flange (or bead) inasmuch as it is spaced inwardly from the adjacent tip of the rung. These inner beads can be formed on the rungs in any suitable manner and as shown herein constitute a pair of abutted single-wall flanges joined by an annular retroverted bend; rungs having a single flange on each end are referred to as "semi-flanged" rungs.

Thus in a typical prefabricated, but not yet assembled, rung, there is included a central shank 34 (see FIG. 10), a pair of inner beads 32 each one near but spaced from a different tip of the rung, and a pair of terminal shank portions 36 each one at a different end of the rung and both coaxial with and of the same diameter as the central shank 34. In other words, each rung essentially comprises an

elongated hollow circular tubular member having inner beads 32 set back from the two ends thereof, the two inner beads 32 lying in parallel planes that are substantially perpendicular to the longitudinal axis of the shank. The outer diameters of the terminal shank portions 36 are circular and of such diameter as to be freely slidably receivable in the apertures 28. The outer diameters of said terminal shank portions should not permit a sloppy fit of the rungs in the matching apertures but rather should induce an easy but nice fit. For example, the outer diameter of the terminal shank portions may be about 0.002" less than the diameter of the apertures 28 so that there is approximately 0.001" radial clearance. No attempt has been made to show this clearance in FIG. 10 because it would represent too great an exaggeration at the scale to which this figure is drawn.

In FIGS. 3-12 there has been shown an assembly machine 38 for carrying out the method of the instant invention and adapted to connect the terminal shank portions 36 at the opposite ends of a single rung to two spaced rails 22 in the same operation. Said machine includes a bed 40 which is stationary, i.e. supported from the floor. Since the machine is rather heavy it normally will remain at a fixed location and it is for this reason the bed has been designated as stationary. It will be understood nevertheless that the machine can be moved about from place to place and in this respect the term "stationary" simply indicates the base of the machine relative to which all other parts are either fixed or movable.

In order to form the outer flanges (beads) necessary to permanently connect the opposite ends of the rungs to the two spaced rails the machine is provided with two heads (a different one for each end of the rung), one being a stationary head 42 and the other a movable head 44. The two heads are substantially identical except for their individual mountings.

One of the heads, i.e. the stationary head, is fixed to the bed 40 so as to be immovable with respect thereto during operation of the machine. Said head comprises an elongated horizontal frame 46 which is securely fastened to the bed 40 as through the medium of pedestal blocks 48, 50. The frame may be bolted to the pedestal blocks and the blocks in turn bolted to the bed. For convenience, the frame 46 will be referred to hereinafter as the "stationary frame."

The movable head 44 constitutes a movable elongated horizontal frame 52 to the under surface of which leg blocks 54, 56 are secured as by bolts. However these blocks are not immovably fastened to the bed 40. Each of the leg blocks is formed with a pair of registered openings (not shown), preferably lined with antifriction means, which are slidable upon massive shafts 58, 60. Each shaft 58, 60 is secured at one end to the pedestal block 50 and at its other end to another pedestal block 63 (see FIG. 4) secured as by bolts to the bed 40 so that the shafts are stationary, i.e. fixed with respect to the bed. The rigid shafts 58, 60 are parallel to one another and extend in a direction generally perpendicular to the narrow widths of the elongated frames 46, 52 and parallel to the lengths thereof. Thereby the movable frame 52 is mounted for movement toward and away from the stationary frame 46. This relative movement of the two frames is a dominant feature of the present invention and the purpose of the same soon will be apparent.

Suitable means is provided to urge, e.g. to bias, the frames towards one another, i.e. towards what will be called "idle" or "adjacent" position. Said biasing means conveniently constitutes a long helical spring 64 anchored at one end to a leg 66 protruding from the pedestal block 50 and at the other end to a leg 68 protruding from the leg block 56. The spring is under tension so that it urges the movable frame 52 toward the stationary frame 46.

Suitable means may be included to limit the inward

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movement of the frame 52. By way of example, said means comprises an abutment member 70 adjustably secured to the bed 40 between the pedestal block 50 and the leg block 54 and located in the path of the leg block. By "adjustably" it is meant that the position of the abutment member 70 can be changed with ease, as for example, by bolting it to any one of a series of holes in the bed, so that the closed position of the two frames can be varied at will and in a matter of seconds. It will be appreciated as the description of this invention proceeds that any given closed position has no effect upon the principle of operation of the machine and that the adjustment is provided simply to speed the assembly cycle if desired.

Each of the heads 42, 44 has mounted on its frames 46, 52 certain operative elements and actuating means therefor. Said elements and actuating means for the two heads are identical and except that, as will be apparent from the drawings and as will be pointed out hereinafter, two of the elements and associated means are opposite in disposition and action, but this simply is a question of orientation and not construction. Accordingly, to shorten the description, the said elements and means will be described without reference to which head they are affiliated with, and similar elements and means on the two heads will be identified by the same reference numerals without differentiating subscripts. However on the drawings, and subsequently in outlining the operation of the machine where it is necessary to distinguish between the movable and stationary heads, these elements and means are and will be further identified by the letter subscripts "s" and "m" which respectively indicate "stationary" (the head 42) and "movable" (the head 44).

Each head has mounted on its horizontal elongated frame a grip sleeve 72 and a swedging tool 74.

Each grip sleeve 72 consists of a fixed jaw 76 and a translatable jaw 78. These are best illustrated in FIGS. 8 and 9 where it will be seen that each jaw is comprised of a heavy body, i.e. a body 80 secured to the frame for the fixed jaw and a body 82 for the translatable jaw. Suitable means (not shown) is included to slidably interengage the two bodies so that the translatable body 82 is mounted for movement toward and away from the fixed body 80 in a direction perpendicular to the lengths of the rails 58, 60. Hence the jaws of the grip sleeve may be considered to open and close transversely. Secured to the fixed body 80 is a semicylindrical trough 84 having the longitudinal edges thereof vertically registered. Secured to the translatable body 82 is a semicylindrical trough 86 having its longitudinal edges vertically registered. The two troughs 84, 86 are disposed with their open sides facing one another and are in transverse alignment so that when the bodies 80, 82 are juxtaposed, i.e. abutting, the two semicylindrical troughs have their longitudinal edges in contact so as mutually to define an elongated cylindrical bore. Said bore is parallel to the lengths of the rails 58, 60, and desirably, is located midway between the rails whereby to minimize skewing stresses. The cylindrical bores thus provided for the fixed and movable frames are in axial alignment. Each cylindrical bore is a few thousandths of an inch larger in diameter than the external diameter of a preformed rung, e.g. 0.001" larger, so that when a rung is in the grip sleeves it is substantially restrained against movement laterally of the bores but can freely move (slide) axially of the bores. This axial movement is necessary to the practice of the present invention.

To facilitate placement and holding of a prefabricated semiflanged rung between the two semicylindrical troughs when the same are in open position, i.e. remote from one another as illustrated in FIG. 8, the machine 38 may include a feed chute 88 integral with the fixed body 80 and defining a feed slot 90 having an upwardly opening vertical leg into which a rung is introduced thwartwise and which terminates at an inclined leg that slopes

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toward the semicylindrical trough 84 on the fixed body 80 so that when a rung is introduced into the feed chute and released it will drop down the feed chute and come to rest against the semicylindrical trough 84 and there will wait for the semicylindrical trough 86 to be closed thereon.

Power actuating means is included to move the translatable body 82, and hence its semicylindrical trough 86, toward and away from the fixed body 80 and its semicylindrical trough 84. Conveniently said power means comprises an elongated hydraulic cylinder 92 the longitudinal axis of which extends transversely of the rails 58, 60. A piston (not shown) of the usual type is slidable within the cylinder 92 and is connected to a piston rod 94 that extends through the otherwise closed end of the cylinder facing the associated head. The outer end of the cylinder likewise is closed. For convenience the piston and piston rod are fixed and the cylinder is movable. More particularly the distal end of the piston rod 94 is fastened to the frame (46 or 52) as by a nut 96 and the cylinder is functionally integral with the translatable body 82. Hence when hydraulic fluid under pressure is introduced into the outer end of the cylinder it will urge the translatable jaw away from the fixed jaw and when hydraulic fluid under pressure is introduced into the inner end of the cylinder it will urge the translatable jaw toward the fixed jaw.

Each swedging tool 74 includes a cylindrical form 98 (see FIG. 10) having a rounded leading periphery to facilitate insertion of the form into the open end of a hollow rung. The diameter of the form is such that it is a tight, i.e. nice, fit within the rung. The base of the form rises from a flaring section 100 that is mounted on a cylindrical bottom section 102. The diameter of the bottom section is slightly greater than the diameter of the form 98, e.g. 0.004" to 0.006" greater, this difference being created by the flaring section. The function of the flaring and bottom sections will be described in connection with the operation of the machine.

The bottom section is carried by a disc 104 that is dished, i.e. deepest at its center where the tool 74 is located. The dishing is at a rather slight angle which has been exaggerated in the drawings (see FIG. 10) and is in the order, for instance, of 2°. The root of the bottom section where it meets the disc is of a minimum tool radius. The disc is mounted on a support 106 that is carried by a heavy plate 108 the lower edge of which rides, as with the aid of rollers, on the frame (46 or 52).

Actuating means is included for the swedging tool 74. Said actuating means comprises an elongated hydraulic cylinder 110 fastened to the frame (46 or 52) and having slidable within it a piston (not shown) that actuates a piston rod 112. The cylinder is so oriented that the piston moves in a direction parallel to the shafts 58, 60. Said piston rod is connected to the plate 108 as by a nut 114. The hydraulic cylinder, the piston and the piston rod are massive and are so positioned as to accurately guide the form 98 in coaxial registry with the open end of a hollow rung located in the associated grip sleeve 72. If desired, although the same usually will not be necessary, a guiding means may be provided for the plate 108 to insure such registry.

It will be observed that the swedging tool 74_s is located on the outer side of its associated grip sleeve 72_s and moves upon actuation toward the grip sleeve in a direction of from left to right as shown in FIG. 3. The swedging tool 74_m likewise is located on the outer side of its associated grip sleeve 72_m and when actuated moves towards its said gripping sleeve in a direction from right to left as illustrated in FIG. 3. Thus when the two swedging tools 74_s and 74_m are concurrently energized for operation they will move in directions towards one another. However when the two grip sleeves 72_s and 72_m are energized for operation they will move in the same directions, these being parallel to one another.

Obviously the movement of the two swedging tools not only is parallel and opposite but also is coaxial, i.e. along a common line which is coincident with the longitudinal axis of the hollow rung then being headed, i.e. flanged.

A simple hydraulic circuit is included to render the actuating means effective either to move the grip sleeves and swedging tools to their operative positions or to their idle positions. Said circuit is illustrated schematically in FIG. 12. An ancillary feature of the circuit, accomplished by a means soon to be described, is that without using any timing mechanism the operative cycle is so controlled that the grip sleeves will engage the rungs before the swedging tools and will become disengaged from the rungs after the swedging tools, thus maintaining good control over the parts of the ladder during the assembly operation.

In particular the hydraulic circuit comprises a prime mover, such for instance as an electric motor 116, connected to drive a hydraulic pump 118. The intake end of said pump is connected by a conduit 120 to an oil reservoir 122. The outlet end of said pump is connected by a conduit 124 through a pressure relief valve 126, a check valve 128 and a filter 130 to a manually controlled four-way valve 132. The movable plug 134 of said valve includes three internal passageways 136, 138, 140. In the idle position of the plug the internal passageway 138 connects the conduits 124 to a conduit 142 that runs to the reservoir 122.

Leading away from the valve 132 there are, in addition to the conduits 124 and 142, two additional conduits 144 and 146. The conduit 144 runs directly to the inner end of the grip sleeve hydraulic cylinder 92_s.

A branch conduit 148 connected to the conduit 144 leads in a manner similar to that already described and similar to that soon to be described to the inner end of the hydraulic cylinder 92_m and the outer end of the hydraulic cylinder 110_m, and another branch conduit 150 connects the conduit 146 in a manner similar to that soon to be described to the outer end of the cylinder 92_m and the inner end of the cylinder 110_m. The various connections to the hydraulic cylinders 92_m and 110_m have not been shown due to the foregoing similarity.

The conduit 144 is connected to the outer end of the swedging tool hydraulic cylinder 110_s through a valve arrangement which permits unrestricted flow in one direction and controlled restricted flow in the opposite direction. Such a valve arrangement constitutes for example a "Colorflow" control valve such as is sold by the Manatrol Corp. of 2372 West 7th Street, Cleveland 13, Ohio. Such a control valve basically includes in a single casing two valves in parallel one of which is a check valve and the other of which is a variable restriction flow valve. In FIG. 12 I have shown this valve arrangement as constituting two separate valves in parallel the two conjointly comprising a single valve arrangement as described. More particularly the conduit 144 is connected to the outer end of the swedging tool hydraulic cylinder 110_s through a check valve 152_s and a controllable restriction flow valve 154_s. The check valve 152_s is oriented to prevent flow therethrough of hydraulic liquid from the conduit 144 to the outer end of the hydraulic cylinder 110_s and to permit free flow in the opposite direction. The restricted flow valve 154_s will permit limited flow, i.e. a selected restricted flow, to an equal degree in both directions.

The conduit 146 runs directly to the inner end of the swedging tool hydraulic cylinder 110_s (and also as noted above through the conduit 150 to the inner end of the swedging tool hydraulic cylinder 110_m). Said conduit 146 furthermore is connected to the outer end of the grip sleeve hydraulic cylinder 92_s (and in similar fashion through the conduit 150 to the outer end of the grip sleeve hydraulic cylinder 92_m) through a Colorflow control valve consisting of a check valve 156_s and a controllable restriction flow valve 158_s. The check valve

156_s is oriented to prevent flow therethrough of hydraulic liquid in the direction from the conduit 146 to the outer end of the hydraulic cylinder 92_s and to permit free flow in the opposite direction. The controllable restriction flow valve 154_s permits limited flow of hydraulic fluid to an equal degree in both directions.

In order to facilitate proper seating of the rails 22 against the inner flanges 32 prior to the forming soon to be described of the outer flanges the machine 38 may include pressure fingers 160_s, 160_m mounted on the respective plates 108_s, 108_m. Said pressure fingers extend in the direction of and are spring biased toward the associated grip sleeves 72_s, 72_m.

To describe the operation of the machine 38 let it be assumed that said machine is in its idle condition as shown in FIGS. 3 and 8. At this time the stationary and movable heads 42, 44 are in their adjacent, i.e. idle, position the movable frame being biased into such position by the spring 64 which forces the leg block 54 into contact with the abutment member 70. Both sets of translatable jaws 78_s, 78_m are spaced from their affiliated fixed jaws 76_s, 76_m, the grip jaw hydraulic cylinders 92_s, 92_m being in their outer, i.e. retracted, positions. The swedging tools 74_s, 74_m likewise are in their outer, i.e. retracted, positions being so positioned by their respective associated hydraulic cylinders 110_s, 110_m. The manually controlled valve 132 is in the position illustrated in FIG. 12 so that hydraulic fluid is circulated between the pump and the reservoir but no hydraulic fluid under pressure is applied to either end of any of the hydraulic actuating cylinders. Since the fixed and translatable jaws are spaced apart the feed slots 90_s, 90_m are open.

With the machine 38 in the foregoing condition a rung 24 is deposited in the feed slots with the inner flanges 32 on the outer sides of the adjacent grip sleeves as shown for example in FIG. 3 in dot-and-dash lines. Obviously the terminal shank portions 36 are free. A pair of rails 22 have their registered apertures 28 threaded over the terminal shank portions so that said terminal portions project from the outer sides of the rails as likewise illustrated in FIG. 3. Due to the positioning secured by the feed slots in which the rung is bottomed, said rung is aligned with both of the swedging tools 74_s, 74_m which latter at this time are spaced from the ends of the rungs since the tools are in their retracted positions.

It should be mentioned that it is not necessary when positioning the rung to have it centrally located in the two grip sleeves, i.e. to have portions of exactly equal length protruding beyond the outer sides of the two sleeves, which seldom realized position is shown in FIG. 3 to simplify illustration. The machine works satisfactorily if either end of the rung extends further from its associated grip sleeve than the other end.

To start operations the control valve 132 is turned to its in-feed position in which the passageway 136 connects the conduit 124 to the conduit 144 and the passageway 140 connects the conduit 146 to the conduit 142. Such action supplies hydraulic fluid under pressure to the conduit 144 and connects the hydraulic fluid in the conduit 146 to the reservoir. The consequent application of hydraulic fluid under pressure to the inner ends of the hydraulic cylinders 92_s, 92_m, and to the outer ends of the hydraulic cylinders 110_s, 110_m and connection of the opposite ends of said cylinders to the reservoir causes said cylinders to actuate the associated grip sleeves and swedging tools. Specifically, the grip sleeves will be closed into sliding engagement with the rungs and the swedging tools moved inward toward the ends of the rungs.

One of the foregoing actions will precede the other. In particular the in-feed movement of the swedging tools will be slower than the in-feed movement of the translatable jaws of the grip sleeves. Referring to FIG. 12 it will be seen that the check valve 152_s (as well as the check

valve 152_m) prevents free flow of hydraulic fluid to the outer end of the swedging tool hydraulic cylinder. Accordingly the only path for flow of hydraulic fluid to this outer end is through the controllable restriction control valve 154_s (and 154_m) so that the infeed motion of the swedging tool is slowed down. On the other hand, the check valve 156_s (as well as the check valve 156_m) permits rapid flow of hydraulic fluid out of the hydraulic cylinder 92_s (and 92_m) effectively bypassing the controllable restriction flow valve 158_s (and 158_m). Thereby the grip sleeves will be speedily closed upon the rungs before the ends of the rungs are contacted by the swedging tools. The effect of this is to firmly locate and hold the rung axially before it is contacted by the swedging tools. This action of course does not prevent longitudinal movement of the gripped rung.

As the swedging tools move toward one another in coaxial alignment (with the frames in their adjacent position) the cylindrical forms 98_s and 98_m enter the hollow ends of the rungs, such insertion initially being limited by the flaring sections 100. If, as usually will be the case, the rung is not precisely centered with respect to the grip sleeves, one or the other of the forms will enter the associated end of the rung before the other and will shift the rung toward the other swedging tool so that ultimately during the in-feed movement of these tools a symmetrical position will be reached such as shown in FIG. 5 in which both swedging tools have had the cylindrical forms inserted into the rungs up to the flaring sections 100.

As the swedging tools continue their inward feeding movement the cylinder forms do not enter deeper into the rungs because at this time in effect the swedging tools are pressing against one another through the rung and because the swedging tool 74_m is mounted on the movable frame 52 which is shiftable with respect to the stationary frame so that the movable head 44 simply is backed away from the head 42 at the combined in-feed rate of both forms. In other words, during this stage of the cycle, the two swedging tools 74_s, 74_m remain in fixed position with respect to one another and to the rung but the rung moves away from the stationary head and the moveable head shifts away from the rung and from said stationary head. Such movement approaches the left hand inner flange (as viewed in FIG. 4) toward the stationary grip sleeve 72_s and approaches the movable grip sleeve 72_m to the adjacent inner flange 32 (the right hand flange as viewed in FIG. 5) until finally the outer ends of the semi-cylindrical troughs of both grip sleeves engage their associated inner flanges 32. The relative positions of an end of a rung and of the associated grip sleeve is shown in FIG. 7. At this stage of the cycle the two grip sleeves form annular anvils on which the inner flanges 32 of the rung are seated, the rails in turn being seated upon the flanges under the force of the pressure fingers 160. It will be observed that the movement of the heads away from one another depends upon the slidable engagement between the grip sleeves and the rung.

After the flanges are seated against the grip sleeves the swedging tools 74_s, 74_m, continue their in-feeding movement. But now the movable head is unable to shift further away from the stationary head being prevented by abutment of the grip sleeves against the inner flanges 32 of the rung. Hence, the pressure acting on the cylindrical forms 98 now presses said forms with considerable force against the ends of the rungs, such force being sufficient to press the flaring sections and subsequently the bottom sections 102 of the swedging tools into the rungs until the tips of the rungs touch the discs 104 as shown in FIG. 6.

However, the swedging tools still do not stop their in-feeding movement and now the full force exerted by the hydraulic cylinders 110_s, 110_m is compressibly applied to the ends of the rungs. This squeezing force is localized at each end of the rung between the tip of the rung and the adjacent inner flange 32 so that effectively the com-

pressive force is exerted on the terminal shank portions 34 of the rungs. Such compressive force exerts a buckling action on the terminal shank portion and thereby forms an outer flange or bead 162 at each end of the rung. The buckling action is implemented by the dished shape of the inner faces of the discs 104 which tends to hold in central position the tips of the rungs while the same are being buckled. Furthermore, these inner faces of the discs press against the freshly formed outer flanges 162 to compress them firmly against the outer faces of the rails and thereby to clamp the rails at each end of the rung between the inner flanges 32 and the outer flanges 162.

Attention is directed to the fact (see FIG. 11) that the bottom sections 102_s, 102_m of the two swedging tools penetrate into the ends of the rung at least up to the plane of the rails whereby to expand the rung into seizing contact with the apertures 28 and thus firmly anchor both ends of the rungs in the opposite rails.

It will be appreciated that due to the floating (shifting) action of the movable head the machine automatically accommodates itself to rungs having any spacings between the inner flanges 32 the machine not being operative to form the outer flanges 162 until the inner flanges have been seated against the associated grip sleeves. However the duration of the cycle will be somewhat shortened if initially the outer ends of the two grip sleeves are spaced apart in the order of, although less than, the space between the inner flanges and it is only for this purpose that the abutment member 70 is provided.

Once the outer flanges 162 have been formed the position of the manually controlled valve 132 is reversed to back off the swedging tools and open the grip sleeves. Such reversal connects the conduit 124 through the passageway 149 to the low pressure conduit 146 and connects the conduit 144 through the passageway 136 to the high pressure conduit 142. This sets up the four hydraulic cylinders for out-feeding movement to restore the actuated elements to their starting position. Due to the check and restriction flow valves the outward movement of the swedging tools is more rapid than the outward movement of the translatable jaws thereby the swedging tools will be stripped from the rung before the grip sleeves open.

The present invention is a division of my copending application Serial No. 131,016, filed August 11, 1961, now Patent No. 3,119,435, for Apparatus for Connecting Preseminflanged Rungs to Preapertured Spaced Ladder Rails.

It thus will be seen that I have provided a method which achieves the several objects of this invention and is well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiment above set forth, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

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

A method for assembling on preapertured ladder rails a hollow rung having spaced inner flanges and terminal shank portions, said method comprising:

- (a) inserting the terminal shank portions of the rung through the apertures in the rails,
- (b) approaching swedging tools to the opposite ends of the rung,
- (c) slidably engaging and supporting the rung intermediate the inner flanges with two anvils each of which is associated with a different one of said swedging tools,
- (d) relatively pulling together each slidable anvil and its associated swedging tool while permitting one slidable anvil and its associated swedging tool to move axially of the rung away from the other slidable anvil and its associated swedging tool,
- (e) terminating such axial movement with the slidable

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anvils engaging the inner sides of each of the inner flanges,
(f) supporting the inner sides of each of the inner flanges with the slidable anvils, and
(g) then compressing each terminal shank portion 5
against a rail between a slidable anvil that supports the inner side of the inner flange adjacent the inner side of said rail and the associated swedging tool that engages the outer end of said terminal shank portion to form a second flange on the outer side of 10
and engaging each associated rail,

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(h) whereby each rail will be compressed between the inner flange and the newly formed second flange so that each end of the rung is secured to a rail.

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