

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

A Method of Making Ladder Joints

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We, R. D. WERNER CO., INC., a corporation organised under the laws of the State of Pennsylvania, United States of America of Box 580, Greenville, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of making a joint between a rail of a ladder and a hollow rung thereof.

During its use the latter is subjected to a variety of complex stresses. In addition to the obvious stress—bending of the rungs under the load of the person standing on the ladder—there are certain other stresses which are generally not appreciated such as stresses tending to rotate the rungs about their longitudinal axis and stresses resulting from forces which tend to twist the ladder itself about its longitudinal axis that is an axis taken along the length of the ladder. All these stresses must be successfully resisted or the ladder will be distorted and thereby—unsafe.

It is an object of the present invention to provide a method of making a joint between a rail of a ladder and a hollow rung thereof by which the rung and the rail are attached together in a secure manner and without danger of the rail or the run fracturing or being weakened.

It is another object of the invention to join a run of a ladder to a ladder rail in such a manner that the assembly of rail and rung resists high axial loads and at which the joint between rung and rail has a high torque capacity.

The method according to the invention is carried out with the aid of a metal ferrule having a smooth end and an end with an outwardly projecting flange, which may be formed on a ferrule either before the ferrule is placed on the ring or afterwards, but in any case

prior to the ring—with the ferrule on it—being assembled with the ladder. Such a flange will be referred to in the following as a prior-formed flange. The invention comprises the steps of placing said ferrule over said rung, inserting both rung and ferrule into an opening in said rail, so that the smooth end of said ferrule projects through said opening and said prior-formed flange abuts against one side of said rail and subjecting the projecting part of said ferrule to a swaging operation whereby metal from said projecting part is caused to flow radially outwards and in tight engagement with the opposite side of said rail and another flange is formed on said ferrule which together with said prior-formed flange clamps said rail to said ferrule.

The method according to the invention can also be applied to ladders whose rails have spaced side walls and aligned openings in both side walls. In this case the method according to the invention comprises the steps of placing a ferrule of the foredescribed shape over a rung of a ladder inserting both run and ferrule into the aligned openings in said side walls so that the smooth end of said ferrule projects through said openings and said prior formed flange abuts against the outside of one side wall, and subjecting the projecting part of said ferrule to a swaging operation whereby metal from said projecting part is caused to flow radially outwards and in tight engagement with the outside of the other side wall and whereby another flange is formed on said ferrule which together with said prior-formed flange clamps both side walls to said ferrule.

When applying the method according to the invention to ladders whose rails have spaced side walls and aligned openings in both side walls, it is also possible to employ two ferrules instead of one. In this case each ferrule has a prior-formed outwardly projecting flange at one of its ends, one of said ferrules being

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formed for part of its length with an internal diameter substantially equal to the external diameter of said rung whilst the remainder of said ferrule has an enlarged internal diameter and the second ferrule being formed throughout its length with an internal diameter substantially equal to the external diameter of said second ferrule being substantially equal to the enlarged internal diameter of said first ferrule, said method comprising the steps of press-fitting said first ferrule to said rung, inserting said first ferrule and said rung through an opening in the inside side wall of said rail and inserting said second ferrule through an opening in the outside side wall of said rail, and telescoping said second ferrule with a press-fit into said first ferrule and onto said rung, so that both side walls of said rail are abutted by the prior-formed radially projecting flanges of said ferrules.

Several embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which

Figure 1 is a perspective view of a vertical press, used in the manufacture of a ladder according to the present invention, showing a portion of a channel-shaped rail of the ladder, openings therein, a ferrule-and-rung assembly inserted vertically through one of said openings in said rail and illustrating its position prior to final forming, and another ferrule and rung assembly inserted through another of the openings in the rail and being joined to the rail, the ferrule embodying a first form thereof;

Figure 2 is a sectional enlarged view of parts of the press of Figure 1, showing the rung-and-ferrule assembly disposed in an opening in the rail of the ladder prior to a final joint-forming step;

Figure 3 is a view taken along the line 3—3 of Figure 2;

Figure 4 is an exploded view disclosing the ladder rail, a ferrule and part of a rung prior to assembly;

Figure 5 is an exploded view, partly in section, showing the ferrule of Figure 4 in telescoped partial engagement with one end of the rung;

Figure 6 is a sectional view, illustrating portions of the press of Figure 1 and the ferrule, rung and associated rail parts;

Figure 7 illustrates the rung-and-rail joint, formed by the press, as shown in Figure 6, but omitting the press parts;

Figure 8 is a sectional view showing the tools of a conventional punch-die press and a straight ferrule adapted to be formed therein with a flange, the tools being in their open positions;

Figure 9 shows the tools of Figure 8 in their closed position;

Figure 10 is a side elevation, partially in section, of a horizontal press, adapted to secure

a ferrule-and-rung assembly to a ladder rail; longitudinal withdrawal of the rail-and-rung assembly from the press being shown in chain lines;

Figure 11 is a sectional view of a die-assembly for prior-forming a ferrule placed on the end portion of a run, said die-assembly being shown in the open position;

Figure 12 is a view similar to Figure 11 showing the die-assembly in a partially closed position;

Figure 13 is a view similar to Figures 11 and 12 showing the die-assembly in the fully closed position;

Figure 14 is a partial longitudinal section of the end portion of a rung, having a prior-formed ferrule placed thereon;

Figure 15 is a horizontal section, showing a portion of an open-type, channel-shaped ladder rail and a run, secured to the rail by means of a ferrule embodying a second form thereof;

Figure 16 is a side view of the preformed ferrule of Fig. 15;

Figure 17 is a view similar to Figure 15, showing the prior-formed ferrule of Figure 16 disposed partially on a rung portion prior to the forming of an outwardly projecting flange on the ferrule;

Figure 18 is a sectional view of a ferrule embodying a third form thereof;

Figure 19 is a horizontal section, showing the ferrule of Figure 18 in assembled relationship with a tubular ladder rail and a ladder rung;

Figure 20 is a side view of one member of a two-part ferrule embodying a fourth form thereof;

Figure 21 is a view similar to Figure 20 of the other member of the two-part ferrule of the fourth form;

Figure 22 is a right-hand end view of the ferrule member of Figure 20;

Figure 23 is a left-hand end view of the ferrule member of Figure 21; and

Figure 24 is a section of the two ferrule members of Figures 20 and 21 in assembled relationship with a rung and a tubular ladder rail, the section being taken in a plane parallel to the rung.

Referring now to the drawings in all of which like parts are designated by like reference characters, Figures 1—3, disclose a conventional punch press of the vertical type for making a joint in accordance with the present invention said joint being formed by a ferrule, a rung and a side rail of a ladder. Figure 10 discloses die parts to be employed in a horizontal punch press for making a joint in accordance with the present invention. The vertical press is designated at 10 in Figures 1—3 and the horizontal press at 100 in Figure 10. The press is adapted to be used in the fabrication of ladders, preferably manufactured of aluminium, magnesium or reinforced fiberglass

or other materials and employing ferrules of malleable material to join the rungs and rails of such ladders together. The ferrules employed in the joint are partially preformed with an outwardly projecting flange on one end before placement in the press. Preferably, the ferrule is adapted to be assembled on the rung with a portion of the ferrule overhanging an end of the rung prior to their insertion into an opening in the side rail of the ladder. As an alternative, the ferrule may be assembled on the run without such a prior overhang.

In each of the presses shown, a male die member is provided with a pilot pin which is adapted to enter a tubular rung of a ladder, said rung being aligned with said pilot pin and retained by a separate die member, and the pilot pin is adapted to back-up an outer end of the rung during compression of the ferrule and during the joint-forming operation.

In Figures 4, 5, 6 and 7, sequential steps in the making of the joint are shown; Figures 8 and 9 disclose a method of preforming a flange 43 on one end of the ferrule prior to its assembly with the rung; Figures 11 to 13 inclusive disclose simultaneous application of a straight ferrule to a rung and forming of a flange 43 on one end of the ferrule. Hence, it can be seen that the flange can be formed on the ferrule in a punch press die and the ferrule then affixed to the rung for final swaging or a flange can be formed on the ferrule after the latter has been placed onto the rung in the overhung position shown. In both cases, the flange is formed on the ferrule prior to the latter and the rung being assembled with the rail.

Referring now more particularly to the Figures of the drawings, it will be noted that in Figure 1 the vertical press 10 is provided with a conventional inertia wheel 12, driven by a belt 14 from a suitable power source (not shown). The press includes an upper solid pilot die member 16 shown in greater detail in Figures 2 and 3 as having a stepped cavity end 17 centrally located therein, a tapered pilot pin 18 projecting downwardly from die member 16 into the cavity 17 and having a maximum diameter which is still slightly smaller than the inner diameter of the rung, and a plurality of spaced, spring-pressed guide pins 19 provided adjacent the corners of the die 16 and radially outwardly of the pilot pin and the stepped end cavity, the spring means for said guide pins being shown at 20. The pilot die 16 is affixed to a ram 8 of the punch press 10 and is moved downwardly towards a split die member 28 aligned with ram 8 and mounted on the press bed 9, said die member 28 gripping an assembly 15, comprising a ferrule 11, rung 13 and a rail 42, the rung 13 being disposed vertically through bore 35 formed inside the die por-

tions 31, 32 and the pilot pin 18 entering the bore of the rung 13 while it is moved downwards.

It is to be noted that the portions 31, 32 provide an end cavity 36 which conforms in contour to the opposed stepped end cavity 17 in the solid die 16 and conforms in contour also to a flange preformed on one end of the ferrule 11 prior to its positioning in an opening 41, such as shown in the side rail 42 of the ladder.

As shown the side rails are generally of, but not limited to channel-shape and comprise a web 44 and flanges 45, 46 perpendicular to the web. The openings 41 are disposed at spaced intervals along the web of the rails. The opening 41 disclosed is preferably, but not essentially, provided with circumferentially of peripherally spaced-apart notches 41a as shown. The split die members 31, 32 are actuated upon downward movement of the ram 8 by cam members 37—37, 38—38 carried by the upper die shoe, and said cam members are adapted, during downward movement of the upper die 16, to contact cam-follower surfaces 39, 40 provided on die blocks 39', 40'. The reciprocal movement of the upper die member 16 is guided by members 21 secured to a split die mounting 22 and slidably journaled in bushings 23 projecting through openings 25 in the upper die shoe 26. The die members 31, 32 are adapted to grip and center the ferrule-and-rung assembly 15, as more fully described hereinafter, and the web 44 of the side rail is adapted to be seated upon flat work surfaces 47, 48 of the die members 31 and 32, respectively.

It is to be noted that the cam members 37—37, 38—38 are provided on generally yoke-shaped members 50, and the spacing between the legs of the yoke having the cam surfaces thereon is sufficient to accommodate the rail 42 therebetween. The assembled ferrule and rung are securely held by the split die member 28 during the down-stroke and in alignment with the pilot pin 18, whereby the latter is caused to enter the bore of the tubular rung 13, and due to its formation and dimensioning, as shown, the pilot pin enters the bore with a progressive swaging action engaging the end of that bore immediately beneath the ferrule 11, as hereinafter more fully described; the spring-loaded guide pins 19 are adapted to locate the pin 18 and exert pressure during such swaging action upon spaced rail portions, surrounding the opening 41 in the rail 42 through which the ferrule end of the rung projects.

When the die 16 reaches its lowermost position, the die cavity 17 receives an end 52 of the ferrule, forming a flange 58 which corresponds in contour to the flange 43 preformed on said ferrule. Hence, opposite faces of the wall portions of rail 42 surrounding the rail opening 41 are clamped between simi-

lar flanges 43 and 58, as shown in Figures 4 to 7 inclusive. When the punch or solid die member 16 is applied to the end 52 of the ferrule and surrounds the same, the pressure applied by the die 16 causes the ferrule metal to flow into the cavity 17. The endwise compression of the ferrule further causes ferrule metal to flow outwardly into compressive engagement within the opening 41 and to provide side-rimming flow along a side of the wall portions of opening 41.

In addition, ferrule metal flows slightly radially inwardly in a compressive grooving action into the wall or upon the outer surface of the end portion of the rung 13 to provide therein a groove or depression 53. This inward collapse of the rung during forming allows the ferrule to expand radially inwardly to form an inwardly projecting rib which interlocks with the depression 53 to clamp the rung to the ferrule, as shown; where the rail openings 41 are provided with notches 41a, ferrule metal expands radially outwardly and fills such notches.

It is to be noted that Figures 8 and 9 disclose the prior-forming of the ferrule by coining a straight ferrule, such as that shown at 15', in a die 16', said die 16' being formed similarly to the die 16, and having a stepped end cavity 17' and a pilot pin 18'. The pilot pin 18' enters the bore of the ferrule. A solid die member 28', having a stepped end cavity 29', with the contour preferred for the flange to be formed on an end of the ferrule, surrounds the outer end of the ferrule and applies pressure, causing the ferrule metal to flow into said cavity 17'. The flange 43 is thus formed on the ferrule; the flanged ferrule can then be used for assembly with the rung and rail according to the disclosure of Figures 1 to 7 inclusive and the disclosure of Figure 10. On the upstroke of the press, the pilot pin 18' strips the thus formed ferrule from the die 28' and thereafter conventional mechanisms may be employed to strip the ferrule from the punch and pilot means.

In Figure 10 a horizontal punch press 100 is shown, having a stem 122 adapted to be clamped to the ram of the press said stem being secured to a top die shoe 126 having a cam member 104 secured to one end of the shoe 126 and adapted to act on a cam 101 at an end of a horizontally disposed, movable solid die member 99. The solid die member 99 has a shape similarly to that of the solid die member 16 in the punch press of Figures 1—3 inclusive, a pilot pin 98 projecting forwardly thereof and an end cavity 170 being provided therein, and spring-loaded guide pins 108 being carried thereby. A split die 124 is adapted to be disposed in spaced relationship thereto, the lower half 141b of the split die being secured to a bottom die shoe 140 and its upper portion 141a being secured to spring-tensioned guide rods 128. Helical spring means

132 are adapted during operation to exert pressure on the upper half 141a to cause the split die 124 to close and to engage the rung 134 before the cam 104 reaches its lowermost position in which the solid die 99 is caused to move towards a rung, ferrule and rail assembly, gripped by the split die 124.

The ferrule 135 in this modified form of the invention is shown overhanging an end of a rung 134, as in the form of Figures 1 to 3 inclusive with respect to rung 13, and in such modification there will be no movement of the rung 134 during swaging by the movable die means. It will be noted that in the form shown, the pilot pin 98 is loaded by a spring 150, said spring being secured at one end to a movable die-mounting 151 and at its other end to a support 153 secured to the press bed 140.

It is to be noted that the pilot pin 98, similarly to the pilot pin 18, is of a diameter which is slightly smaller than the inner diameter of the rung and that it moves forward on a down-stroke of the ram, whereas on an upstroke of the ram, the spring 150 returns the pilot pin and solid die 99 to the position shown in solid lines in Figure 10. Should the ferrule be placed on the rung so that its unflanged end portion is flush with the end of the rung or be adapted to the use of overhang ferrules, then the rung will have to be shifted away from the solid die 99 during swaging. In the case where a pair of dies are used to form both ends of a rung simultaneously, the dies should preferably be adapted to float away from the ends of the rung or overhang ferrules be used.

In the form of the invention illustrated in Figure 10, the split die 124 has an end cavity and is shown as remaining stationary during swaging, the solid die 99 being movable. It will be understood, however, that the split die gripping the rung, ferrule-and-rail assembly may be caused to move and the solid die remain stationary, or both the solid and split dies may be caused to move simultaneously. In operation, as shown in Figure 10 and the rail faces the opposite way compared with Figure 6 the ferrule-rung-and-rail assembly, is placed in the bottom half 141b of the split die 124 while the top part 141a is held above spaced from the bottom part. The ram is then moved downwardly, causing the upper die portion 141a to close about the rung 134; during this operation, the side rail 142 is disposed forwardly of the edge of the split die. After the rung is surrounded and gripped by the two parts of the split die 124, the ferrule-rung-and-rail assembly is moved from the position shown in chain lines back or to the right to the position shown in solid lines. The die now surrounds a flange 143 preformed on the ferrule 135; the spring-loaded guide pins 108 act on the side rail 142

to maintain the same perpendicular to the axis of the rung 134; the pilot pin 98 is caused to enter the bore of the rung 134, and aligned portions of the end cavity 170 of the solid die 99 engage the edge 152 of the ferrule 135, applying a compressive force thereto to cause the metal to flow radially outwardly into compressive engagement within the opening in the rail and in a side-rimming flow along the side of that rail facing the die 99 and surrounding that opening. As pressure is applied, there will be relative movement between the rung and the side rail and ferrule. The pilot pin is adapted to control the inward collapse of the rung and ferrule as described in connection with the embodiment of Figures 1 to 7, inclusive, and the movement of the ferrule metal is as heretofore described.

On the upstroke of the press, after the cams 101, 104 are disengaged, the tension spring 150 strips the solid die 99 and pilot pin 98 from the swaged assembly. During this interval, the compressed springs 132 hold the top die member 141a of the split die 124 in engagement with the rung and maintain the assembly in its initial clamped position. The compression springs 132 are thus adapted to hold the upper die member stationary for a certain distance even during movement of the ram and the top die shoe upwardly, to retain the rail assembly therein until the assembly is stripped therefrom mechanically or manually.

In Figures 11 to 14, an arrangement is shown for forming flange or a ferrule 210 while the latter is placed on the rung 234. In this approach, a solid die 218 carrying a specially formed spring-loaded pilot pin is employed; the pin shown is a floating pin having a swaged end or nose portion 232, an annular part 232a adjacent thereto, a stepped shoulder 214' and a stem portion 216, having an enlarged flange 222. The step portion 216 is adapted to be disposed in a bore 216a in the solid die member 218, and the enlarged flange or head 222 of the pilot pin is of greater diameter than the inner diameter of the bore 216a. Said head 222 is seated in an enlarged rearwardly disposed bore 220 in the die member 218 and is movable between fixed stops 226 and 228. A coil spring 224 is seated in a recess 229 in a rear wall 228 of the die member 218, and the opposite end of the coil abuts against the head 222 of the pilot pin.

A straight ferrule shown at 210 is first telescoped over a portion of the stem 216 and is carried in a central tapered opening 230 adjacent the forward end of the solid member 218. The die member is then moved forwardly from the position shown in Figure 11 towards a split die member 236 which grips a rung 212 therein and said ferrule is adapted to be provided, as shown in Figure 12, with a portion which is telescoped over an end of the rung 212, projecting out-

wardly of the split die member, as best shown in Figure 11. Continued movement of the die and pilot pin into the bore 234 of the rung causes the ferrule to be advanced to bottom on the end cavity 238 and continued pressure by means of movement of the solid die causes the die 218 to exert a swaging pressure upon the ferrule to expand the same radially outwardly into the end cavity causing a flange to be formed therein and at the same time an inward radial movement of the rung and ferrule produces in the ferrule an inwardly projecting rib and in the rung a groove or depression as indicated at 260 (Fig. 14). The pilot pin 232, similarly to the pilot pins 18 and 98 in Figures 1 and 10, backs up such inward flow.

It will be noted that in the form shown in Figure 11, the pressure exerted by the spring 224 is added to that of the member so as to increase the overall pressure exerted. Figure 14 shows the radially inward collapse of both rung and ferrule, as well as the radially outward expansion of the ferrule metal to form the flange on the ferrule.

Referring now to the form of ferrule for producing the ladder joint shown in Figure 15, channel-shaped ladder side rails 310 are first provided with spaced openings 311 in the web thereof conforming in shape to the ladder rungs 312 and ferrule 313 to be received therein. The openings 311 are circular in form and the rungs 312 are circular in cross-section and preferably serrated on their outer surfaces. The ferrules 313 are tubular, each having a bore 314 of only slightly greater diameter than the rungs whereby the ferrules may be tightly press-fitted or telescoped over the rungs.

The ferrules 313 are provided, prior to their assembly with the rungs, with an outwardly curved flange 315 of relatively large diameter intermediate an annular stepped portion 316 and a shoulder 317 of relatively smaller diameter. The shoulder 317 merges with the flange 315 by means of an outwardly curved portion 318. The flange 315 is provided with a straight inner face 319 disposed perpendicular to the surface of the step 316. The step 316 is of greater radial cross-section than the remaining tubular portion 320 of the ferrule, and portion 320 has therefore the smallest cross-section of all portions of the ferrule; the step is of the same width as the thickness of the web 321 of the rail and is adapted to be disposed within the opening 311 so as to strengthen and reinforce the rail during assembly of the latter and in its use.

As shown in Figure 17, each of the ferrules with its preformed flange 315 is telescoped over an end of its associated rung 312 and preferably overhangs the same, the end 320 protruding outwardly therefrom, the shoulder or stepped portion 316 is peripherally enclosed by the portions of the web 321 surrounding

the opening 311 in the rail 310 and the protruding portion 320 and telescoped end of the rung 312 projects outwardly of the rail web. The protruding portion is adapted to be

5 formed by compression, as hereinbefore disclosed, into an outer flange 322 which, as shown in Figure 15, overlies the outer wall of the rail web 321, surrounding the opening 311. As shown in Figures 15 to 17, the flange

10 315 is of greater diameter than the flange 322 formed as above described whereby considerable support is provided for the web 321 of the side rail 310 while compressive stress is exerted in forming said flange 322 and securing the ferrule to the rail. The flange

15 322 further reduces radial stress and bearing stress in the side rail.

The step 316 is preferably joined to the body portion 320 as best illustrated in Figure

20 16, by a rounded or tapered edge 323 whereby upon compression the material of the ferrule portion 320 readily flows over the same to form the flange 322 securing the ferrule to the rail 310.

25 In the third form of my invention shown in Figures 18 and 19 inclusive, adapted for use with a rail having spaced side walls and being, e.g. of tubular or box-like shape, the tubular ferrule 313' is provided with a pre-

30 formed flange 315', a preformed shoulder 317' joined thereto and being of smaller diameter than the flange 315'. The flanges are disposed at the inner edge of the ferrule, and are of greater radial cross-section than other portions of the tubular ferrule 313'.

35 The flange 315' is provided, similarly to flange 315 in the form of Figures 15 to 17 inclusive, with a flat outer face 319' which is disposed at right angles to the tubular body portion 320' of the ferrule and is adapted to abut against the outer wall portions 330 surrounding an opening 311'' in a portion 330 of the inner wall of the box-shaped and, as illustrated, rectangular tubular rail 310' through which the

40 body portion 320' of the ferrule, enclosing an outer end of the rung 312', projects. It will be noted that a flange of reduced diameter forming a step or shoulder 316' is provided intermediate an outermost portion 325 of the ferrule and the body portion 320'. When the ferrule protrudes through the opening 311'' in a wall portion 330 of the tubular rail, the step 316' is disposed within the opening 311' and the body portion 320' acts as a spacer disposed between the outer rail wall 310'' and the flange 315'. The shoulder 316' is thus circumscribed by the outer wall 310'' of the rail surrounding the opening 311' and strengthens that wall while compressive stress is exerted on the protruding end 325 of the ferrule in pressing the same against the outer wall surface surrounding said opening and forming the flange 326 around the opening 311' as shown in Figure 19. The tubular end 325 of the ferrule preferably overhangs

the rung prior to its assembly with the rail, in a manner similar to the body portion 320 in Figures 15 to 17. It will be noted that the forward edge 321' of the portion 320' in the latter embodiment abuts against the inner wall surfaces 327, surrounding the opening 311' and, together with flange 315'', acts as back-up reinforcement means during the securing of ferrule and rung to the rail.

It will further be noted that the opening 311' is smaller than the opening 311'' and that the shoulder 316' is smaller than the flange 326.

Referring now to the fourth form of the ferrule of this invention as shown in Figures 20 to 24, to produce the joint shown in Figure 24, a tubular side rail 410 of rectangular box-like form having parallel spaced side walls 411 and 412 is provided, said side walls having aligned rung openings 413 and 414 respectively, the opening 413 in the inner wall being, in the form shown, of greater diameter than the opening 414 in the outer wall. As shown herein, the rung openings 413 and 414 are preferably circular in form and receive the circular ferrule members 415 and 416, respectively and circular rungs 417 therein.

Each of the ferrule members 415 and 416 is formed as a sleeve and provided with a flange 418, 418' and a shoulder 419, 419' respectively about its outer peripheral edge, said flanges and shoulders being formed prior to assembly with the rung in any preferred manner such as that shown in Figures 8 and 9. The flanges 418, 418' and the shoulders 419, 419' are adapted to abut against portions of the rail surrounding the rung opening through which the respective ferrule member is inserted, when the ferrule members are assembled with the rung and rail.

The first ferrule member 415, as shown in Fig. 22 is of substantially cylindrical form, the interior of the same consisting of two parts 420, 421 of different inner diameter, the portion 420 underlying the flange 418 and shoulder 419 and portions adjacent thereto, being of smaller inner diameter than the end portion 421 extending therefrom. An inner shoulder 422 is thus provided between the portions 420, 421 of the ferrule and the shoulder 422 is preferably curved inwardly from the portion 421 toward the portion 420 into which it merges.

The second ferrule member 416, as shown in Figure 23, is also cylindrical in form; the interior of the same is preferably of constant diameter throughout, its outer diameter being substantially the same as the inner diameter of the portion 421 of the first ferrule member 415.

It is to be noted that in assembling the rail and rung, the ferrule member 415 is preferably press fitted over the rung 417 with an end portion 424 of said rung 417 extending outwardly thereof for a short distance. The

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5 rung 417 and the ferrule member 415 are then projected into the larger rung opening 413 in the side wall 411 of the tubular rail 410. The ferrule member 415 is of such length that when the preformed flange 418 abuts against the outer surface of the inner wall 411, the outer edge 425 of the ferrule member 415 is stopped by and abuts against that portion of the inner surface of the outer side wall 412 of the tubular rail 410 which surrounds the opening 414 therein. Clearance is provided between the portion 421 of the ferrule 415 member and the rung 417 into which the body portion 416' of the ferrule member 416 is projected. The ferrule member 416 is provided with a curved inner edge 427 which abuts against and is cammed inwardly by the shoulder 422. The ferrule member 416, is preferably of slightly greater length than the portion 421 of the ferrule member 415 into which it is press-fitted and further driving force on the ferrule member 416 distorts underlying portions of the rung 417 as shown at 427' and keys the ferrule members 415, 416 to the rung.

30 In the event further security is desired between the ferrule members, a plurality of longitudinal grooves 428, 429 may be provided in the interior of the ferrule member 415 and in the exterior of the body portion 416' of the ferrule member 416 respectively and adhesive material, such as epoxy resin, may be injected therein. The grooves 428, 429 are adapted to communicate with each other, as shown.

35 The method according to the invention provides a stress-and-strain resistant ladder joint, with reinforcing means provided therefore to strengthen structurally those portions of the side rails adjacent the rung openings, which, in the case of fiber glass ladders, is of particular importance. The rungs may be of aluminium, fiber glass, or other material, corrugated or uncorrugated, and the ferrules of aluminium or other light weight material. The form of the rungs, rung openings and ferrule members may be varied; as for example, they may be of oval or rectangular form if desired, without departing from the invention herein shown, described, and claimed. In the event of the rungs being D-shaped, rectangular, square, oval, or of any other shape, it will be understood that the rail openings and ferrules will be suitably formed to receive such shapes.

55 We are aware that within the scope of the appended claims, numerous and extensive departures may be made, e.g. in size and shape of the various parts of the joint according to the invention.

WHAT WE CLAIM IS:—

1. A method of making a joint between a rail of a ladder and a hollow rung thereof with the aid of a metal ferrule, having a smooth

65 end and an end with a prior-formed outwardly projecting flange, as hereinbefore defined, said method comprising the steps of placing said ferrule over said rung, inserting both rung and ferrule into an opening in said rail, so that the smooth end of said ferrule projects through said opening and said prior-formed flange abuts against one side of said rail and subjecting the projecting part of said ferrule to a swaging operation whereby metal from said projecting part is caused to flow radially outwards and in tight engagement with the opposite side of said rail and another flange is formed on said ferrule which together with said prior-formed flange clamps said rail to said ferrule..

70 2. A method of making a joint between a rail of a ladder and a hollow rung thereof with the aid of a metal ferrule, having a smooth end and an end with a prior-formed outwardly projecting flange as hereinbefore defined; said rail having spaced side walls and aligned openings in both side walls, said method comprising the steps of placing said ferrule over said rung, inserting both rung and ferrule into aligned openings in said side walls so that the smooth end of said ferrule projects through said openings and said prior-formed flange abuts against the outside of one side wall, and subjecting the projecting part of said ferrule to a swaging operation whereby metal from said projecting part is caused to flow radially outwards and in tight engagement with the outside of the other side wall and whereby another flange is formed on said ferrule which together with said prior-formed flange clamps both side walls to said ferrule.

90 3. A method of making a joint between a rail of a ladder and a hollow rung thereof with the aid of a metal ferrule according to claims 1 or 2 in which metal from the projecting part of said ferrule is caused by said swaging operation to flow radially inwards and in tight engagement with said rung.

4. A method of making a joint between a rail of a ladder and a rung thereof according to claims 1 and 2 in which an interlocking rib and depression are formed on the circumference of said ferrule and said rung respectively.

5. A method of making a joint between a rail of a ladder and a rung thereof according to claim 4 in which the rib and the depression in said ferrule and said rung respectively are formed by the same swaging operation which produces a flange on the smooth end of said ferrule.

6. A method of making a joint between a rung of a ladder and a rung thereof according to claim 4 in which the rib and the depression on said ferrule and on said rung respectively in a separate swaging operation.

7. A method of making a joint between a rail of a ladder and a hollow rung thereof according to any of the preceding claims and



5 rung 417 and the ferrule member 415 are then projected into the larger rung opening 413 in the side wall 411 of the tubular rail 410. The ferrule member 415 is of such length that when the preformed flange 418 abuts against the outer surface of the inner wall 411, the outer edge 425 of the ferrule member 415 is stopped by and abuts against that portion of the inner surface of the outer side wall 412 of the tubular rail 410 which surrounds the opening 414 therein. Clearance is provided between the portion 421 of the ferrule 415 member and the rung 417 into which the body portion 416' of the ferrule member 416 is projected. The ferrule member 416 is provided with a curved inner edge 427 which abuts against and is cammed inwardly by the shoulder 422. The ferrule member 416, is preferably of slightly greater length than the portion 421 of the ferrule member 415 into which it is press-fitted and further driving force on the ferrule member 416 distorts underlying portions of the rung 417 as shown at 427' and keys the ferrule members 415, 416 to the rung.

10 In the event further security is desired between the ferrule members, a plurality of longitudinal grooves 428, 429 may be provided in the interior of the ferrule member 415 and in the exterior of the body portion 416' of the ferrule member 416 respectively and adhesive material, such as epoxy resin, may be injected therein. The grooves 428, 429 are adapted to communicate with each other, as shown.

15 The method according to the invention provides a stress-and-strain resistant ladder joint, with reinforcing means provided therefore to strengthen structurally those portions of the side rails adjacent the rung openings, which, in the case of fiber glass ladders, is of particular importance. The rungs may be of aluminium, fiber glass, or other material, corrugated or uncorrugated, and the ferrules of aluminium or other light weight material. The form of the rungs, rung openings and ferrule members may be varied; as for example, they may be of oval or rectangular form if desired, without departing from the invention herein shown, described, and claimed. In the event of the rungs being D-shaped, rectangular, square, oval, or of any other shape, it will be understood that the rail openings and ferrules will be suitably formed to receive such shapes.

20 We are aware that within the scope of the appended claims, numerous and extensive departures may be made, e.g. in size and shape of the various parts of the joint according to the invention.

WHAT WE CLAIM IS:—

1. A method of making a joint between a rail of a ladder and a hollow rung thereof with the aid of a metal ferrule, having a smooth

65 end and an end with a prior-formed outwardly projecting flange, as hereinbefore defined, said method comprising the steps of placing said ferrule over said rung, inserting both rung and ferrule into an opening in said rail, so that the smooth end of said ferrule projects through said opening and said prior-formed flange abuts against one side of said rail and subjecting the projecting part of said ferrule to a swaging operation whereby metal from said projecting part is caused to flow radially outwards and in tight engagement with the opposite side of said rail and another flange is formed on said ferrule which together with said prior-formed flange clamps said rail to said ferrule..

70 2. A method of making a joint between a rail of a ladder and a hollow rung thereof with the aid of a metal ferrule, having a smooth end and an end with a prior-formed outwardly projecting flange as hereinbefore defined, said rail having spaced side walls and aligned openings in both side walls, said method comprising the steps of placing said ferrule over said rung, inserting both rung and ferrule into aligned openings in said side walls so that the smooth end of said ferrule projects through said openings and said prior-formed flange abuts against the outside of one side wall, and subjecting the projecting part of said ferrule to a swaging operation whereby metal from said projecting part is caused to flow radially outwards and in tight engagement with the outside of the other side wall and whereby another flange is formed on said ferrule which together with said prior-formed flange clamps both side walls to said ferrule.

80 3. A method of making a joint between a rail of a ladder and a hollow rung thereof with the aid of a metal ferrule according to claims 1 or 2 in which metal from the projecting part of said ferrule is caused by said swaging operation to flow radially inwards and in tight engagement with said rung.

85 4. A method of making a joint between a rail of a ladder and a rung thereof according to claims 1 and 2 in which an interlocking rib and depression are formed on the circumference of said ferrule and said rung respectively.

90 5. A method of making a joint between a rail of a ladder and a rung thereof according to claim 4 in which the rib and the depression in said ferrule and said rung respectively are formed by the same swaging operation which produces a flange on the smooth end of said ferrule.

95 6. A method of making a joint between a rung of a ladder and a rung thereof according to claim 4 in which the rib and the depression on said ferrule and on said rung respectively in a separate swaging operation.

100 7. A method of making a joint between a rail of a ladder and a hollow rung thereof according to any of the preceding claims and

in which the prior-formed flange of said ferrule is of greater diameter than the flange formed on said ferrule after its insertion into an opening in said ladder rail.

- 5 8. A method of making a joint between a rail of a ladder and an open-ended hollow rung thereof according to claim 1 in which said ferrule comprises a tubular body portion and a stepped portion, arranged between said
10 body portion and said prior-formed flange and having a diameter smaller than said flange and larger than said body portion, the inner face of said flange being perpendicular to the surface of said stepped portion and in which
15 said stepped portion is disposed within the opening of said ladder rail when said ferrule is inserted into said opening, whilst said inner face abuts against one side of said rail, and said tubular body portion is subjected to
20 said swaging operation.

9. A method of making a joint between a rail of a ladder and a hollow rung thereof according to claim 2 in which said ferrule comprises a tubular body portion, the inner face of said prior-formed flange being perpendicular to the surface of said body portion, an outermost portion at the opposite end of said body portion, and a step portion intermediate said body and outermost portions, said
30 stepped portion having a diameter smaller than said body portion and larger than said outermost portion, and in which said stepped portion is disposed within the opening in the outside side wall of said rail, when said ferrule, together with said rung, is inserted into the
35 coaxial openings in the side walls of said rail, whilst said flange abuts with its inner face against the inside side wall of said rail, and said outermost portion is subjected to said swaging operation.
40

10. A method of making a joint between a rail of a ladder and a hollow rung thereof, said rail having spaced parallel side walls, and coaxial openings in the side walls, with the aid
45 of two ferrules, each ferrule having a prior-formed outwardly projecting flange, as hereinbefore defined, at one of its ends, one of said ferrules being formed for part of its length with an internal diameter substantially equal to the external diameter of said rung whilst the remainder of said ferrule has an enlarged internal diameter and the second ferrule being formed throughout its length with an internal
50 diameter substantially equal to the external diameter of said rung, the external diameter of said second ferrule being substantially equal to the enlarged internal diameter of said first

ferrule, said method comprising the steps of press-fitting said first ferrule to said rung, inserting said first ferrule and said rung through an opening in the inside side wall of said rail and inserting said second ferrule through an opening in the outside side wall of said rail, and telescoping said second ferrule with a press-fit into said first ferrule and onto said rung, so that both side walls of said rail are abutted by the prior-formed radially projecting flanges of said ferrules.

11. A method of making a joint between a rail of a ladder and a hollow rung thereof according to claim 10 in which an interlocking depression and rib are formed in the circumference of said rung and of one of said ferrules respectively.

12. A method of making a joint between a rail of a ladder and a hollow rung thereof according to claim 10 or 11 in which the smooth end of said first ferrule abuts against the outside wall of said rail, after said ferrule has been inserted through the opening in the inside side wall.

13. A method of making a joint between a rail of a ladder and a hollow rung thereof according to claims 10, 11, or 12, in which said ferrules are provided on their interengaging portions which longitudinal grooves and in which adhesive material is injected into said grooves.

14. A method of making a joint between a rail of a ladder and a hollow rung thereof according to any of the claims 1 to 9, in which the smooth end of the ferrule on which the second flange is formed by a swaging operation, overhangs said rung at the beginning of said swaging operation.

15. A method of making a joint between a rail of a ladder and a hollow rung thereof according to any of the claims 1 to 9, in which said rung and the ferrule on which the second flange is formed by a swaging operation, are held against displacement relative to said rail during said swaging operation.

16. A ladder having hollow rungs and in which said rungs are joined to a rail of said ladder by a method in accordance with any of the preceding claims.

17. A ladder having hollow rungs substantially as described with reference to any of the accompanying drawings.

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