

Feb. 21, 1950

R. PAPALIA
NAIL DRIVING APPARATUS

2,498,503

Filed May 9, 1945

4 Sheets-Sheet 1

Fig. 1

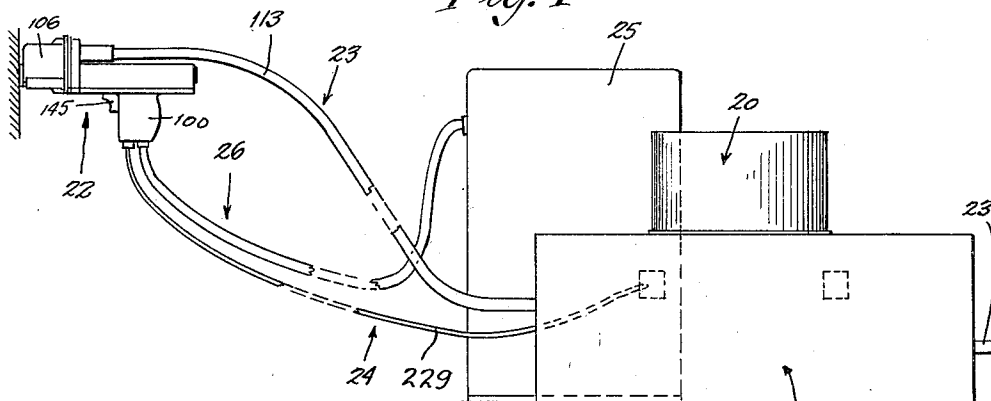


Fig. 13

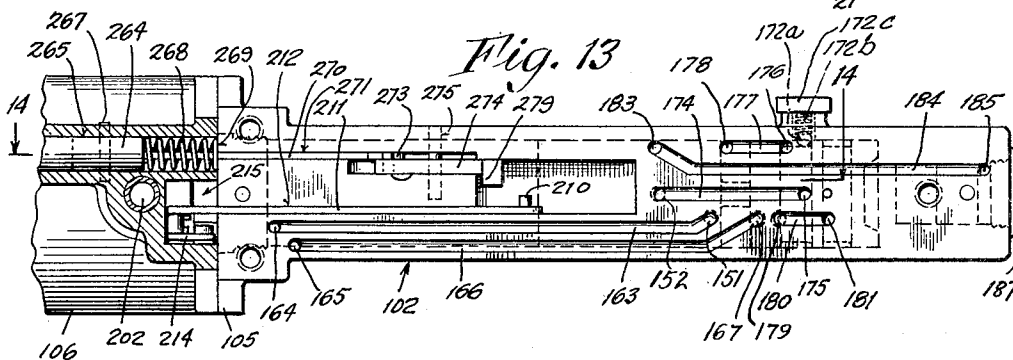


Fig. 14

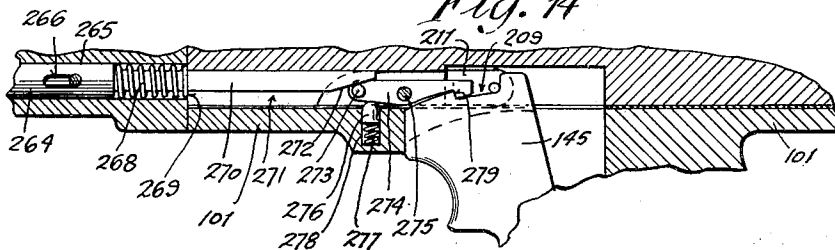
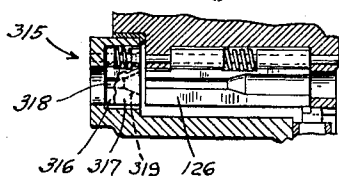


Fig. 19

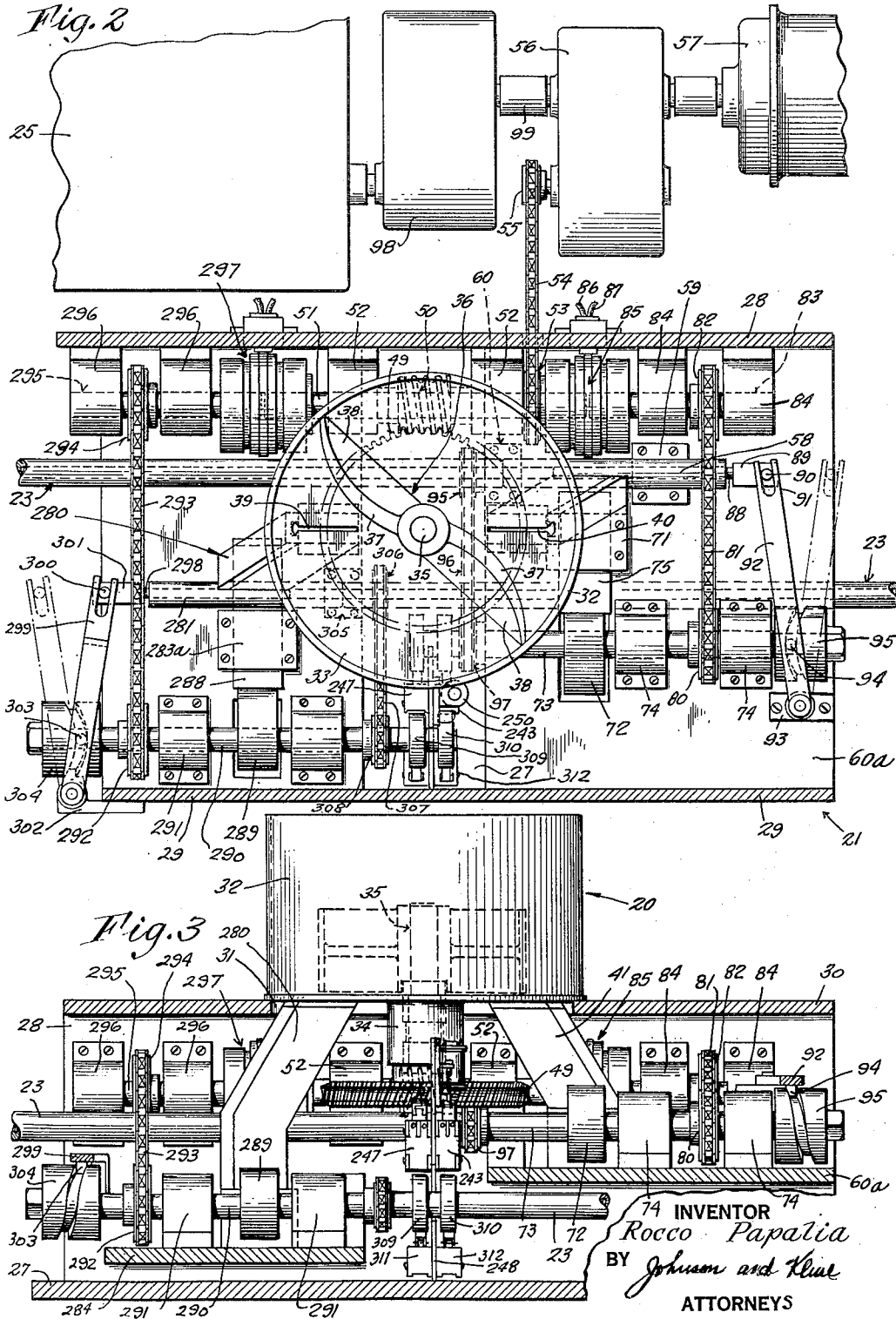


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Fig. 2



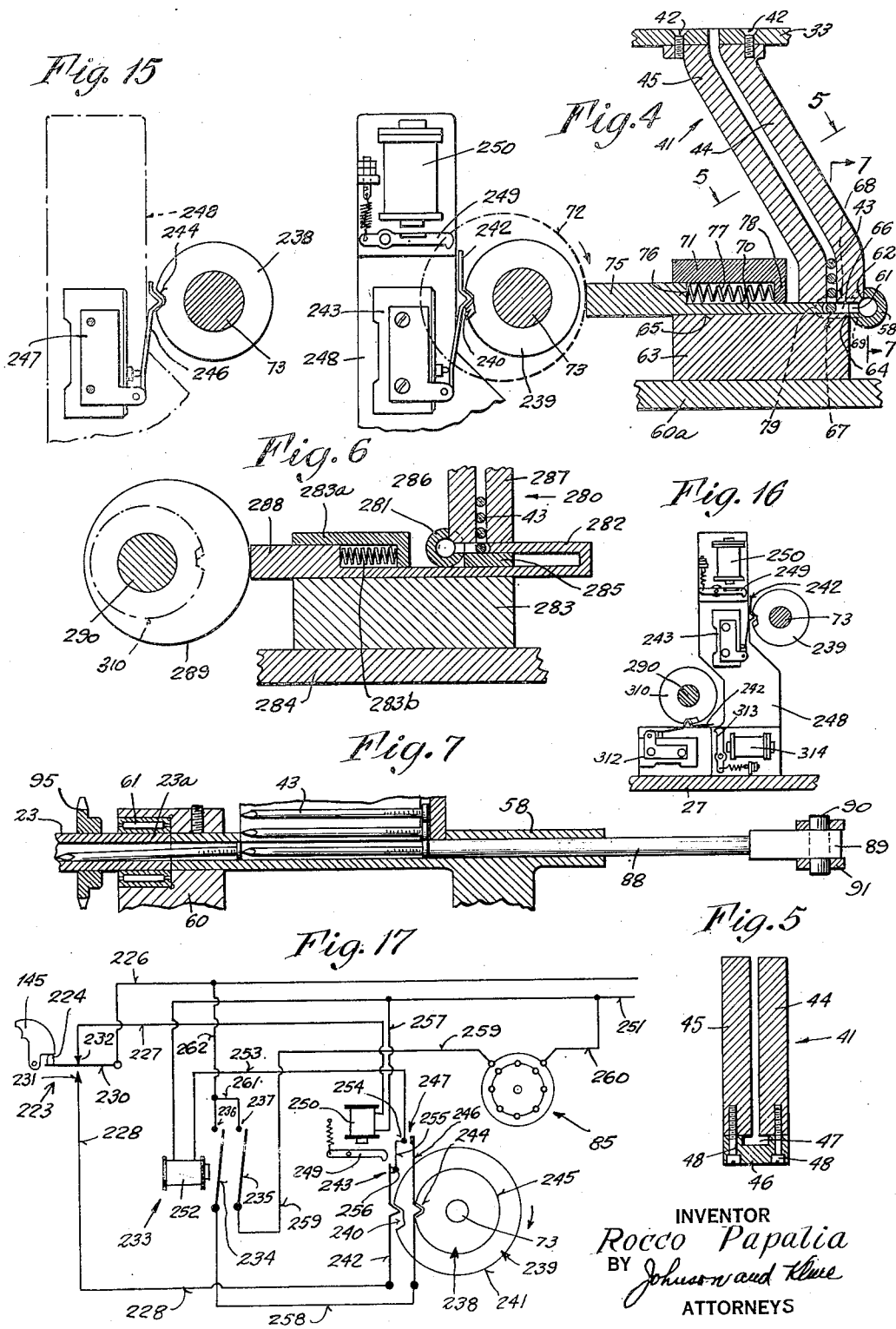
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4 Sheets-Sheet 3



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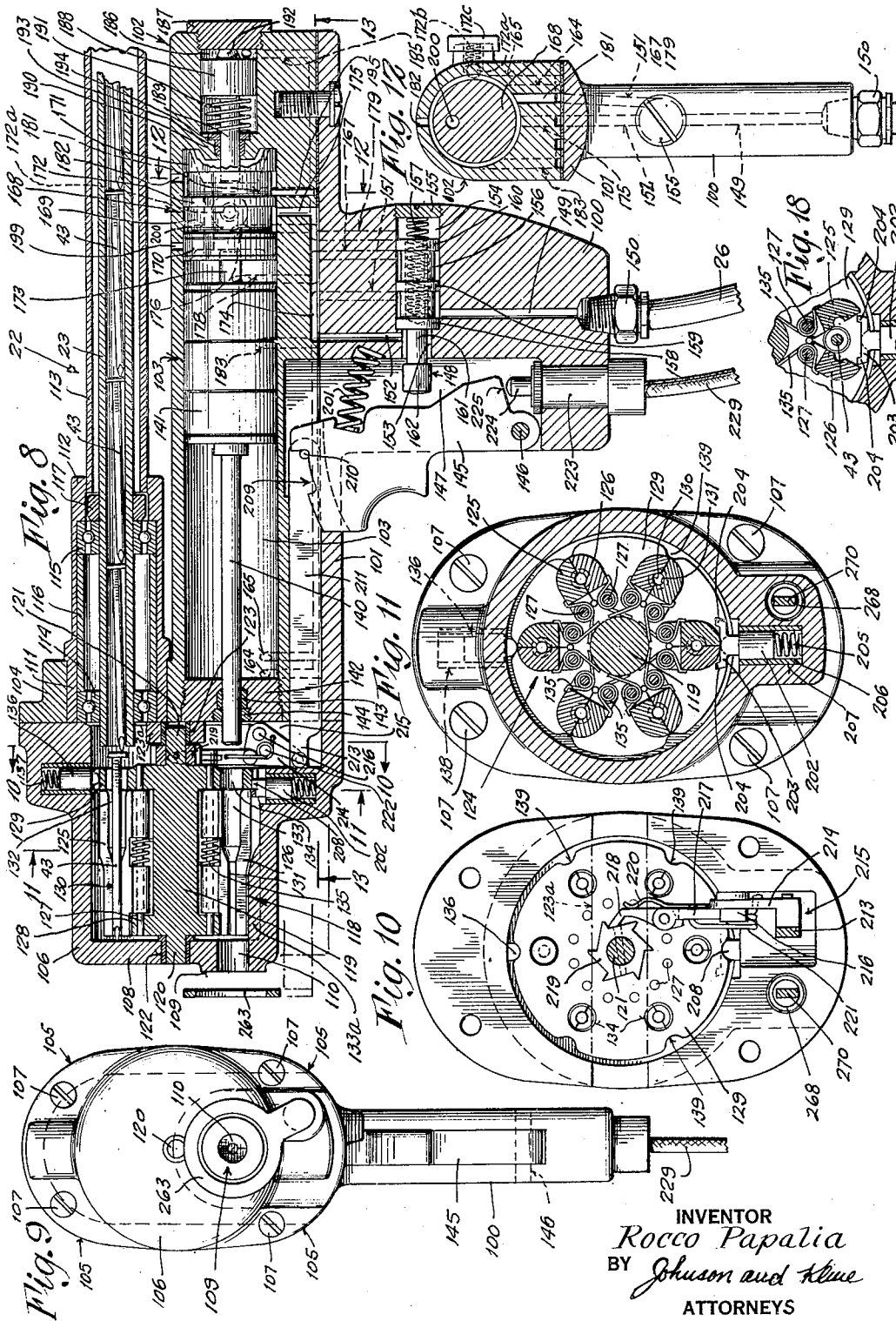
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NAIL DRIVING APPARATUS

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UNITED STATES PATENT OFFICE

2,498,503

NAIL DRIVING APPARATUS

Rocco Papalia, Bridgeport, Conn.

Application May 9, 1945, Serial No. 592,737

29 Claims. (Cl. 1—1)

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This invention relates to nailing machines, and more particularly to semi-automatic, power-driven, portable nailing machines.

Heretofore, in building construction where wooden beams, studs, siding and the like were to be assembled by nailing, the common procedure was to fit the members in place, usually holding them with one hand, while the nailing was done by a hammer which was swung with the other hand. This procedure was generally tiresome and time-consuming, and slowed considerably the erection of the structure.

An object of the present invention is to obviate the disadvantages of this erection procedure as practiced in constructing structural forms, buildings and the like. This is accomplished by the provision of a highly efficient, conveniently operative, automatic nailing machine wherein a large number of nails may be quickly and accurately driven in succession into beams, siding, sheathing and the like, all with a minimum of skill and effort being required on the part of a workman. The nailing machine as provided by the invention comprises a hopper wherein a large quantity of nails may be deposited, and comprises a feeding means associated with the hopper for feeding nails therefrom one at a time for driving into the work, and also comprises portable hammering tools of light and compact design which may be easily held and manipulated by a workman, and may be applied in any position to the work, even where space is constricted, the hammering tools being flexibly connected with the hopper and feed mechanism so that nails may be automatically conveyed to it to replace the nails driven into the work. The hopper and feeding mechanism is so arranged that it may feed nails equally well to more than one hammering tool as a result of which several workmen may use the machine simultaneously to nail work in different places, all of the nails for the operations being supplied from the one hopper. The flexible connections between the hammering tools and the hopper and feed mechanisms may be of substantial length, so that the range or area covered by the machine is considerable for any given position of the hopper. The hammering tools may be operated simultaneously or singly as desired, the machine therefore being flexible in its operation.

Another object of the invention is to provide a powered automatic nailing machine which is safe in use, so that the likelihood of workers becoming inadvertently injured is considerably minimized. It is important that with a machine of the present type, special safety means be

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provided since the hammering tools are somewhat of the nature of guns from which the nails, acting as missiles, may be ejected under considerable velocity. If these nails were ejected into space, they could strike a worker either directly or by rebound and cause severe personal injury. By the present invention inadvertent ejection of the nails from the hammering tools when the latter are not being applied to workpieces is prevented by a safety device which automatically locks or makes inoperative the hammering means. However, when the hammering tool is applied to a workpiece preparatory to driving a nail therein, the safety device is automatically operated so that the hammering means may be made operative, and may then strike repeated blows to drive in the nail.

Yet another object of the present invention is to provide a powered automatic portable nailing device wherein, when a nail has been driven home, the hammering is automatically discontinued, and may not be again started to further drive the same nail. Thus, all of the nails will be driven home to the proper depth, and will not be overdriven or inadvertently countersunk, nor will they be underdriven. In accomplishing this the hammering tool is so organized that when the reciprocating hammering attains a certain advanced position it will be automatically de-energized even though the control means for the hammer is maintained in operative position. When, however, the control means is released, a new nail is automatically presented to the hammer, and subsequent operation of the control means will then again energize the hammer and cause it to operate.

Still another object of the invention is to provide a nailing machine having a hammering tool flexibly connected with a hopper, wherein the likelihood of jams occurring in the flexible conveying means between the tool and the hopper is minimized. As a result, the loss of time which would be occasioned by locating jams and freeing the same is practically eliminated, resulting in much higher production in a given period of time. The flexible connection between the hopper feed mechanism and the hammering tool, in the embodiment of the invention illustrated herein, comprises a flexible tube through which the nails are fed end to end preferably points foremost. Means are provided for rotating this tube so that the movement of the nails therethrough is facilitated, and so that the possibility of a nail catching on the inside of the tube is eliminated.

A still further object of the invention is to

provide an improved hopper and feed mechanism whereby elongate articles such as nails, rivets and the like may be fed, by force and with a positive action, to the applicator or hammering tool. By thus dispensing with a feed wherein reliance is solely placed on gravity, the delivery of the nails to the hammering tool is made positive and effective.

A feature of the invention is that the positive mechanism of the machine is made to operate through but a single complete feeding cycle in response to the actuation of the hammering tool to drive in a nail, and the mechanism is automatically halted or made inoperative until the next nail of the hammering tool is being started in the work. The feed mechanism responds to actuation of a manually operable trigger of the hammering tool, as the latter is depressed during the nail-driving operation. The control for the feeding mechanism is such that the single cycle of operation will not be repeated regardless of how long the trigger is held in or depressed, and if the trigger should be inadvertently released after the cycle has once been initiated and before the hammering is completed, the cycle will still be carried to completion.

Another feature of the invention is the timing of the rotation of the flexible nail-conveying tube, so that the latter turns only periodically and only when nails are being fed through the tube. This reduces the power required to operate the machine, and reduces wear on the flexible tube, and the bearings for the latter.

Still another feature of the invention is the provision, in a power-driven, automatic portable hammering tool fed from a remote hopper, of a single manually operable member which takes care of the operations of positioning the nails one by one in front of the hammer, controlling the operation of the latter, and also controlling the forced-feed to the hammering tool as well as the rotation of the conveying tube, all automatically and in proper sequence without requiring attention on the part of the workman. The manually operable member of the tool, which is in the form of a trigger, is reciprocally movable between off and on positions. To operate the various parts of the nailing machine all that is required of a workman is merely to press the trigger and release it. These movements will then automatically coordinate the operations of the machine, to deliver and drive nails into the work at any point where the hammering tool is applied under the direction of the workman. In the embodiment of the invention illustrated herein, when the trigger is depressed the hammer is caused to become operative to drive into the work a nail which has already been properly positioned for driving. Also, the force-feed mechanism of the machine is actuated to deliver another nail to the hammering tool, to make up for the nail being driven into the work. When the nail has been driven home, the hammer automatically becomes inoperative. Upon release of the trigger, the hammer is retracted to its starting position and a new nail is presented in front of the hammer preparatory to the next driving operation. Since all these operations are carried out automatically by merely depressing and releasing the trigger, no skill or thought is required on the part of the workman to use the machine. A feature of the automatic control as thus effected by the trigger movement is that, upon release of the trigger after driving in a nail and when the hammering tool has been re-

positioned to a new place on the work by the workman, a new nail is already in position to be driven and the mere act of depressing the trigger immediately causes the hammer to become operative to drive in the new nail. Thus no time is taken up after repositioning of the hammering tool with any operations such as feeding or positioning the nails, before the hammer may be made operative.

Still another feature of the invention is the provision of an automatic, power-driven hammering tool of portable and compact design wherein, during the initial driving of a nail, the shank of the latter is supported to prevent its bending. As a result, the likelihood of nails becoming bent in the tool and jamming the mechanism thereof is obviated to a great extent.

A further feature of the invention resides in the simplicity of construction and ease of manufacture of the hammering machine as outlined above.

Other features and advantages will hereinafter appear.

In the accompanying drawings:

Figure 1 is an elevational view of the nailing machine of the invention, shown in reduced scale.

Fig. 2 is a fragmentary plan view of the machine, showing the nail hopper and feed mechanisms on a slightly larger scale.

Fig. 3 is a front elevation of the nail hopper and feed mechanisms of Fig. 2.

Fig. 4 is a detail (further enlarged) showing in vertical section the right-hand magazine of the feed mechanism of Figs. 2 and 3, and showing in elevation a circuit control device for the feed mechanism.

Fig. 5 is a section taken on the line 5—5 of Fig. 4.

Fig. 6 is a detail showing in vertical section the lower portion of the left-hand magazine of the feed mechanism, and showing the nail transfer device between the magazine and the nail conveying tube.

Fig. 7 is a fragmentary section taken on the line 7—7 of Fig. 4.

Fig. 8 is an axial section taken through the hammering tool of the machine.

Fig. 9 is a front or head-on elevation of the hammering tool.

Fig. 10 is a part-elevation part-section taken on the line 10—10 of Fig. 8.

Fig. 11 is a part-section part-elevation taken on the line 11—11 of Fig. 8.

Fig. 12 is a section taken on the line 12—12 of Fig. 8.

Fig. 13 is a section taken on the line 13—13 of Fig. 8.

Fig. 14 is a section taken on the line 14—14 of Fig. 13.

Fig. 15 is a detail, in elevation, of another part of the circuit control device for the feed mechanism shown in Fig. 4.

Fig. 16 is a detail showing the circuit control device for the feed mechanisms in side elevation on a reduced scale.

Fig. 17 is a schematic circuit diagram of the electrical control system associated with one of the hammering tools and feed mechanism for the latter.

Fig. 18 is a fragmentary section of a nail transfer means at the discharge station of the hammering tool, the jaws of said means being spread apart by the head of a nail, and being maintained in spread position by a yieldable detent, and

Fig. 19 is a fragmentary section through the

front wall or muzzle of a modified form of hammering tool.

As shown in Fig. 1, the nailing machine of this invention comprises a nail hopper 20 in the form of a vertical cylinder mounted on a housing or frame 21 containing nail feeding mechanisms, also comprises hammering tools 22 (only one of which is shown) connected with the feeding mechanisms by flexible nail conveying tubes 23 and by flexible electric cables 24, and further comprises a compressed air tank 25 shown connected with a hammering tool 22 by an air hose 26.

According to the present invention the machine is so organized that a substantial quantity of nails may be placed in the hopper 20 whereupon the nails will be automatically and positively advanced through the nail conveying tubes 23 to the hammering tools 22 when the latter are operated. The tools are so arranged that when applied to work they may be actuated by an operator, and may receive the advanced nails from the conveying tubes and simultaneously drive previously received nails in succession into the work. The entire operation of the machine is automatic and under the control of the workmen handling the hammering tools 22. The operations required of a workman or operator to drive nails into the work are extremely simple and easily performed, so that an absolute minimum amount of skill is required.

When an operator desires to drive nails into the work it is merely necessary for him to grasp one of the hammering tools 22 and apply the muzzle of the tool to the work at the point where a nail is to be driven. Thereupon, by actuating but a single manually operable member, the hammering tool may be made operative and a nail automatically driven into the work to exactly the depth required. When the nail has reached this desired depth, the hammering tool automatically ceases its blows without any attention being required on the part of the operator. The depth to which the nail is driven may be predetermined, so that the nails can be driven flush, or can be countersunk. As soon as the hammering tool ceases to operate, indicating that the nail has been properly driven home, the workman removes the tool from the work and releases the manually operable member, whereupon the tool automatically becomes ready for use again, to drive in another nail.

The hammering tool 22 is extremely compact and of comparatively small size and weight, so that it may be easily manipulated and readily used in places where space is limited, and the flexible connections 23, 24 and 26 extending from the tool 22 may be of substantial length so that the tool may be used over a wide area without necessitating repositioning of the hopper, feed mechanisms and compressed air tank.

Thus, when the machine of this invention is being used in the erection of buildings, the hopper 20 and housing 21 may be located at a central point on the floor of a building if the latter is of small size, and the hammering tools 22 extended to cover most of the locations where hammering is to be done on this floor. Or, the hopper and housing may be located on the floor above that where the hammering tools are being used so that gravity aids the advancing of the nails through the conveying tubes 23.

Referring to Figs. 2 and 3, illustrating the hopper and feed mechanisms, the housing 21 comprises a base 27 having opposite side walls

28 and 29 which support a cover plate 30. As shown in Fig. 3 the cover plate 30 has a large central aperture 31 over which is supported the hopper 20, the latter having cylindrical side walls extending upwardly from a circular base 33.

The base 33 is of the hopper at its underside is provided with a depending boss 34 through which a vertical shaft 35 extends, the boss acting as a bearing and support for the shaft. A paddle 36 is secured to the shaft 35 inside of the hopper to rotate with the said shaft, the paddle comprising a pair of curved oppositely extending blades 37 having along the centers of their rear faces reinforcing webs 38. The outermost and also the bottom edges of the blades 37 are made to extend closely adjacent to the sides and bottom of the hopper 20 so that there is little clearance between the latter and the paddle 36, thereby preventing any nails from becoming wedged in or jammed at these points and stalling the paddle. Nails which are deposited in the hopper 20 may therefore be made to continuously move in circular paths while resting on the hopper bottom by rotating the paddle 36 counterclockwise.

As shown in Fig. 2 the bottom 33 of the hopper is provided with a pair of oppositely disposed, radially extending slots 39 and 40, each slot having an outline substantially similar to that of a nail, but slightly larger in all dimensions.

Considering the slot 40, a depending magazine tube 41, Figs. 3 and 4, is secured to the underside of the hopper bottom 33 by screws 42 so as to receive and stack in consecutive arrangement nails 43 which fall through the slot.

As shown in Fig. 5 the magazine 41 has a T-shaped bore or interior space which may be occupied by the nails 43 (Fig. 4) in juxtaposed side-by-side relationship. The magazine 41 may be formed in any suitable manner. However, I prefer to construct it of a pair of rails 44 and 45 which are joined together in spaced relationship along one edge by a plate 46 having a rectangular groove 47 extending longitudinally in its inner surface. The plate 46 is preferably secured to the rails 44 and 45 by countersunk filler head-screws 48 as shown.

Thus, if the paddle 36 is continually rotated while the hopper 20 contains nails the latter will be swept over the slots 39 and 40, and considering the latter slot, when the nails are properly positioned they will drop through the same and fill the magazine tube 41 in consecutive side-by-side relationship, as shown in Fig. 4.

For the purpose of driving the paddle 36 continuously, the lower end of the shaft 35 is provided with a worm wheel 49 adapted to mesh with a worm 50 carried on a shaft 51 journaled in bearings 52. The shaft 50 has a sprocket 53 driven by a chain 54 which latter is in turn driven by a sprocket 55 of a gear reducer 56 powered from an electric motor 57. Energization of the motor 57 will therefore result in the paddle 36 being continually rotated, and will therefore cause the nails 43 to be fed to the magazine tube 41.

Adjacent the lower end of the magazine 41 a receiving pipe 58 is mounted, having an inside diameter slightly larger than the heads of the nails 43, Fig. 4. The receiving pipe 58 may be mounted on brackets 59 and 60 carried by a horizontal shelf 60a as shown in Fig. 2. Intermediate its ends at the point where the magazine 41 is located the pipe 58 is provided with a cut 61 to partially receive one lower corner 62

of the rail 44, see Fig. 4. As shown in this figure, the corner 62 is cut off slightly so that it conforms to the inside diameter of the receiving pipe 58. A block 63 is mounted on the shelf 60a of the housing 21 so that an upper corner 64 of the block extends along the outer peripheral surface of the receiving pipe 58 at the cut 61 thereof. The upper surface 65 of the block 63 is made to align with the lower surface of the cut 61 as shown in Fig. 4. A space 66 is provided for between the lower surface of the magazine 41 and the upper surface 65 of the block, this space being slightly larger than the diameter of the shanks of the nails 43. The upper surface 65 of the block 63 has a short groove 67, indicated by dotted lines, extending to the corner 64 to provide clearance for the heads of the nails 43, and the bottom surface of the magazine rail 44 has a corresponding groove 68 similarly indicated, for the same purpose, Fig. 4. Also, the wall of the receiving pipe 58 adjacent the corner 64 of the block 63 is cut out as indicated by dotted lines at 69, so that the cutout is coextensive with the groove 67.

For the purpose of transferring the nails 43 one at a time from the magazine 41 to the receiving tube 58 a transfer slide is provided comprising a plate 70 resting on the upper surface 65 of the block 63, the plate having a thickness such that it may be slidably received between the said upper surface and the lower surface of the magazine 41. A guide for the slide plate 70 is provided in the form of a block 71 which is secured to the block 63 and extends over the plate 70 as shown.

Reciprocation of the slide plate 70 is accomplished by a cam 72 carried on a shaft 73, Figs. 2 and 4, the shaft being journaled in bearings 74 mounted on the shelf 60a of the housing. Engaging the cam 72 is a follower 75 in the form of a block integral with the slide plate 70. The block 75 is thicker than the slide plate 70 so that a shoulder 76 is provided, which is engaged by one end of a compression spring 77, the spring being enclosed by the guide block 71 and its other end engaging an integral shoulder 78 of the block. The spring 77 therefore maintains the follower 75 in engagement with the cam 72, and rotation of the latter will cause reciprocation of the transfer plate 70 so as to shift the nails 43 one at a time from the magazine 41 into the receiving pipe 58. Preferably the working edge of the transfer plate 70 which engages the nails is provided with a concave surface as shown, and a slot 79, indicated by dotted lines in Fig. 4, is formed in said edge to provide clearance for the heads of the nails 43.

When the transfer plate 70 is in the retracted position shown in Fig. 4 it clears the bore of the magazine 41 so that the lowermost nail of the magazine may drop by gravity from the bore onto the upper surface 65 of the block 63. The succeeding nails 43 will then all descend in the magazine by virtue of their weight, this weight being borne by the lowermost nail resting on the block 63. Since all of the nails are closely confined and maintained substantially in alignment side by side there is no possibility of the nail heads overlapping, or of the nails jamming at any point.

The cam 72 and shaft 73 are driven by means of a sprocket 80 carried on the shaft, over which a chain 81 runs, the chain also passing over a sprocket 82 carried by a countershaft 83, see Figs. 2 and 3. The countershaft 83 is journaled

in bearings 84 secured to the side wall 28 of the housing, the bearings carrying the shaft in such location that the latter is aligned with the shaft 51 which is being continually driven by the motor 57.

For the purpose of intermittently operating the countershaft 83 a magnetic clutch 85 is provided, connecting the countershaft with the shaft 51, the clutch being made operative by electrical energization through wires 86 and 87. Operation of the clutch 85 is accomplished automatically as a result of operation of the hammering tool 22 when nails are being driven into the work, as will be more fully explained in detail later. Generally, for each nail driven by the hammering tool 22 the clutch 85 is made operative for a length of time sufficient to cause one cycle of operation of the transfer plate 70, said cycle comprising advancing movement of the plate to transfer a nail 43 to the receiving pipe 58 and retracting movement of the plate back to its starting position, so that a single nail 43 has been removed from below the magazine 41 and placed in the receiving pipe 58.

Nails from the receiving pipe 58 are transferred to the flexible nail conveying tube 23 for delivery to the hammering tool 22, and for this purpose, as shown in Figs. 2 and 7, the nail conveying tube 23 is brought into the housing 21, and its end 23a is coupled to the end of the pipe 58 within the bracket 60, the end 23a being carried by a roller bearing 61 so as to be easily rotatable. Thus, since the nail conveying tube 23 is aligned with the pipe 58 nails received by the latter may be moved longitudinally, point foremost into the conveying tube.

According to the present invention means are provided for forcibly advancing such nails, in succession, through the conveying tube 23 to the hammering tool 22 periodically as the tool drives nails into the work and becomes conditioned for receiving nails to replace those driven.

As shown in Figs. 2 and 3, this positive nail advancing means comprises a plunger 88 adapted to extend through the bore of the pipe 58 so that nails disposed in the latter from the magazine 41 may be driven past the point of transfer. The outer end of the plunger 88 has a head 89 provided with a driving pin 90 which latter is engaged by the fork 91 of a lever 92 pivotally mounted on a block 93 secured to the shelf 60a. The lever 92 has a follower pin 94 extending into the groove of a cylindrical cam 95 which is mounted on the shaft 73 to rotate therewith.

Thus, at the time that the transfer plate 70 is advancing to transfer a nail into the receiving pipe 58 the plunger 88 is being withdrawn from the pipe ahead of the plate by the lever 92 and cam 95. After transfer of a nail, and when the plate 70 is being retracted the plunger 88 is advanced within the pipe 58 causing the transferred nail to be advanced and shifted point first past the transfer opening in the pipe, thereby making way for a succeeding nail.

Repeated periodic operation of this transfer and feed mechanism as controlled by the magnetic clutch 85 will therefore cause the nails 43 in the magazine 41 to be disposed in succession, point foremost within the nail conveying tube 23 so as to completely fill the latter and extend to the hammering tool 22.

To facilitate the feeding of the nails 43 through the flexible conveying tube 23, according to this invention, means are provided for periodically

rotating the tube in step with the operation of the transfer and feeding mechanism controlled by the clutch 85. For this purpose the end 23a of the conveying tube, which is carried by the bracket 60 so as to be rotatable therein, has a sprocket 95 mounted on it, the sprocket being driven by a chain 96 which is in turn driven from a sprocket 97 carried by the shaft 73. Thus the nail conveying tube 23 is made to rotate intermittently, its rotation occurring during the periods that the magnetic clutch 85 is driving the transfer and feeding mechanism for the nails, and by this organization there is minimized the likelihood of the points or heads of the nails becoming wedged or jammed at any place within the conveying tube 23.

Referring again to Figs. 1 and 2, the hammering tool 22 derives its power through the air hose 26 from the compressed air tank 25, which latter is supplied by an air compressor 98 driven through a coupling 99 from the gear reduction unit 56.

Considering now the hammering tool 22, the latter is shown in axial section in Fig. 8. The tool has a casing comprising a handle portion 100 integral with an elongate base portion 101 on which latter there is mounted a housing 102 for the driving mechanism of the hammer, the said mechanism including a cylinder 103. The housing 102 at its foremost end has an upward extension 104, and is provided with flanges 105 at said end to which a nosepiece 106 is secured by screws 107. In its front face 108 the nosepiece 106 has a muzzle 109 in which there is an aperture 110.

The upwardly extending portion 104 of the housing 102 is bored to receive a press-fitted sleeve 111 which extends rearwardly therefrom. The rear end 112 of the sleeve 111 receives and has rigidly secured to it a flexible conduit 113 which incloses the nail conveying tube 23 and protects the latter against injury, as well as permitting rotation of the tube without interference.

For the purpose of rotatably mounting the conveying tube 23 within the sleeve 112 for easy turning, a pair of ball bearings 114 and 115 is provided separated by a spacer sleeve 116. The nail conveying tube 23 extends through and is carried by the ball bearings 114 and 115, and is therefore free to rotate easily when the tube is being driven during advancing movement of the nails 43. A collar 117 is secured to the tube 23 adjacent the bearing 115 to prevent undue axial movement of the tube.

According to the present invention a novel nail transfer and supporting means is provided within the nose portion 106 of the tool casing whereby nails 43 may be received from the conveying tube 23 and may be consecutively automatically positioned preparatory to being driven out through the muzzle 109 into the work. This means is in the form of a drum or rotary member 118 having a core portion 119 whose ends 120 and 121 are of reduced diameter and are carried in bushings 122 and 123 located one in the front wall of the nosepiece 106 and the other in a strut 123a across the rear of the nosepiece, Figs. 8 and 10. The core 119 of the rotary transfer member is thus rotatably mounted to turn within the nose portion of the tool casing. A plurality of nail receiving and supporting means 124 are carried by the core portion 119 of the transfer member 118, said means being located in squirrel cage arrangement about the core portion and each comprising a pair of jaws 125 and 126 mounted on shafts 127 which

latter at their ends are carried by circular flanges 128 and 129 of the core portion 119. The jaws 125 and 126 have semicylindrical, longitudinally extending grooves 130 and 131 respectively which cooperate with each other to provide a cylindrical cavity adapted to accommodate the shank of a nail 43, as shown in Figs. 8 and 11.

Referring to Fig. 8, the grooves 130 and 131 have tapered and enlarged portions 132 and 133 respectively which cooperate to form an enlarged mouth or entrance for the nails, and when the heads of the latter are driven forward from the mouths into the grooves 130 and 131, causing the jaws 125 and 126 to spread apart, the nail heads will engage a ridge or rib 133a in the nose portion 106 of the casing, thereby maintaining the nail heads centralized during the driving operations. The circular flange 129 of the core 119 is of sufficient diameter to extend past the rear-end surfaces of the jaws 125 and 126, and circularly disposed apertures 134 are provided in said flange to align with the enlarged mouths of the jaws. As shown in Fig. 8, the apertures 134 are slightly larger in diameter than the heads of the nails 43 so that the nail heads may be driven through the apertures at the time that the nails are being discharged from the muzzle 109. Prior to the passage of the nail heads through the apertures 134, and when the nails 43 are being supported by the jaws 125 and 126, the shanks of the nails 43 will be centralized in the apertures 134, so that the nail heads are properly centralized and will not meet with obstruction when being driven out of the muzzle 109. The jaws 125 and 126 are yieldably held together by coil springs 135 carried on the shafts 127 and engaging the jaws and the core portion 119 of the rotary member.

As seen in Fig. 8, the jaws 125 and 126 are so carried by the core portion 119 of the rotary member 118 that when the latter is rotated, the nail receiving cavities formed by the jaws will become successively aligned with the nail conveying tube 23. Thus, nails 43 may be transferred from the tube 23 to the nail transfer and supporting means 124 in succession, and the nails will be frictionally held by said means until driven therefrom by force.

The station occupied by a nail transferring and supporting means 124 when aligned with the nail conveying tube 23 I term a loading station. The point diametrically opposite this loading station I term a discharge station, this being the point where a nail transfer means 124 is aligned with the aperture 110 of the muzzle 109.

For the purpose of insuring proper alignment of the nail transfer means 124 at the loading and discharge stations a detent is provided in the form of a plunger 136 charged by a spring 137 and carried in an inner recess 138 of the nose portion 106, the plunger engaging the peripheral surface of the flange 129, and the said surface having a plurality of indentures or notches 139 for accommodating the nose of the plunger. Thus, when the rotary member 118 is turned, the detent means comprising the plunger 136 and the flange 129 will tend to position the nail transfer means 124 consecutively in proper alignment at the loading and discharge stations.

According to this invention a novel hammer or driving means is provided for driving a nail supported at the discharge station, point foremost, through the nozzle 109 and into a workpiece with sufficient force to completely sink the nail up to its head. This means comprises a plunger or ham-

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mer member 140 connected with a piston 141 which latter is reciprocable in the cylinder 103. The foremost end of the cylinder 103 is provided with a closure or head 142 centrally apertured to slidably receive the plunger 140, the head having a packing 143 held in place by a ring 144 threaded into the head.

The piston 141 is made to rapidly automatically reciprocate under pressure from compressed air fed through the air hose 26 leading from the tank 25. For the purpose of controlling the operation of the piston 141, and therefore the plunger or hammer 140, a trigger 145 is provided, pivotally mounted on a pin 146 in the handle portion 100 of the tool casing, said portion being provided with a recess 147 into which the trigger may extend. The trigger 145 when depressed operates a valve 148 which diverts air from a main air supply duct 149 which is connected through a fitting 150 with the air hose 26. The air is diverted according to the position of the valve 148 into either of two ducts 151 and 152 extending upward through the handle portion 100 and supplying the cylinder 103.

As clearly shown in Fig. 8, the valve 148 is carried in a stepped bore in the handle 100, the bore having a portion of small diameter 153 and a portion of large diameter 154, the latter being closed by a threaded plug 155. The valve 148 comprises a hollow body 156 in which a compression spring 157 is carried, the spring engaging the plug 155 and yieldably holding the valve in extended position as shown. The body 156 of the valve has three spaced circular flanges 158, 159 and 160 which fit closely to the inside surface of the enlarged bore portion 154. A neck 161 of smaller diameter than the bore portion 153 extends through the latter and terminates in a head 162 which is normally located outside of the bore portion 153 but is of a size to closely slidably fit said portion when the trigger is depressed and the valve moved to a retracted position.

With the parts as shown in Fig. 8 air from the duct 149 is conducted through the duct 151 which, as shown in Fig. 13, connects with a duct 163 in the underside of the housing 102 of the tool casing. The duct 163 extends forwardly and connects with a port 164 opening into the forward end of the cylinder 103 closely adjacent the head 142 thereof. This causes an air pressure in the forward chamber of the cylinder and on the forward face of the piston 141, maintaining the latter in its retracted or starting position shown. A second port 165 opens into the cylinder 103 closely adjacent the port 164 but slightly rearward thereof. This port 165 connects with a duct 166 in the underside of the housing 102 of the casing, Fig. 13. Referring to Fig. 8, the duct 166 connects with a vertical duct 167 in the handle portion 100 of the casing, the latter duct opening into the enlarged valve bore 154 between the flanges 159 and 160 of the valve 148, and said flanges sealing off the duct when the valve is in extended position. Therefore, even though there is a second port 165 in the forward chamber of the cylinder 103, no air can escape through this port when the parts are in the positions shown in Fig. 8, and the cylinder 141 will be maintained in retracted position.

For the purpose of automatically reciprocating the piston 141 when the trigger 145 is depressed and the valve 148 retracted so as to cause compressed air to flow into the duct 152, a reversing valve in the form of a piston 168 is provided in the rearward portion of the cylinder 103, said

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valve being adapted for automatic operation in response to the movements of the piston 141. The reversing valve 168 has a body portion 169 of smaller diameter than the inside of the cylinder 103. At the ends of the body portion 169 are flanges 170 and 171 respectively which closely slidably fit and seal against the inner walls of the cylinder 103, and intermediate the flanges 170 and 171 there is provided a third flange 172 also sealing against the cylinder walls.

Normally, the valve 168 is in a rearward position as shown in Fig. 8, being held therein by a plunger extension 173 carried by the piston 141 which extension engages the forward end face of the valve 168. The air duct 152 which receives air when the valve 148 is retracted connects with a duct 174, Figs. 8 and 13, formed in the undersurface of the housing 102 of the tool casing. The duct 174 connects with a port 175 opening into the cylinder 103 between the flanges 170 and 172 of the reversing valve 168. Communicating with the space between these flanges 170 and 172 of the valve is a port 176 which connects with a duct 177, Fig. 13, the latter connecting with a port 178 opening into the cylinder 103 just beyond the rear face of the piston 141. This causes an air pressure against the face of the piston and drives the latter forwardly in the cylinder 103.

A nail carried in the nail transfer means 124 at the discharge station aligned with the plunger 140 will be struck a blow on the head by the plunger, thereby driving the nail, point out, partially through the muzzle 109 and into the work. During the forward movement of the piston 141, the chamber in the cylinder ahead of the piston will be vented through the port 165 as follows: This port connects with the ducts 166 and 167, the duct 167 communicating with a duct 179 since both of these latter are located between the flanges 159 and 160 of the depressed valve 148. The duct 179 connects with a duct 180, in turn connecting with a port 181 opening into the cylinder between the flanges 170 and 172 of the reversing valve 168. A vent port 182 is provided in the cylinder wall between the flanges 171 and 172 of the valve 168 so that the port 181 thus communicates with the port 182 and is therefore vented to the atmosphere. As a result the air in the forward chamber of the cylinder 103 ahead of the piston 141 may escape to the atmosphere as the piston is forced forwardly.

The piston 141 will come to rest at some point wherein its rear face is beyond a port 183 opening into the cylinder 102. When the piston 141 comes to rest, the air which has been driving it will be forced through the port 183 and through a duct 184, Fig. 13, in the undersurface of the housing 102 of the casing. The duct 184 connects with a port 185 opening into a bore 186 in the rear end of the housing 102. This bore is closed by a threaded plug 187, and contains a piston 188 having a plunger or pin 189 extending through a transverse wall 190 to the rear face of the valve 168. A compression spring 191 is carried about the pin 189, engaging one end-face of the piston 188 and the transverse wall 190 so as to yieldably hold the piston in a retracted position as shown. The piston is prevented from abutting the plug 187 by means of a central boss 192 which serves to space it therefrom and prevent sealing off of the port 185. The pin 189 passes through packing 193 held in the transverse wall 190 by a threaded ring 194.

When air is forced into the port 185 it moves

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the piston 188 and pin 189 forwardly against the pressure of the spring 191, and in so doing moves the reversing valve 168 forwardly to the extent that the flange 172 thereof passes the port 175 and comes to rest immediately ahead of the latter. The forward movement of the valve 168 is limited by a pin 195 which extends into the cylinder between the flanges 172 and 171 of the valve for engagement with the latter flange.

When the reversing valve 168 has been moved forwardly the port 175 which is being supplied with compressed air is made to communicate with the port 181, Figs. 8 and 13, which latter port is connected with the duct 180, the duct in turn connecting with the duct 179, Fig. 8. Due to the retracted position of the valve 148 the duct 179 is still in communication with the duct 167, which latter is connected with the duct 166 and port 165. Thus, compressed air is brought in again into the forward chamber of the cylinder 103, causing the piston 141 to be rapidly moved rearward to its initial starting position. When the air is entering the port 165 it cannot escape through the port 164 since the ducts 163 and 151 connected with the latter are sealed off due to the fact that the duct 151 opens up into the space between the flanges 158 and 159 of the retracted valve 148, and since said flanges prevent the escape of air.

During the time that the reversing valve 168 is in its forward or shifted position, and when the piston 141 is being forced rearwardly the port 178 in the cylinder is connected so as to vent into the atmosphere and thereby permit the air to the rear of the piston to be discharged. This venting is accomplished by means of a vent port 199 in the wall of the cylinder 103. When the reversing valve 168 is in the forward position the vent port 199 communicates with the port 176, since both of these lie between the flanges 170 and 172. Since the port 176 is connected by the duct 177 with the port 178, the latter is therefore vented to the atmosphere.

At the time that the reversing valve 168 is in its forward position and when the piston 141 is being driven rearward the vent 182 is closed off by the flange 171 of the reversing valve so that air from the port 175 cannot escape through the vent, but must pass through the port 181, the ducts 180 and 179, thence through the ducts 167, 166 and the port 165 to drive the piston 141 back. Similarly, when the reversing valve 168 is in its rearward or starting position the vent port 199 is closed off by the flange 170 of the reversing valve, so that air issuing from the port 175 into the cylinder cannot escape through the vent but must pass through the port 176, the duct 177 and through the port 178 to drive the piston 141 forward.

At the time that the piston 141 is in any of the successive forward positions that it assumes as it drives a nail 43 deeper and deeper into the work, and also when the piston is being forced rearward, the reversing valve actuating piston 188 will be in retracted position as shown, having been moved to this position by the coil spring 191. This is because, since the hammering piston 141 has come to rest in forward position and has caused the valve operating piston 188 to advance and shift the reversing valve 168 forward, the air driving the piston 188 is thereby vented. The venting of this air is accomplished as follows: With piston 141 and the reversing valve 168 in forward positions, the ports 183 and 178 will, of course, be in communication

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with each other, and the port 178 will be venting through the duct 177 and ports 176 and 199 to the atmosphere. Thus, the air occupying the space between the piston 188 and the plug 187 may pass out into the atmosphere, since the port 185 connects through the duct 184 to the port 183. Therefore, the spring 191 will return the piston 188 to its initial or starting position, and this will enable the hammering piston 141 when it returns to retracted position to drive the reverse valve 168 ahead of it so that the latter is also returned to starting position.

By the provision of a duct 200, Figs. 8 and 12, extending between the opposite end faces of the reversing valve 168 the latter may be shifted either forward or rearward by the pin 189 and plunger 173 respectively without being retarded due to trapped air on either side of the valve. To yieldably hold the valve 168 in either forward or rearward position, a detent is provided comprising a ball 172a and spring 175b carried in a recess in the housing 102, see Fig. 12, the recess being capped by a closure 172c. The ball 172a is adapted to engage the flange 172 of the valve 168, and by advancing slightly past either the forward or rearward edge of the flange, functions to prevent inadvertent movement of the valve.

When the trigger 145 is released, it is returned to the extended position shown in Fig. 8 by a coil compression spring 201 engaging the rear surface of the trigger and the opposite interior surface of the handle portion 100 within the recess 147. Upon the trigger 145 being released the trigger operated valve 148 will be returned to its extended position shown by the coil spring 157.

At the time that a nail 43 is driven partially through the nail transfer and supporting means 124 at the discharge station, the head of the nail will cause the jaws 125 and 126 of the said means to spread apart considerably, as shown in Fig. 18. When the nail head has just left the nail transfer means 124, but is still in the aperture 110 of the muzzle 109, the jaws 125 and 126 will be held apart by a detent plunger 202 having a yoke portion 203 and upstanding fingers 204. The plunger 202 is continually urged upwardly by a compression spring 205, the latter and the plunger being located in a bushing 206 carried in an internal recess 207 in the nose portion 106 of the tool casing.

Referring to Figs. 8 and 10 the plunger 202 has a rounded head 208 adapted to engage the periphery of the flange 129 of the rotary transfer member 118, and adapted to enter the notches 139 of said flange so as to function as a detent in conjunction with the detent plunger 136 at the top of the nose portion 106 of the casing. Referring to Fig. 11, when the rotatable transfer member 118 is turned from the position shown, the plunger 202 will be depressed by engagement of the head 208 thereof with the periphery of the flange 129, and the fingers 204 of the plunger will be retracted so that they do not engage or interfere with the jaws 125 and 126 during the latter's travel to the next, succeeding position. However, as shown in Fig. 18, after the jaws 125 and 126 have been spread apart by the head of a nail being driven into the work, the fingers 204 of the detent will engage the mating surfaces of the jaws and prevent the latter from moving together again until the rotary transfer member 118 has been rotated. Thus, the hammering plunger 140, when driving

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a nail the last fraction of an inch through the aperture 110 of the muzzle 109, will not strike the jaws 125 and 126 nor be interfered with in any way by the latter.

It will thus be seen that, referring to Fig. 8, when the trigger 145 is depressed to move the valve 148 inward to retracted position, the air pressure in the air hose 26 will cause a rapid automatic reciprocation of the piston 141 and hammering plunger 140. Each succeeding reciprocation of the piston and plunger will drive a nail 43 at the discharge station deeper into the work, and therefore the forward travel of the piston and plunger will become increasingly greater as the reciprocation continues.

Means are provided, according to the present invention, for automatically holding or stalling the piston 141 and the plunger 140 when a predetermined advanced position of the same has been reached, indicating that the driven nail has reached the desired depth in the work. In accomplishing this, the port 165 is utilized. When the driven nail has reached the desired depth, the forward position of the piston 141 will be such that the port 165 will just be covered and sealed off by the front edge portion of the piston. As soon as this occurs, of course, the driving air will have been prevented from entering the forward chamber of the cylinder ahead of the piston 141, and therefore the latter will not be returned to its starting position but will remain stalled in fully extended position. Thus, the reciprocation of the piston 141 and plunger 140 will be automatically halted even though the trigger 145 is held in, and the valve 148 is in its inward or retracted position. This signifies to an operator that the nail has been driven in by the machine to the extent desired. Upon release of the trigger 145, the trigger operated valve 148 will be moved to its extended position, and air from the duct 149 will again pass through the ducts 151 and 163, and through the port 164 which, not being covered and sealed off by the piston 141, will permit the air to drive the piston rearward to its starting position.

According to the present invention means are provided, responsive to the operation of the trigger 145 for automatically rotatably advancing the rotary transfer member 118 upon completion of the driving in of a nail, and for automatically feeding another nail into an empty nail transfer means 124 shifted to the loading station, to make up for the driven nail so that the succession of nails fed to the discharge station will not be interrupted.

The automatic rotation of the rotary transfer means 118 is preferably accomplished during the releasing movement of the trigger 145, and after the trigger responsive valve 148 has been returned to its extended position, inactivating and returning the hammering plunger 140 and piston 141 to retracted, starting position.

To accomplish this, the top surface of the trigger 145 is provided with a wide notch 209, Figs. 8 and 14, into which there extends a pin 210 carried by a sliding link 211 carried forwardly in a deep longitudinal groove 212 in the undersurface of the housing 102 of the tool casing. The front end 213 of the link 211 is apertured and pin connected to a bell crank 214 located in a recess 215 and pivoting on a pin 216 secured to one wall of the recess. The bell crank 214 is in turn pivotally connected to a link 217 which pivotally carries a pawl 218, Fig. 10. A ratchet 219 is mounted on and is keyed to the reduced pivot portion 121

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of the core 119 of the rotary transfer member 118, and is located for engagement with the pawl 218, to be driven by the latter. A flat spring 220 is secured to the link 217 for yieldably maintaining the pawl 218 in engagement with the ratchet 219. Also, a wire spring 221 carried on a pin 222 is anchored at one end to the bell crank 214 and at the other end to the link 217 to yieldably hold the latter forwardly in a vertical transverse plane.

When the trigger 145 is being depressed, during the final part of its movement it will engage the pin 210 and pull rearwardly the link 211, thus operating the bell crank 214 and lowering the pawl 218, see Fig. 10, until the latter engages the next or succeeding tooth of the ratchet 219. This does not disturb the rotative position of the rotary transfer member 118, however, and since the trigger is now depressed the plunger 140 and piston 141 will be operative to hammer in a nail. However, upon completion of the nail driving, when the trigger 145 is released, it will move outwardly an extent until the valve 148 is returned to extended position, the valve causing withdrawal of the piston 141 and the plunger 140 to their retracted, starting positions. As the trigger 145 moves further to its extended position under the urging of the spring 201, the pin 210 will be engaged by the trigger and the latter will drive the link 211 forward, raising the pawl 218 and rotating the rotary transfer member 118 through one-sixth of a revolution, thereby aligning the next set of nail transfer means 124 respectively with the loading and discharge stations. Thus, a nail 43 carried by the nail transfer means 124 which has been newly brought into alignment with the hammering plunger 140 will be in readiness for driving. Also, an empty transfer means 124 will be aligned with the nail conveying tube 23 at the loading station in readiness for receiving another nail. Feeding of the nails 43 from the nail conveying tube 23 into the empty nail transfer means 124 is also accomplished automatically, according to the present invention, during the actuation of the trigger 145. Preferably this is accomplished during the time that the trigger 145 is being depressed, and for this purpose an electrical switch 223 is provided, mounted in the handle portion 100 of the tool casing below the trigger 145, said switch having a plunger 224 adapted to be engaged and driven by a shoulder 225 of the trigger.

Referring to Fig. 17, the switch 223 is of the single pole double throw type, and has three wires 226, 227, and 228 extending from it comprising a flexible cable 229 which is led into the housing 21 of the feed mechanism.

The switch 223, Fig. 17, has a blade 230 operable by the plunger 224 and connected with the wire 226, and has contacts 231 and 232 for cooperation with the blade 230. Normally, when the trigger 145 is in its released position, the switch blade 230 is touching the switch contact 232. When the trigger 145 is depressed, the switch blade 230 leaves the contact 232 and engages the contact 231.

A novel circuit control is provided in connection with the switch 223, and with the magnetic clutch 85, whereby the feeding mechanism which transfers the nails 43 from the magazine 41 into the receiving pipe 58, and which advances the nails in said pipe and through the nail conveying tube 23, is made to operate through but a single cycle so as to transfer a single nail and advance the nails in the tube by one for each operation of the trigger 145 and the hammering tool 22. This cycle is carried out in response to depressing the trig-

ger 145, and once initiated will proceed to its completion even though the trigger is inadvertently released before the hammering has been completed. Also, after the cycle has proceeded to completion, it cannot be repeated while the trigger 145 remains in depressed position regardless of how long the latter is held in said position. Thus, each time that a nail held in the tool 22 is driven into the work by the hammer, one nail only will be delivered from the nail conveying tube 23 to replenish the nails in the tool, and after such delivery the feeding mechanism will automatically become inoperative without requiring any attention on the part of an operator.

Referring to Fig. 17, the control which accomplishes this automatic feeding comprises a relay 233 having a pair of armatures 234 and 235 adapted to respectively engage contacts 236 and 237. When the relay 233 is deenergized, the armatures are normally separated from the contacts, providing an open circuit condition. Associated with the shaft 73 and cam 72 of the nail transfer mechanism for the magazine 41, there is provided a pair of rotary cams 238 and 239, see Figs. 4 and 17. These cams are carried on the shaft 73 to rotate therewith, being located adjacent the sprocket 97. The cam 239 has a wide notch 240 in a circular periphery 241, for engagement with a switch actuating arm 242 operating a microswitch 243, see Fig. 16. The cam 238 has a narrow notch 244 in a circular periphery 245, for engagement with a switch actuating arm 246 operating a microswitch 247.

Referring to Fig. 16, the microswitch 243 is carried on a vertical supporting plate 248 which is mounted on the base 27 of the feed mechanism housing 21, and the microswitch 247 is located directly opposite the microswitch 243, on the other side of the vertically supported plate 248, Fig. 3.

As shown in Figs. 4, 16 and 17, a latch 249 is provided, mounted on the vertical plate 248 and adapted to maintain the switch operating arm 242 in depressed position after it has been moved to said position by rotation of the cam 239. Associated with the latch 249 is a magnet 250, which, when energized, operates the latch to release the switch operating arm so that the latter may be moved to extended position wherein it occupies the notch 240 of the cam.

Referring to Fig. 17, the circuit connections for the switch 223 of the automatic feed control are as follows: The wire 226 comprises one side of a supply line. The other side of the supply line comprises a wire 251 which connects with one end of the coil 252 of the relay 233. The other end of the relay coil 252 is connected by a wire 253 to one contact 254 of the microswitch 247, and this is connected by a jumper 255 to one contact 256 of the microswitch 243.

The wire 227 leading from the trigger operated switch 223 connects with one end of the magnet coil 250, the other end of which is connected by a wire 257 to the line wire 251. The wire 228 leading from the switch 223 connects with the other contact of the microswitch 243, represented diagrammatically by the switch operating arm 242 in Fig. 17. The remaining contact of the microswitch 247, represented diagrammatically by the switch operating arm 246 in Fig. 17 is connected by a wire 258 to the relay armature 234, and the relay armature 235 is connected by a wire 259 to the magnetic clutch 85 whose other connection is thru a wire 260 to the line 251. The relay contacts 236 and 237 are connected together by a

jumper 261 which latter is connected by a wire 262 to the line wire 226.

Fig. 17 shows the position of the various parts of the control when the trigger 145 is in released position, the hammering tool 22 being in readiness for use. The magnet 250 is continually energized, maintaining the latch 249 in releasing position. The microswitch 243 is normally closed, and the microswitch 247 normally open, and the relay contacts normally open. When the trigger 145 is depressed, the circuit is broken thru the magnet 250, thereby releasing the latch 249. Also, a connection is made between the arm 230 of the trigger operated switch 223 and the contact 231 thereof, and this energizes the relay coil 252. Immediately, the relay contacts are closed, thereby energizing the magnetic clutch 85, whose energization causes the shaft 73 to be driven, operating the transfer mechanism between the magazine 41 and the nail-receiving pipe 58, and also operating the feeding mechanism comprising the plunger 88.

Rotation of the shaft 73, which is in a clockwise direction, causes the cams 238 and 239 to rotate clockwise. At the initiation of movement of the cams, the microswitch 247 will be closed, thereby completing a holding circuit for the relay coil 252 thru the relay contacts 236 and 234. Thus, if the trigger 145 should be inadvertently released, it could not halt the operation of the nail transfer and feeding mechanism since the energization of the relay 252 will be maintained thru the holding circuit. As the rotation of the cams 238 and 239 progresses, the microswitch 243 will be opened, thereby rendering inoperative the connection provided between the arm 230 and contact 231 of the trigger controlled switch 223.

The cams 238 and 239 will continue to rotate thru a single revolution representing the cycle of operation of the nail transfer and feeding means, during which cycle one nail will be transferred from the magazine 41 to the receiving pipe 58, and the nails in the receiving pipe 58 and the nail conveying tube 23 will be advanced by one. This advance causes the foremost nail in the conveying tube 23 to be transferred into the empty nail conveying means 124 waiting at the loading station. Upon completion of the one revolution of the cams 238 and 239, the microswitch 247 will be opened by the arm 246 entering the notch 244. This will deenergize the relay coil 252, since it opens the holding circuit for the relay. However, during the rotation of the cam, the switch operating arm 242 has been caught by the latch 249 so that it is held in depressed or open-circuit position. Upon completion of the revolution of the cams 238 and 239, the switch operating arm 242 will not again drop into its notch 240 since it is prevented from doing so by the latch 249. Thus, although the trigger 145 is held depressed, the relay cannot be again made operative to cause the cycle of the transfer and feeding mechanism to be repeated, since energization of the relay after its holding circuit has been broken must be effected through the microswitch 243.

The time of the cycle of operation of the nail transfer and feeding mechanism as brought about by the control circuit shown in Fig. 17 is preferably shorter than the time required for the hammering tool to fully drive a nail into the work, so that when the tool automatically stops after the nail has been driven home the feeding of a new nail to the tool 22 has already been com-

pleted. However, it is not necessary for this cycle to be shorter than the time required for a nail to be driven home, since the cycle carries on to completion even though the trigger 145 is released.

After a nail 43 has been driven by the hammering tool 22 and the feeding of a replacement nail completed, and when the trigger 145 is being released, the switch arm 230 of the trigger controlling switch 223 will be disengaged from the contact 231 and will again engage the contact 232, reenergizing the magnet 250 and pulling the latch 249 to releasing position, whereupon the switch operating arm 242 will be released and may again enter its associated notch 240 in the cam 239. Thereupon the control system is returned to its initial position, in readiness for another cycle of operations at the time that the trigger 145 is again depressed to drive in another nail.

According to the present invention a safety device is provided in connection with the hammering tool 22 whereby inadvertent operation of the latter while the muzzle thereof is not being held against a workpiece, is prevented. Thus, there is minimized the likelihood of a nail being forcibly and with great speed projected from the muzzle of the tool while it is being held in the hands of an operator, either during moving of the tool to a new spot for the driving in of a nail, or while it is being otherwise handled. Such a nail inadvertently ejected from the muzzle would become a missile which might cause serious injury to a fellow workman or to other persons.

In accomplishing this, referring to Figs. 8, 9, 13 and 14, a pressure operable ring 263 is provided, mounted on a plunger 264 so as to be carried in front of the muzzle 109 in alignment therewith and spaced therefrom. The plunger 264 extends into a bore 265 in the nose portion 106 of the tool casing, and has a limited axial movement therein as provided by an elongate slot 266 in the plunger receiving a stop pin 267 carried by the casing. The plunger 264 is yieldably held in extended position by a compression spring 268 located between the inner end of the plunger and a shoulder 269 of the casing. A flat link 270 connected with the plunger 264 extends rearwardly thereof through the spring 268 and through a deep longitudinal groove 271 in the undersurface of the housing 102 of the tool casing, the rear end of the link terminating in a tapered portion 272. For cooperation with the tapered end 272 of the link 270, Fig. 14, a pin 273 is provided carried on a lever 274 pivotally mounted on a pivot pin 275 carried by the housing 102. When the plunger 264 and link 270 are in extended position as shown, the pin 273 is held in engagement with the tapered end 272 of the ring by a plunger 276 charged by a compression spring 277, both plunger and spring being carried in a recess 278 in the base portion 101 of the tool casing. The other end of the lever 274 has a shoulder 279 forming a latch adapted to engage the notch 209 of the trigger 145. Normally, with the parts in the positions shown in Fig. 19, which positions are occupied when the tool 22 is not being held against a workpiece, the lever 274 locks the trigger 145 so that the latter may not be depressed to cause operation of the hammer. However, when the hammering tool 22 is pressed against a workpiece, the ring 263 is moved backward against the muzzle 109, causing the plunger 264 and the link 270 to move inward or rearward, thereby partially

rotating the lever 274 counterclockwise and releasing the trigger 145. The hammering tool 22 may thus be operated without danger of a nail being projected into space from the muzzle, to possibly cause personal injury. After the hammering has been completed and the trigger 145 released, and the tool 22 is removed from the work, the safety ring 263 and the plunger 264 will again be extended by the compression spring 268, thereby locking the trigger 145 against inadvertent movement.

In the broader aspects of the invention the hammering tool 22 may be supplied with nails by means other than the nail conveying tube 23. For example, other well-known types of magazine feeds may be employed to deliver nails to the rotary transfer member 118.

According to this invention, the nailing machine may have a plurality of nail feeding and conveying means, so that a plurality of nailing tools 22 may be employed, to be supplied from the single hopper 20. Accordingly, as shown in Figs. 2 and 3, the nail slot 39 in the bottom 33 of the hopper connects with a second nail magazine 280, see Fig. 6, which latter is adapted to stack nails for transference to a nail receiving pipe 281. A nail transfer member 282 is provided, having a U shape, said member being adapted to slide between a guide provided by a block 283 mounted on the shelf 284 and by a block 285 and rails 286 and 287 of the magazine 280. The transfer member is integral with a cam follower 288 slidable on the block 283 under a guide 283a, the follower being charged by a spring 283b to maintain it in engagement with a cam 289. The cam 289 is carried on a shaft 290 journaled in bearings 291 which are mounted on the shelf 284. Motive power for the shaft 290 is provided through a sprocket 292, chain 293, and sprocket 294 which latter is carried on a countershaft 295 journaled in bearings 296 mounted on the side wall 28 of the feed mechanism housing. A magnetic clutch 297 is provided for coupling the countershaft 295 with the shaft 51, which latter is continually rotating.

For feeding nails from the receiving pipe 281 to the other flexible nail conveying tube 23, a plunger 298 is provided, slidable in the pipe and operated by a slotted lever 299 engaging a driving pin 300 carried by the head 301 of the plunger. The lever 299 is pivotally mounted on a bracket 302 secured to the side wall 29 of the housing, and is operated by means of a pin or follower 303 engaging a cylindrical cam 304 carried by and rotatable with the shaft 290.

The receiving pipe 281 and the nail conveying tube 23 are coupled at their ends in a bracket 305, and the tube is adapted to be driven or turned through a sprocket 306 and chain 307, the latter running over a sprocket 308 carried by the shaft 299. The operation of this transfer and feed mechanism is similar to that already described in connection with the nail magazine 41.

A control mechanism is associated with the feed mechanism, substantially similar to that already described and shown in Fig. 17, said control including cams 309 and 310 carried by the shaft 290, and including microswitches 311 and 312, Fig. 3, mounted on the vertical supporting plate 248 for operation by the cams 309 and 310. The microswitch 312 has associated therewith a latch 313 and magnetic operator 314 therefore, similar to the latch 249 and magnet 250 already described.

The microswitches 311 and 312 are connected

in circuit with a suitable relay and with the magnetic clutch 297 to control the operation of the latter in response to movement of the trigger of a second hammering tool 22, so that the transfer and feed mechanism operates through one complete cycle for each actuation of the trigger, as already described.

The hammering tools 22 are compact, light and easily carried, and may be manipulated, applied and operated by one hand of a workman. Thus, in the erection of a structure, the workman may hold the member to be nailed with one hand, and apply the hammering tool 22 to the member with the other hand, so as to conveniently and quickly drive a nail into the member to secure it in place. The workman is relieved from continually having to reach for nails, as was heretofore necessary; nor do there occur the time-consuming incidents such as retrieving dropped nails, straightening bent nails, etc. The nails may be driven in by the tools 22 at an angle, or straight, and in quick succession, all to the proper depth.

It will thus be seen that by the present invention there is provided a highly efficient, automatic nailing machine wherein a large quantity of nails may be deposited in a hopper and automatically fed to a plurality of hammering tools as these latter require replacements for the nails driven into the work. Each hammering tool is operated solely by a single member or trigger in such a manner that no skill is required on the part of an operator. The trigger not only controls the starting of the hammering means, but also automatically controls the feeding of nails to the tool, and automatically controls the presenting of nails in front of the hammers to be driven thereby into the work.

The hammering tools are compact and small in size, and readily maneuvered so that they may be used in constricted spaces. The flexible connections to the hammering tools permit them to be held at various angles without difficulty, and by virtue of the substantial length of these connections permit the tools to be used over a considerable area without necessitating shifting of the hopper and feed mechanisms. Also, the tools are safe during use and during handling due to the provision of the means for automatically preventing inadvertent operation of the hammer when the tool is not being held against the work.

The nail feeding and conveying mechanism associated with each of the hammering tools is automatically controlled in a manner that it completes a single cycle of operation each time the trigger of the hammering tool is operated during the driving-in of a nail, and thereby the likelihood of nails being jammed in the hammering tools is minimized to a considerable degree. The feeding mechanisms also are constructed with provision for periodically rotating the nail conveying tubes during the feeding of nails therethrough, so that the likelihood of jams occurring within the tubes is minimized.

Either hammering tool may be operated independently of the other or the tools may be operated simultaneously without difficulty. The hammering of the nails is so controlled that when a nail is driven home to a predetermined desired depth, the hammering automatically ceases without attention on the part of an operator, thereby not only assuring uniformity in the driving of the nails but indicating to a user when the nail has been driven home. Also, the sequence of automatic operations controlled by the movement of the trigger is such as to conserve time, since

both the depressing and releasing movements of the trigger are utilized, and after the trigger has been released the tool is immediately ready for a subsequent nailing operation without waiting for transference of a new nail into position, or waiting for the feeding of a replacement nail to the tool.

The nails are fed to the hammering tools with a positive action, and therefore the operation of the machine is positive and reliable. The hammering tools are so arranged that during the initial period when a nail is being driven into the work at the time that a great part of the shank still remains outside of the work, the shank is supported so that the likelihood of its becoming bent during the driving operation is minimized to a considerable degree.

Referring to the modification illustrated in Fig. 19, the muzzle portion 315 of a hammering tool is shown, having a pair of pivotally mounted jaws 316 and 317 which are spring urged together, and which have grooves 318 cooperating to form a split channel through which the nail shank extends, and by which it is held, when the nail is being driven. The grooves 318 have tapering enlarged portions 319 to form a mouth or entrance for the nail heads, the latter spreading the jaws when passing therethrough.

Thus, a further support for the shanks of the nails 43 is provided, located closely adjacent the work, this support further preventing shifting of the hammering tool when the nails are being driven and the heads of the latter have spread apart the jaws 125 and 126.

Variations and modifications may be made within the scope of this invention and portions of the improvements may be used without others.

I claim:

1. Nailing apparatus comprising a nail hopper; a portable automatic hammer; means for operating the hammer; a flexible nail feed tube for transferring nails from the hopper to the hammer; electrically operated means movable through a predetermined cycle for feeding the nails along said tube; and means including a manually operable member carried by the hammer, for controlling the operation of the hammer, said means also initiating the cycle of said electrically operated means for feeding nails thereto whereby for each nail driven by the hammer a nail is transferred from the feed tube to reload the hammer.

2. Nailing apparatus comprising a nail hopper; a portable automatic hammer; means for operating the hammer; a flexible nail feed tube for transferring nails from the hopper to the hammer; electrically operated means acting through a cycle for feeding a nail from the feed tube to reload the hammer; and means including a manually operable member carried by the hammer, for controlling the operation of the hammer, said means also actuating the said electrically operated means for feeding nails thereto whereby for each actuation of the member to operate the hammer to drive a nail fully into the work, one nail only is transferred from the feed tube to reload the hammer.

3. Nailing apparatus comprising a hopper; a nail conveying tube; means for depositing nails one at a time into the nail conveying tube; means for intermittently advancing a succession of the nails along the tube to the delivery end thereof; a drum having a plurality of chambers successively aligned with the delivery end of the tube, the nails being transferred one at a time from

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the tube to the drum; nail driving means including a hammer aligned with a chamber of said drum containing a nail for driving the nail into the work, said means also including means for automatically reciprocating the hammer to cause it to repeatedly strike the nail until it is driven to the desired depth; a fingerpiece for controlling the operation of the hammer; means operated by the fingerpiece for controlling operation of the nail advancing and depositing means at each operation of the fingerpiece; and means for rotating the drum step by step at each operation of the fingerpiece to move an empty chamber into alignment with the nail conveying tube and a loaded chamber into alignment with the hammer, said last-named means operating on the return movement of the fingerpiece.

4. Nailing apparatus comprising a hopper; a nail conveying tube; means for depositing nails one at a time into the nail conveying tube; means for intermittently advancing a succession of the nails in end-to-end relation along the tube to the delivery end thereof; a hammer for driving the nails; and means for transferring the nails in the tube one by one to position to be driven into the work by the hammer.

5. Nailing apparatus comprising a nail hopper; a portable automatic hammer; means for operating the hammer; a flexible nail feed tube for transferring a succession of nails from the hopper to the hammer; means separate from the hammer operating means and operable through a cycle independently of the operation of said hammer for advancing the nails in the feed tube; and manually operable means carried by the hammer for controlling the operation of the latter, said means being connected to the separate operating means to control the nail-advance means whereby for each nail driven by the hammer the nails in the feed tube are advanced by one nail, thereby to reload the hammer.

6. Nailing apparatus comprising a nail hopper; nail feed means leading from the hopper; means for placing nails one at a time into the feed means; means acting on the nails for intermittently advancing a succession of nails in end-to-end relation along the feed means to the delivery end thereof; a hammer for driving the nails; and means for transferring the nails at the delivery end of the feed means one by one into position to be driven by the hammer into the work.

7. Nailing apparatus comprising a nail hopper; nail feed means leading from the hopper and carrying a succession of nails therein in end-to-end relation; means for placing nails one at a time into the feed means in end-to-end relation; a nail transfer and supporting device located adjacent the delivery end of the feed means, for receiving nails one by one from the latter, and for transferring the nails in progression to a driving station and supporting the same thereat; a hammer at said driving station; and means for reciprocating the hammer to drive the nails into the work.

8. Nailing apparatus comprising a hopper; a flexible nail conveying tube; means for depositing nails one at a time from the hopper into the nail conveying tube; means for advancing a succession of the nails along the tube to the delivery end thereof; a rotatable nail transfer device having a plurality of means for supporting nails in squirrel-cage arrangement about its axis, said nail supporting means being successively presented to the delivery end of the conveying tube by rotation of the transfer device, to receive nails

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from the said tube; a hammer associated with the transfer device at a driving station, for driving the nails into the work, said nail supporting means being presented successively to the driving station by rotation of the transfer device; means for automatically reciprocating the hammer to cause it to repeatedly strike a nail at the driving station, said means including a fingerpiece for controlling the operation of the hammer; and means operated by the fingerpiece for rotating the nail transfer device and for controlling the means advancing the nails in the conveying tube whereby for each cycle of operation of the fingerpiece a nail is positioned in the transfer device and the latter rotated so as to bring a nail to the driving station, said transfer device rotating on the return movement of the fingerpiece.

9. In a nailing apparatus, nail feed means comprising a hopper; a flexible nail feed tube for transferring nails from the hopper to a portable hammer; means for placing nails one at a time into the feed tube to provide a succession of nails in end-to-end relation; and means acting on the nails in the tube for advancing the nails in the feed tube, said last-named means acting in predetermined sequence with the placing of nails therein.

10. In a nailing apparatus, nail feed means comprising a hopper; a flexible nail feed tube for transferring nails from the hopper to a portable hammer; means for placing nails one at a time into the feed tube; and means for advancing the nails in the feed tube, including means for rotating the tube during the advance of nails therein to prevent jamming.

11. In a nailing apparatus, nail feed means comprising a hopper; a nail magazine tube connected with the hopper; means for filling the magazine tube with nails from the hopper, and for maintaining said tube filled; a flexible nail conveying tube associated with the magazine tube and connected with a portable hammer; means for transferring nails one at a time from the magazine tube to the conveying tube; and means for advancing the nails in the conveying tube in predetermined sequence with the transferring of nails thereto, including means for rotating the conveying tube during the advance of the nails to prevent jamming.

12. In a nailing apparatus, nail feed means comprising a hopper; a pair of nail magazines connected to the hopper; a pair of flexible nail feed tubes connected respectively with the magazines; means for loading the magazines with nails from the hopper; means for feeding the nails one at a time from the magazines respectively to the flexible feed tubes with the nails in end-to-end relation; and means acting upon the nails in the tube for advancing the nails in each of the feed tubes in predetermined sequence with the loading of the nails therein.

13. A portable nailing machine comprising a hammer mounted for reciprocative movement; a nail magazine; a manually operable trigger; means operable through a predetermined cycle upon actuation of said trigger for removing nails successively from the magazine and supporting the nails in front of the hammer; and a second means separate from the first means and under the control of the trigger and operative after operation of said first-named means for reciprocating the hammer to cause the latter to strike a supported nail repeated blows and drive the same into the work.

14. A portable nailing machine comprising a

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hammer mounted for reciprocative movement; a nail magazine; a manually operable trigger; means operable through a predetermined cycle upon actuation of said trigger for removing nails successively from the magazine and supporting the nails in front of the hammer; a second means separate from the first means and under the control of the trigger and operative after operation of said first-named means for reciprocating the hammer to cause the latter to strike a supported nail repeated blows and drive the same into the work; and means controlled by the trigger and operative after said second-named means for moving the hammer to a retracted starting position and maintaining the latter therein when the trigger is released.

15. A portable nailing machine comprising a nail receiver; a hammer mounted for reciprocative movement with respect to the receiver, to drive a nail held by the receiver from the latter into the work; a manually operable trigger; fluid operated means under control of the trigger for reciprocating the hammer to cause the latter to strike the nail repeated blows; and means controlled by the trigger for moving the hammer to a retracted starting position and maintaining the latter therein when the trigger is released, so that another nail may be positioned by the receiver for driving by the hammer.

16. A portable nailing machine comprising a hammer mounted for reciprocative movement; a nail magazine; a manually operable trigger; means under the control of the trigger for removing nails successively from the magazine and supporting the nails in front of the hammer; means under the control of the trigger and operative after operation of said first-named means for reciprocating the hammer to cause the latter to strike a supported nail repeated blows and drive the same into the work; and means controlled by the trigger and operative after said second-named means for moving the hammer to a retracted starting position and maintaining the latter therein when the trigger is released, said first-named means operating after operation of the said last-named means, and in response to release of the trigger.

17. A portable nailing machine comprising a rotatable nail carrying member having means for supporting a plurality of nails in squirrel-cage arrangement about its axis; means for imparting a stepped rotary movement to the member to move the nails to a discharge station; magazine means for supplying nails; means for feeding a nail supplied by the magazine means into each successive supporting means of the member at a loading station during the periods the member is motionless; means for driving the nails successively from the supporting means of the member at a discharge station during the said periods, said nail supporting means including guide means to surround the shank of the nail and expand to permit passage of the head of the nail when the latter is driven from the member at the discharge station; and means for maintaining the guide means expanded after the initial expansion, for the duration of the operation of the drive means.

18. A portable nailing machine comprising a rotatable nail carrying member having means for supporting a plurality of nails in squirrel-cage arrangement about its axis; means for imparting a stepped rotary movement to the member to move the nails to a discharge station; a nail supplying tube adapted to carry a plurality of nails

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point-to-head one after another to said member; means for feeding the nails one at a time from the tube to the nail carrying member at a loading station during the periods the member is motionless; and means for driving the nails carried by the member successively from the latter at a discharge station during the said periods.

19. A portable nailing machine comprising a rotatable nail carrying member having means for successively supporting a plurality of nails in squirrel-cage arrangement about its axis; magazine means for supplying nails; means for feeding a nail supplied by the magazine means into each successive supporting means of the member at a loading station; a hammer aligning with one of the nail supporting means of the member at a discharge station; manually operable means; means actuated by the manually operable means for controlling the operation of the hammer; and separate means also actuated by said manually operable means for advancing the member a step at a time to bring successive nail supporting means of the member to the loading and discharge stations respectively.

20. A portable nailing machine comprising a rotatable nail carrying member having means for supporting a plurality of nails in squirrel-cage arrangement about its axis; nail feed means associated with the member at a loading station to supply nails to said member; means for driving a nail, associated with the member at a discharge station; manually operable means for controlling the operation of the nail driving means; and separately controlled means actuated by the manually operable means for imparting a stepped rotary movement to the member, including means for advancing the nails in the feed means one at a time to the nail supporting means of the member during the periods that the latter is motionless.

21. A portable nailing machine comprising a drum having nail receiving and carrying chambers; a nail supply tube aligning with one of the chambers which receives a nail from the tube; a hammer aligning with one of the chambers carrying a nail; manually operable means; means actuated by the manually operable means for controlling the operation of the hammer; and separately controlled means also actuated by said manually operable means for advancing the drum to move an empty chamber into alignment with the tube and a nail loaded chamber into alignment with the hammer.

22. A portable nailing machine comprising a drum having nail receiving and carrying chambers; a magazine tube aligning with an empty one of the chambers which receives a nail from the tube; a hammer aligning with one of the chambers carrying a nail; manually operable means for controlling the operation of the hammer; means controlled by said manually operable means for advancing the drum to move an empty chamber into alignment with the magazine tube and a nail loaded chamber into alignment with the hammer; and means controlled by the manually operable means for advancing the nails one at a time from the magazine tube to the aligned chamber.

23. A portable nailing machine comprising a drum having nail receiving and carrying chambers; a magazine tube aligning with an empty one of the chambers which receives a nail from the tube; a hammer aligning with one of the chambers carrying a nail; manually operable means for controlling the operation of the ham-

mer; and means controlled by the manually operable means for advancing the nails one at a time from the magazine tube to the aligned chamber.

24. A portable nailing machine comprising a drum having nail receiving and carrying chambers; a magazine tube aligning with one of the chambers to receive nails from the tube; a hammer aligning with one of the chambers carrying a nail; means for reciprocating the hammer to drive a nail; manually operable means for controlling the operation of the hammer; means controlled by said manually operable means for advancing the drum to move an empty chamber into alignment with the magazine tube and a nail loaded chamber into alignment with the hammer; and guide means in each of said chambers to surround the shank of the nail to hold the nail during repeated blows by the hammer and expand to permit passage of the head of the nail after the nail has been driven a predetermined distance by the hammer.

25. A portable nailing machine comprising a drum having nail receiving and carrying chambers; a magazine tube aligning with one of the chambers to receive nails from the tube; a hammer aligning with one of the chambers carrying a nail; means for reciprocating the hammer to drive a nail; manually operable means for controlling the operation of the hammer; means controlled by said manually operable means for advancing the drum to move an empty chamber into alignment with the magazine tube and a nail loaded chamber into alignment with the hammer; guide means in each of said chambers to surround the shank of the nail to hold the nail during repeated blows by the hammer and expand to permit passage of the head of the nail after the nail has been driven a predetermined distance by the hammer; and means for holding said guide means expanded until the drum is again advanced.

26. A portable nailing machine comprising a drum having nail receiving and carrying chambers; a nail supply tube for supplying nails to the chambers; a hammer aligning with one of the chambers carrying a nail; means for reciprocating the hammer to drive a nail; manually operable means for controlling the operation of the hammer; means controlled by said manually operable means for advancing the drum to move an empty chamber into alignment with the tube and a nail loaded chamber into alignment with the hammer; a split guide for the nails in each chamber, adapted to be opened to permit passage of the head of the nail when struck by repeated blows of the hammer; and a wedge for holding the guide open during the final driving of the nail and until the drum is again advanced.

27. In a portable power-driven hammering tool, a casing; a hammer mounted in the casing for reciprocative movement; means for driving the hammer with a varying stroke as the

nail is driven in; means for positioning a nail in front of the hammer to be driven by the latter into a workpiece; and means for rendering said hammer driving means inoperative when the hammer stroke has increased a predetermined amount in driving the nail into the workpiece.

28. A portable nailing machine comprising a casing; a hammer mounted in the casing for reciprocative movement; means for positioning a nail in front of the hammer, to be driven by the latter out of the casing and into the work; means, including a manually operable member, for automatically reciprocating the hammer with a varying stroke as the nail is driven in when the member is depressed; means for rendering inoperative the hammer reciprocating means when the stroke of the hammer, in driving the nail, has increased a predetermined amount; and means for returning the hammer to starting position when the manually operable member is released.

29. Nailing apparatus comprising a hammering tool, a manual actuator for controlling the operation thereof, a nail supply feeding means including instrumentalities for transferring the nails from the supply to the tool, electrically operated means for operating said instrumentalities in a cycle to feed a nail from the supply to the tool, the circuit thereto being closed and said electrically operated means being rendered operative for a complete cycle by each actuation of the manual actuator.

ROCCO PAPALIA.

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Certificate of Correction

Patent No. 2,498,503

February 21, 1950

ROCCO PAPALIA

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 6, line 6, strike out the word "is" after the numeral "33"; column 7, line 46, for "integral" read *internal*; column 10, line 73, for "nozzle" read *muzzle*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of July, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.