Dec. 13, 1966 K. W. MACDONALD ETAL 3,291,081

APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

Filed April 14, 1964 8 Sheets-Sheet 1

Fig. 1.

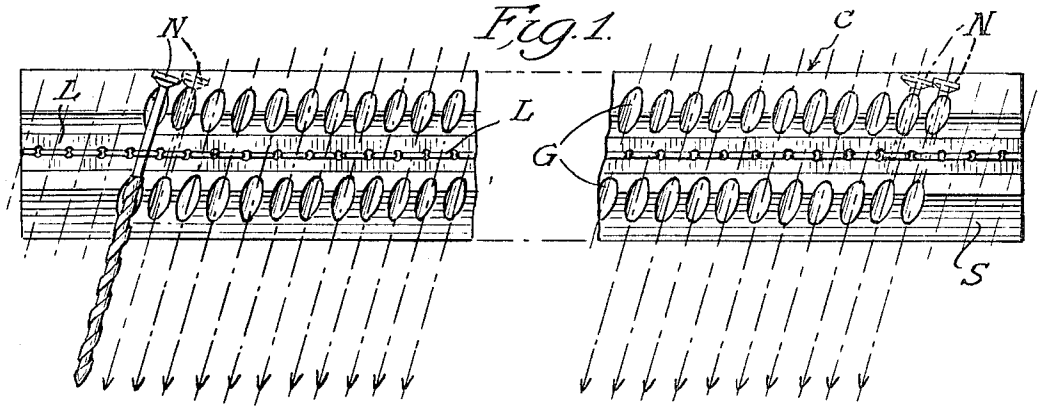
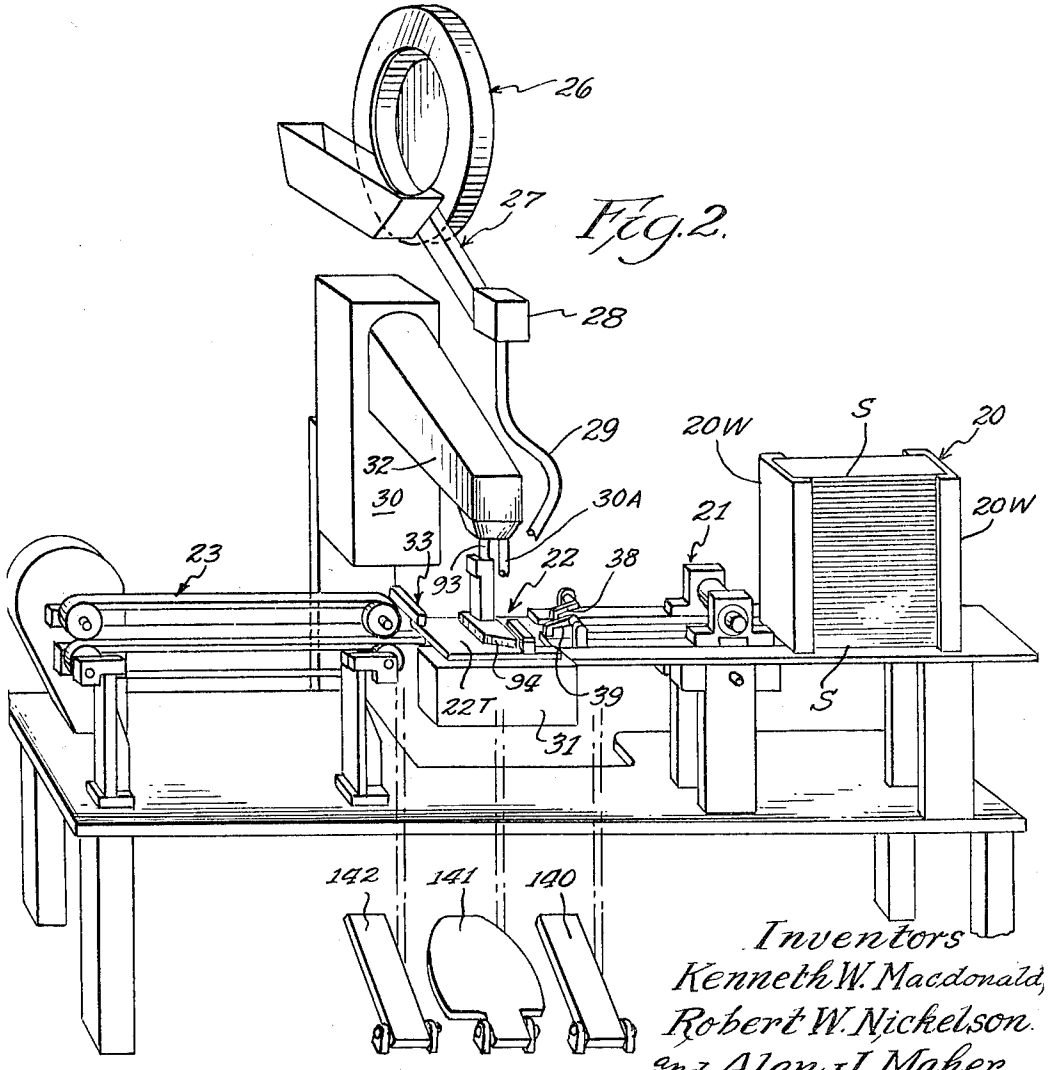


Fig. 2.



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APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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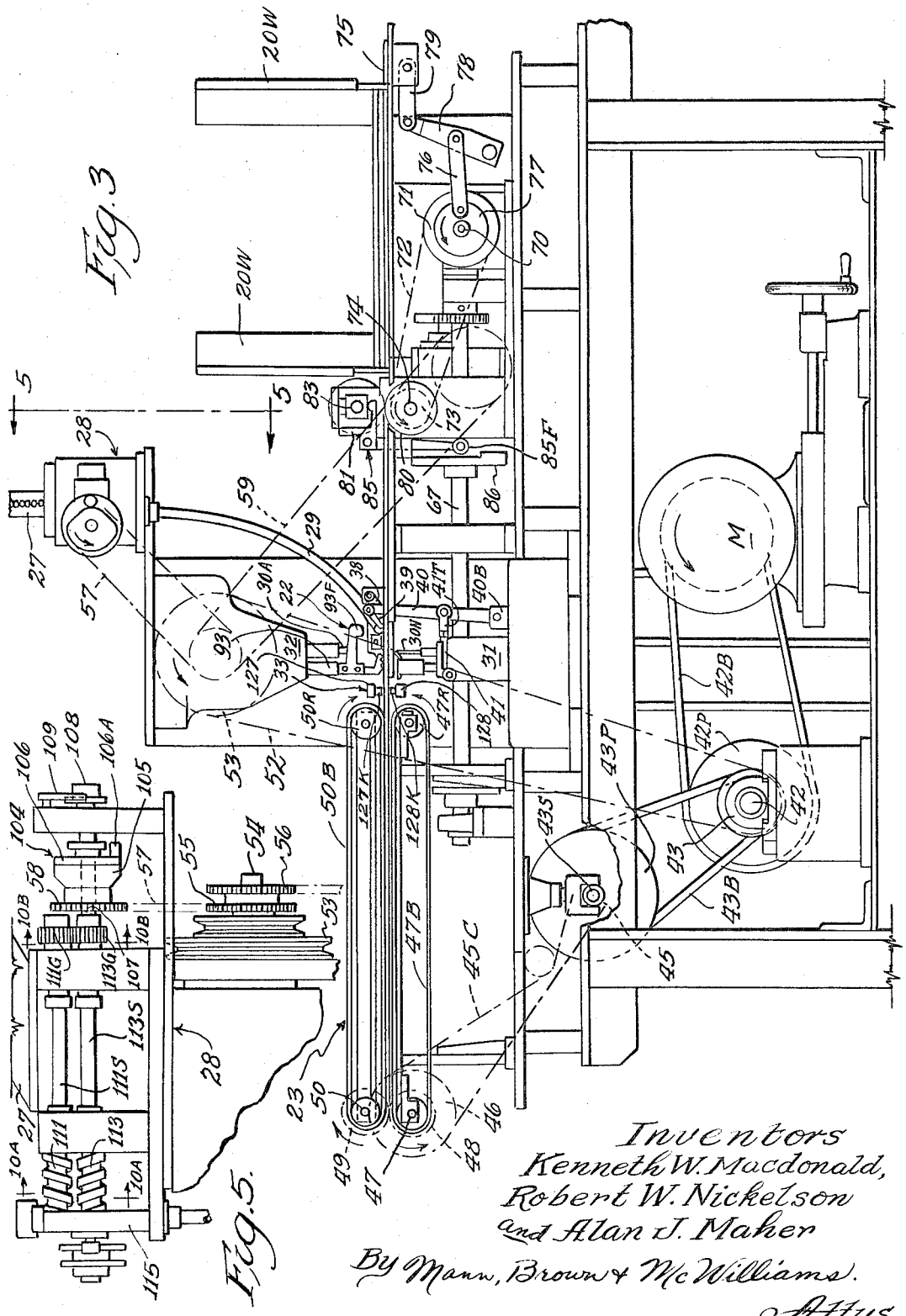


Fig. 3

Fig. 5.

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APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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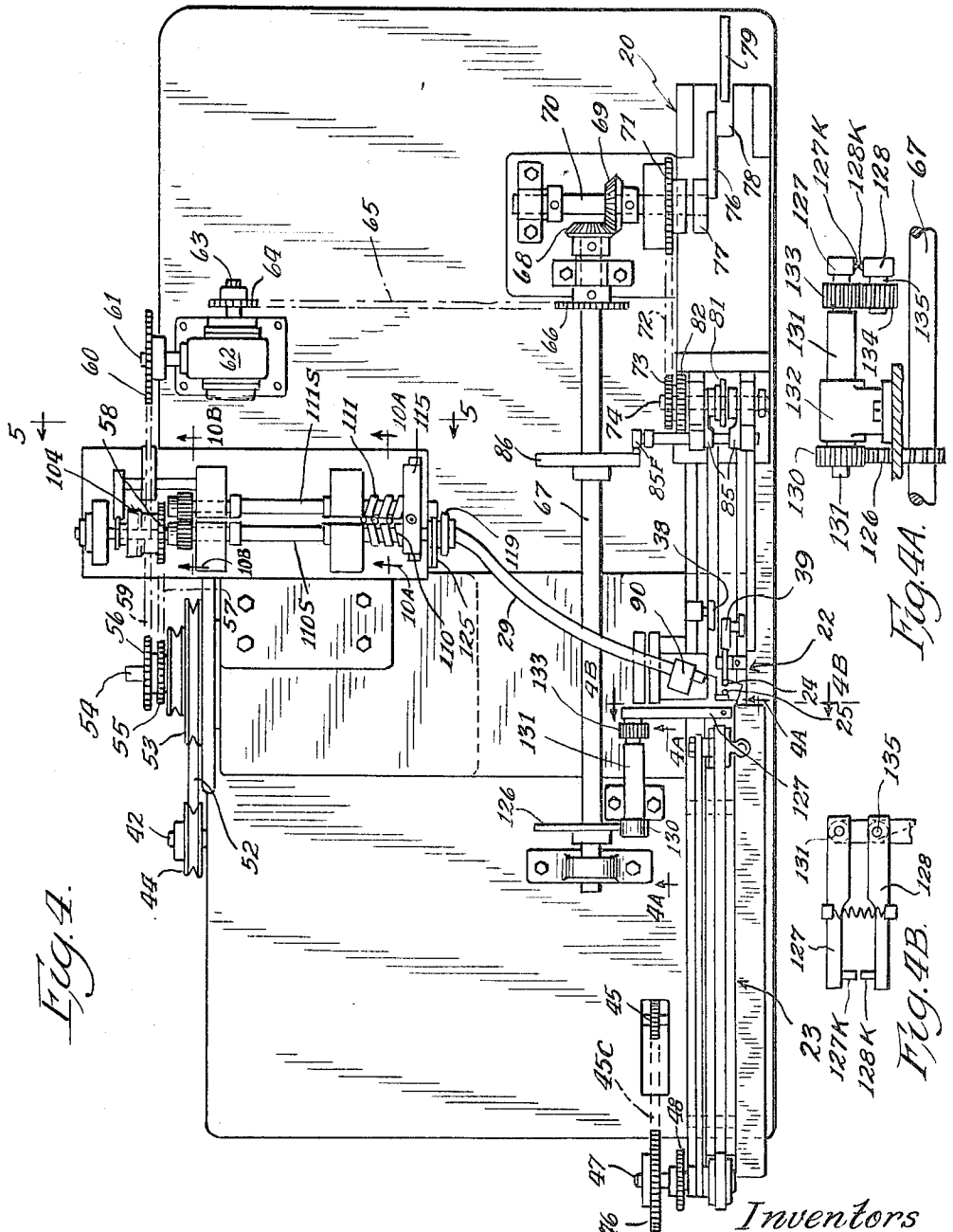


Fig. 4.

Fig. 4A.

Fig. 4B.

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APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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Fig. 6B.

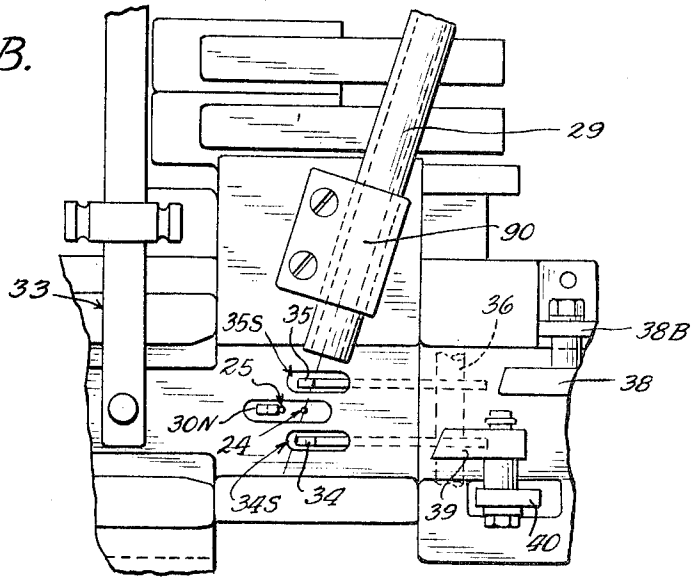
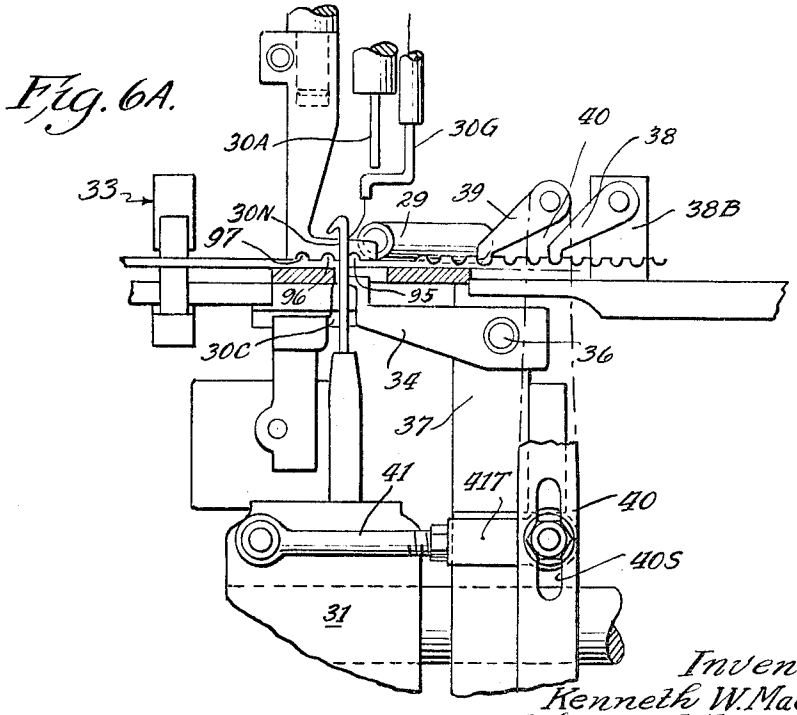


Fig. 6A.



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APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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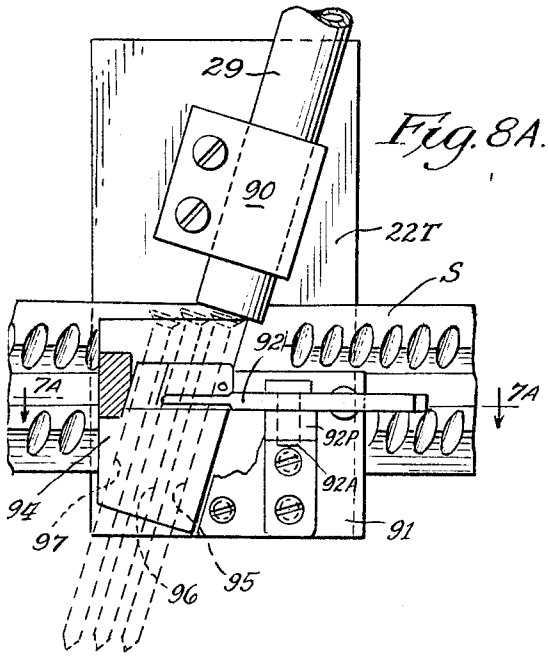


Fig. 8A.

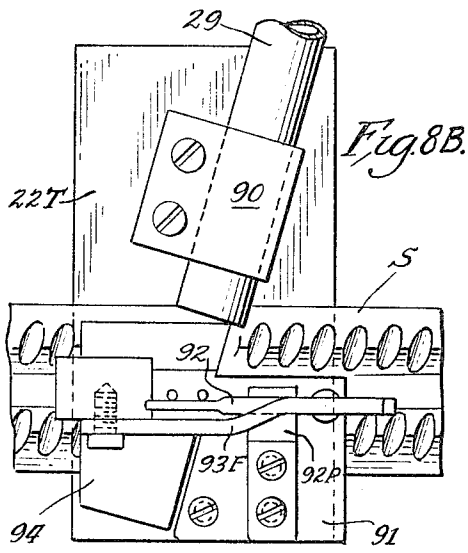


Fig. 8B.

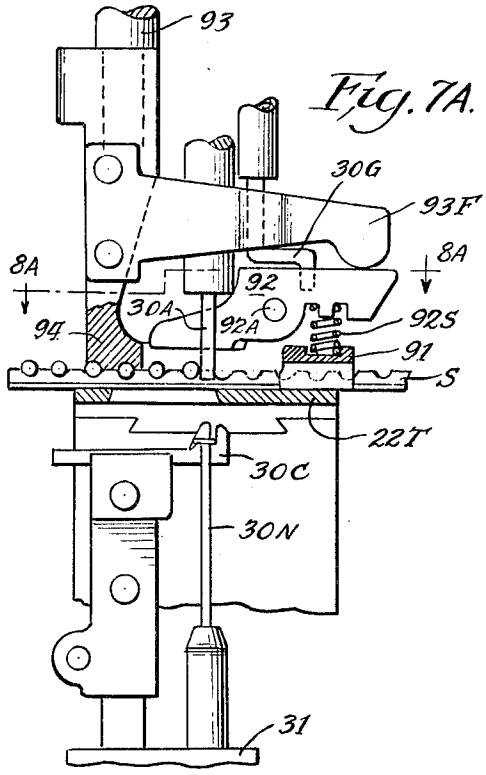


Fig. 7A.

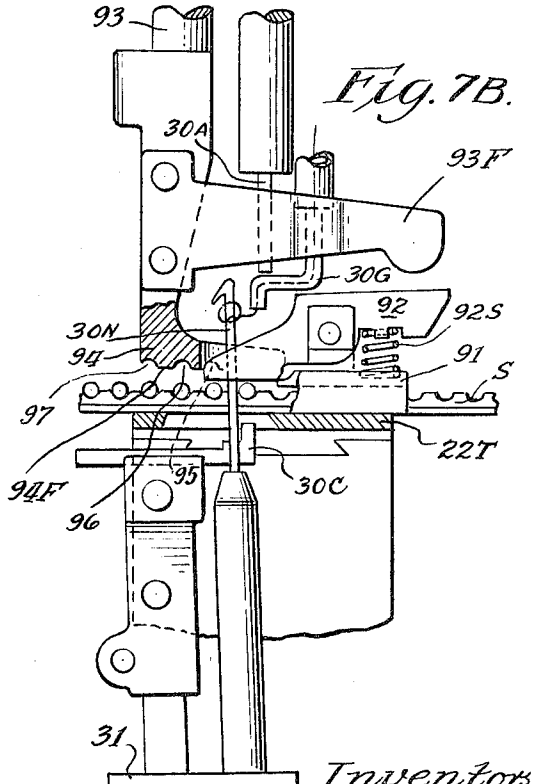
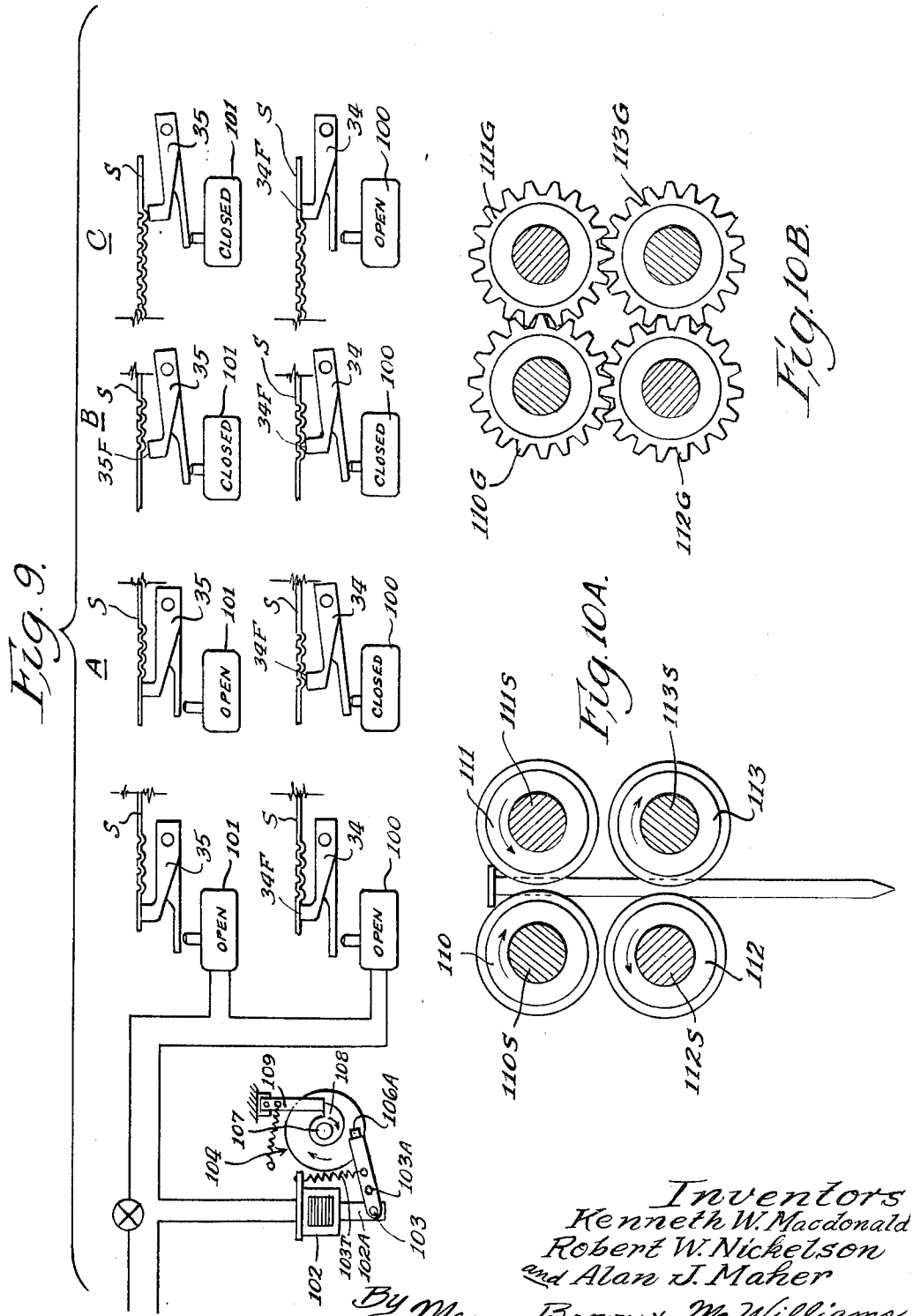


Fig. 7B.

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APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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Dec. 13, 1966 K. W. MACDONALD ETAL 3,291,081

APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

Filed April 14, 1964 8 Sheets-Sheet 7

Fig. 11A.

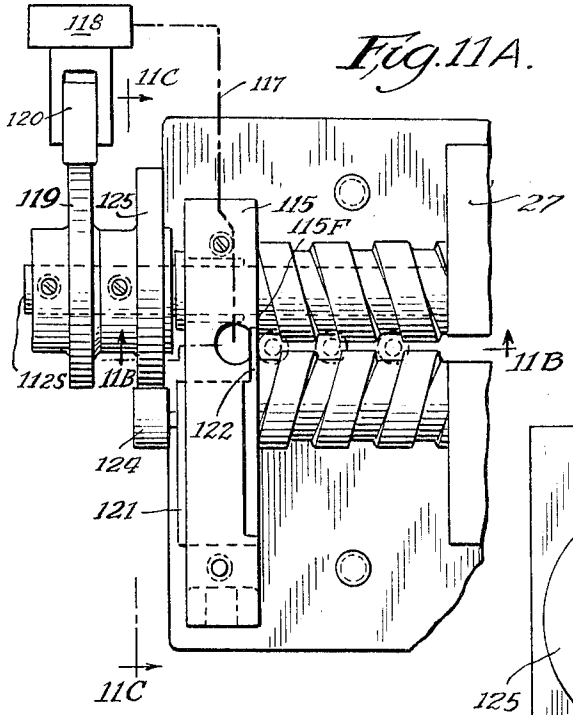
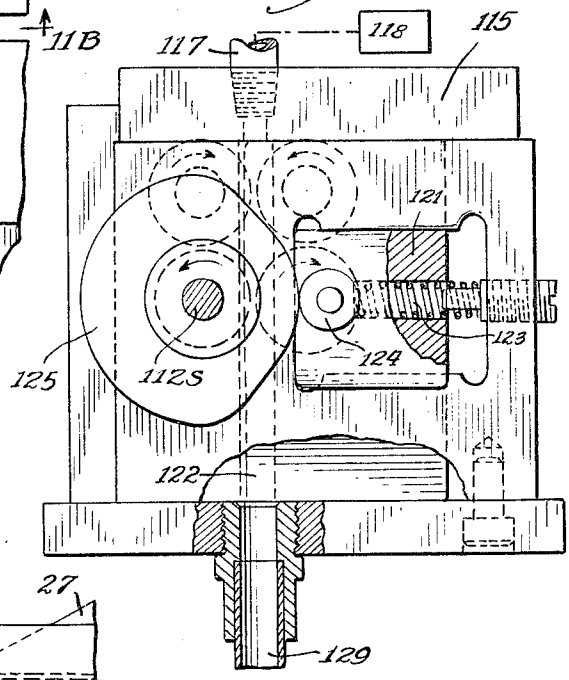


Fig. 11C.



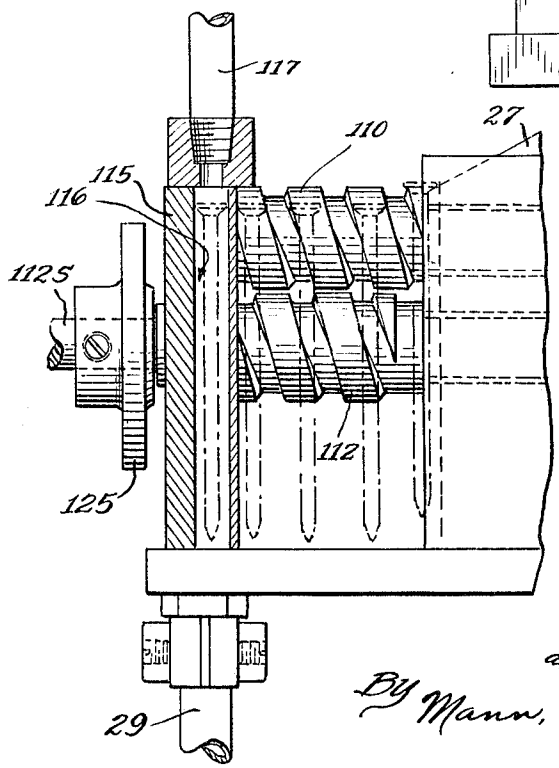


Fig. 11B.

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APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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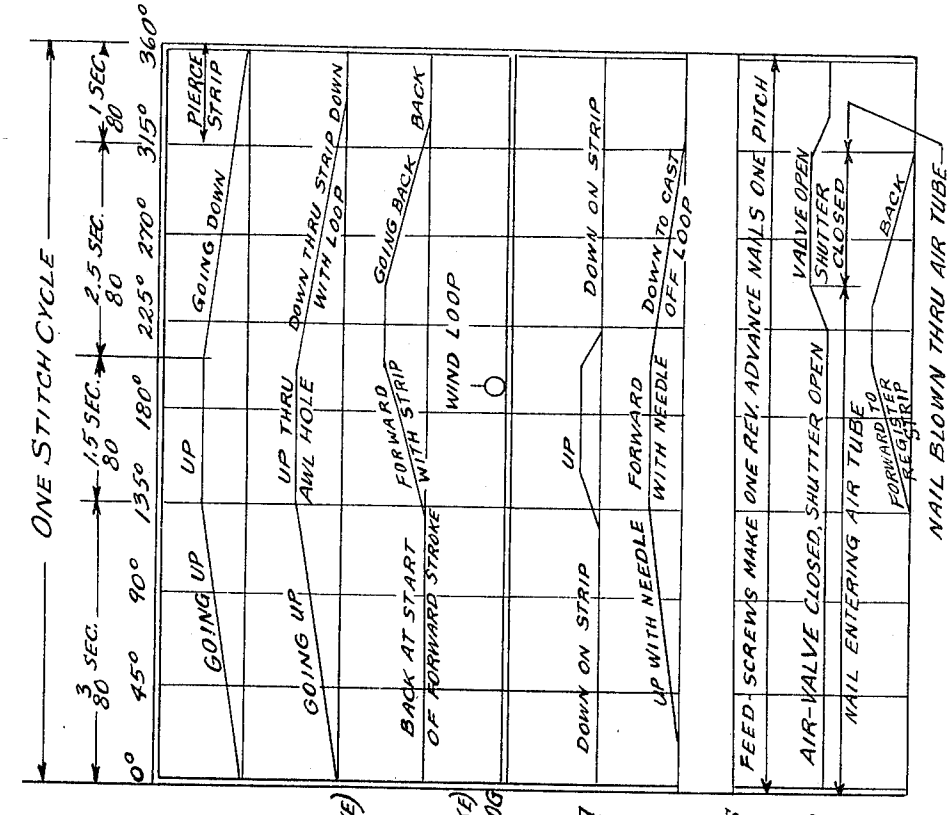


Fig. 12.

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United States Patent Office 3,291,081 Patented Dec. 13, 1966

3,291,081

APPARATUS FOR PACKAGING NAILS AND SIMILAR ARTICLES

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Filed Apr. 14, 1964, Ser. No. 359,584
16 Claims. (Cl. 112—104)

This invention relates to automatic high speed handling and packaging of nails and similar articles, and more particularly is concerned with providing a method and apparatus for producing a loaded clip of a type directly suitable for use in nail driving machines, the loaded clip comprising an elongated carrier strip having a series of nails stitched thereto in a predetermined single file, side-by-side relation established by preformed grooves provided in such strip. The nails are oriented obliquely to the strip in the preferred loaded clip arrangement and to prevent endwise projection of the nails, the grooveless ends of the strip are extended beyond the endmost nails.

The principal object of the invention is to provide an automatic machine to deliver nails at timed intervals and properly oriented for location in and individual securement in uniformly spaced side-by-side receiving grooves provided in elongated carrier strips.

Another object of the invention is the provision in such a machine of means for synchronizing delivery and deposit of nails individually in each groove with stitching of each nail individually to retain it in its groove.

Still another object of the invention is the provision in such a machine of one or more of the following:

Means for automatically supplying strips in endwise succession; means for advancing each strip endwise in step-by-step fashion to register first with a nail delivery point and then with a stitch point; means responsive to each strip for sensing the groove capacity and groove positions thereof; means for metering nails in quantities corresponding to the groove capacity of the strip and for delivering the metered quantity of nails individually and in timed relation to fill each groove of the strip in succession; positive mechanical registry mechanism engageable with each groove in the strip to register the position thereof continuously with respect to the nail delivery point and the stitch point; and means for cutting off the stitching thread after each strip is loaded to enable discharge of the loaded clips individually.

A further object of the invention is the provision of a means and method for feeding and metering nails in closely spaced side-by-side relation, and delivering such nails individually in endwise orientation at regular intervals for deposit within receiving grooves located in side-by-side spaced relation in an elongated carrier strip that is advanced step-by-step at corresponding intervals.

High speed automatic packaging of nails in predetermined arrangement in preformed receiving grooves requires high precision in the strip movement and in the nail delivery; and synchronization of these actions is important. Where the nails are to be secured to the strip by means of individually stitching each nail, the stitching cycle must be carefully synchronized with both strip movement and nail delivery.

In accordance with this invention, the strip movement establishes each groove in registry first with the nail delivery point and then with the stitch point and this is conveniently provided by imparting movement to the strip primarily by the stitching needle to advance the strip one groove pitch during each stitch cycle. Accuracy of strip registry at the nail receiving point, however, is determined by mechanical registry devices that engage directly in each of the successive grooves. This achieves

a repeatable accuracy that may not be realized by direct control from the stitching needle, as any error in its action may accumulate to serious proportions.

The nails to be inserted in the grooves are force fed at high speed to be delivered individually and in time spaced relation at a single nail delivery point. The nail flow is timed to start up at the beginning of each strip cycle by mechanical sense elements that respond to the first groove of the approaching strip, and nail flow is interrupted under the control of these sense elements which also respond to the last groove of the departing strip.

In the preferred form illustrated in this disclosure, the carrier strips are moulded to present a series of side-by-side spaced receiving grooves, each of which is interrupted centrally to define a lengthwise region on the strip where a line of stitching is applied.

Other objects and advantages of this invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification, and in which like numerals are employed to designate like parts throughout the same:

FIG. 1 is a fragmentary side elevational view illustrating a loaded clip of the type to be produced in accordance with this invention;

FIG. 2 is a generalized perspective view illustrating the overall arrangement of the principal components of the machine of this invention;

FIG. 3 is a front elevational view illustrating the overall arrangement of the principal components and the driving arrangement therefor;

FIG. 4 is a plan view of the machine;

FIGS. 4A and 4B are details of a thread cut-off unit and are taken on the lines 4A—4A and 4B—4B, respectively, of FIG. 4;

FIG. 5 is an enlarged detailed elevational view of a nail counter and feed unit and is taken approximately as indicated by the line 5—5 on FIGS. 3 and 4;

FIG. 6A is an enlarged detailed elevational view of the work station and illustrating various control mechanisms located thereat;

FIG. 6B is a plan view of the work station arrangement of FIG. 6A;

FIGS. 7A and 7B are fregmentary side elevational views of the work station illustrating sequential positions of the elements during a typical stitch cycle;

FIGS. 8A and 8B are plan views corresponding respectively to FIGS. 7A and 7B;

FIG. 9 is a diagram of a nail counting control circuit arrangement and includes a sequence of views illustrating a typical operating cycle of strip sensing facilities that control this circuit;

FIGS. 10A and 10B are detailed sectional views taken on the lines 10A—10A and 10B—10B respectively as indicated in FIG. 5;

FIG. 11A is an enlarged fragmentary plan view illustrating the movement of nails through the feed screw unit;

FIG. 11B is a fragmentary sectional view taken on the line 11B—11B of FIG. 11A;

FIG. 11C is an end view partly in section taken as indicated on the line 11C—11C of FIG. 11A; and

FIG. 12 is a timing chart for the machine.

Loaded clip

Referring now to the drawings, and more particularly, to FIG. 1, there is illustrated a loaded clip C of the type that is to be mass produced in accordance with the teachings of this invention. This loaded clip C is useful directly in nail driving machines and the like and it also conveniently may serve as a storage and shipping package to facilitate handling of nails during delivery, inventory, and sale. The clip is comprised of an elongated molded car-

rier strip S, loaded with a set of nails N, arranged in essentially parallel single file, side-by-side relation in grooves G provided along an open side face of the strip. Each groove G is comprised of and defined by hollowed pockets aligned in spaced relation to flank an elongated central portion of the strip. The nails are retained on the strip by a continuous line of stitching L provided in the elongated central portion so that each nail and the central strip region there adjacent is encircled by an individual stitch.

Various types of nails other than that which is illustrated here may be packaged with the same type of carrier strip. The invention also contemplates packaging of other elongated fasteners such as screws, paper fasteners, and similar articles in similar types of carrier strips, all in accordance with the techniques described hereinafter, For convenience, however, the term "nail" is used throughout the specification and claims, but it shall be understood to embrace similar types of articles as mentioned so long as such articles may be handled in a similar fashion.

The strips S are preferably molded from a fibrous material such as is marketed under the trade name CEL–U–MOL and each strip may have a set of 50 nail receiving grooves G in regularly spaced side-by-side relation along an intermediate length section thereof. The grooves extend generally crosswise of the strip direction and preferably are inclined at an angle to normal on the order of 16°.

In a typical strip construction, a groove and stitch pitch spacing of 0.232" is employed between the fifty adjacent grooves. As there are 56 stitch pitches in a strip, each end will extend beyond the midpoint of each endmost groove. Thus the leading end of the strip projects 3½ stitch pitches beyond the leading groove and the trailing end of the strip projects 2½ stitch pitches beyond the trailing groove. The requirement is occasioned by the nailing machines in which the loaded clips are used and it is accommodated by providing special arrangements for metering and feeding of nails in synchronized relation for deposit in the strip grooves.

General machine arrangement

In FIG. 2 there is shown a general arrangement for a preferred machine employed for feeding nails individually to and threadedly securing nails individually in the elongated carrier strips S to produce the final loaded clips C of FIG. 1. Accordingly, as generally represented, the machine comprises a strip storage and feed station **20** for feeding strips individually and in succession to a strip travel path that has infeed means **21** for regulating strip approach travel, a work station **22** intermediately therealong, and delivery conveyor means **23** for regulating strip discharge travel. The carrier strips S are moved through the work station **22** in an accurately registered step-by-step action to momentarily register each nail receiving groove of each strip first with a nail delivery point **24** (FIG. 6B) and then with a stitch point **25** (FIG. 6B), with these points having a predetermined integer groove pitch spaced relation along the travel path. Preferably, these points **24** and **25** are spaced apart a single groove pitch to facilitate securement of each nail immediately following deposit in its corresponding groove.

The nails are delivered from a storage drum **26** to an inclined nail raceway **27** along which the nails move in side-by-side rearwardly inclined shingled relationship. The nail raceway is centered upon a nail counter and feed unit **28** through which the nails are metered at regularly spaced intervals into an air line **29** that defines a flow conduit leading to and defining the nail delivery point **24**. The nails move individually and in endwise orientation through the air line **29** at high speed under the control of a force feed such as may be provided by pneumatic pressure.

A stitcher machine **30** constitutes the main structural component of the disclosed arrangement and it is preferably of the so-called shoe-stitch type in that it includes an awl **30A** for puncturing holes in the strip material to provide for subsequent entry of a needle **30N** (see FIGS. 7A and 7B). By way of example, the basic stitcher machine **30** may be of a type manufactured by the Puritan Manufacturing Co. under their designation, "Low-Post Single-Needle Sewing Machine." This machine produces a chain stitch comprised of successive distinct loops, each confining a nail in a corresponding groove.

In general, the stitcher machine **30** has a movable yoke **31** underlying the work station **22** and reciprocally movable in the strip travel direction and a stationary head **32** overhanging the work station. The yoke **31** has internal mechanism for raising and lowering the needle **30N** and this in conjunction with the yoke movement generates a loop-shaped needle travel path. The yoke **31** also carries a cast-off **30C** that is movable conjointly with the yoke to maintain proper relationship for removing each thread loop as it is drawn down by the needle **30N**.

The head **32** carries the awl **30A** and a thread guide **30G** which rotates about a vertical axis to wind one turn of thread about the needle **30N** during each forward stroke thereof.

A thread cut off unit **33** is located at the exit side of the work station **22** and operates once for each strip cycle to sever the thread at the trailing end of each strip, after each such strip has been fully loaded and is partially engaged in the delivery conveyor **23**. The belt speed at the delivery conveyor **23** is somewhat greater than the travel speed of a strip through the stitching station to apply a pulling tension to the next strip, assisting strip indexing action of the needle, thereby relieving the needle **30N** of excessive strain during the feed stroke. The thread cut-off unit **33** severs the thread between strips after a strip has exited from the stitching station and the delivery conveyor **23** carries away the loaded strip at top belt speed for delivery to suitable packaging facilities. Momentarily, the next strip is advanced by the action of the needle **30N** and without the assistance of the delivery conveyor until the lead end of the strip enters the belts of conveyor **23**.

In the preferred loaded clip package as illustrated in FIG. 1, the nail feed unit **28** is controlled to begin with the appearance of the first groove and to stop with the departure of the last groove. Nail counting and control mechanism is provided at the work station **22** to control an overrunning clutch **104** located at the rear of the unit to establish an on-off drive from the continuously running sprocket **58** to the intermittently running feed unit **28** (FIG. 5). The nail counting and control mechanism includes a pair of sense elements **34** and **35** (FIGS. 6A, 6B and 9) movable upwardly through laterally spaced access slots **34S** and **35S** provided to sense the arrival at the nail delivery point **24** of the lead groove in the strip and to sense the departure from the nail delivery point of the final groove of the strip. The sense elements **34** and **35** are rotatable about a common pivot shaft **36** (FIGS. 6A and 6B) mounted in a stationary upright **37**.

Strip register and indexing mechanism is provided along the strip travel path in advance of the nail delivery point and is operable to position the strip during each step-by-step advance to assure registry of each strip groove with the nail delivery point **24** at the end of each step-by-step advance. For this purpose, a first pawl **38** (FIGS. 6A and 6B) is pivotally mounted to a stationary bracket **38B** carried on the machine and is resiliently biased by a torsion spring (not shown) normally to act downwardly to engage in a strip groove for maintaining the strip against accidental displacement, with the pawl **38** being free yieldable to ride up upon the strip face and permit step-by-step advance of the strip as imparted by the stitching needle.

A second pawl **39** of identical form is pivotally mounted from the top of an oscillating indexing lever **40** which is driven in synchronism with the stitcher yoke **31** to generate a strip indexing movement that assists the needle **30N** in advancing the strip step-by-step. The indexing lever **40** has its lower end pivoted to a stationary bracket **40B** (FIG. 3) mounted on the base of the stitcher. An adjustable connecting rod **41** has its opposite ends pivotally connected

to the stitcher feed yoke 31 and the lever 40 for imparting to the pawl 39 a fore and aft movement corresponding to that imparted to the needle. The pawl 39 is biased by a torsion spring (not shown) to engage during successive cycles in successive grooves of the strip. This pawl 39 thus remains in and moves with a particular groove during the advance stroke of the needle 30N but is free to rise during the return stroke of the needle at which time the strip position is maintained by the first pawl 38. The connecting rod 41 has a threaded rod end 41T engaged to the indexing lever 40 to facilitate precise adjustment of the pawl 39 at integer groove pitch spacings from the nail delivery point. Accurate groove pitch movement is imparted to the pawl 39 by the indexing lever 40 by initial adjustment of the rod end 41T which is secured along a vertical slot 40S that is provided in the indexing lever.

While the needle of the stitcher effectively synchronizes step-by-step advance of the strip with the nail feed, any error in the strip advancing stroke of the needle becomes cumulative. The pawl 38 is provided to achieve registry after each strip cycle and the pawl 39 assists the needle in advancing the strip one groove pitch.

Stitcher action

The stitching action is best illustrated in the sequence of elevational views 7A and 7B and corresponding plan views 8A and 8B. The elements performing the stitching operation include the awl 30A disposed vertically above the work table 22T which supports the strip during passage through the work station and acting during its downstroke in each stitch cycle to punch a hole in the strip which is stationary at this particular time; the hooked needle 30N located below the table and executing a vertical upstroke along the line of the awl to enter the punched hole as the awl is withdrawn, with the needle then moving forwardly along the strip path to advance the strip one groove pitch; the thread guide 30G located above the work table adjacent to the awl and rotatable about a vertical axis to swing in a generally forward direction and wind one turn or loop of thread around the hook of the needle during the forward strip indexing movement of the needle; and a cast-off 30C located below the table adjacent to and moving in synchronism with the yoke 31 to remove from the needle the thread loop which the needle has drawn through the strip and through the thread loop formed by the preceding cycle, thus to form a series of interlocking loops on the underside of the carrier strip. This is commonly called a chain stitch.

Synchronized drive

For each strip of quantity of 50 nails are delivered at automatically timed intervals in synchronism with the movement of the carrier strip grooves past the nail delivery point 24. Accordingly, the mechanism for driving the nail feed unit 28 must be synchronized with mechanism for adancing the carrier strip S, groove by groove, through the work station 22. The particular stitcher machine 30 described above has a needle movement that enables the needle 30N to impart a step-by-step advancing movement to the strip. The needle stroke in the direction of the strip travel path is selected to be approximately one groove pitch.

The basic synchronized drive arrangement for the machine is shown in FIGS. 3 and 4 and includes a variable speed drive motor M connected through a belt 42B and pulley 42P to drive a countershaft 42 which is equipped adjacent its front end with a pulley 43 (see FIG. 3) and which is equipped at its rear end with a pulley 44 (see FIG. 4).

The front pulley 43 drives a belt 43B that is engaged to an intermediate plley 43P carried on a stub shaft 43S which drives a sprocket 45 and chain 45C that is trained about a larger drive sprocket 46 of the delivery conveyor 23. The sprocket 46 is carried on a shaft 47 that mounts a drive gear 48 which meshes with a gear 49 carried on a shaft 50. The shafts 47 and 50 drive belts 47B and 50B respectively, which are trained about idler rollers 47R and 50R to complete the delivery conveyor 23.

The pulley 44 (FIG. 4) at the rear of the countershaft 42 drives a belt 52 which is engaged on a pulley 53 mounted on a main drive shaft 54 of the stitcher machine 30. The main shaft 54 of the stitcher machine is additionally equipped with drive sprockets 55 and 56 (FIGS. 4 and 5). Drive sprocket 55 engages a chain 57 that is trained about a sprocket 58 mounted at the rear of the nail feed unit 28 to drive the nail feed unit at one-to-one ratio for enabling the feed unit 28, when activated, to supply one nail for each stitch cycle. Manual control apparatus comprising treadles 140 and 141 are provided to permit the operator to effect a single stitch cycle as well as a continuous stitching run. The treadle 140 provides a single stitch and the treadle 141 is depressed to bring about a continuous stitching action of the machine. The treadles are, of course, connected to the stitch drive in any suitable fashion to permit the desired degree of sensitivity and control.

Sprocket 56 (FIG. 4) is engaged to chain 59 to drive a sprocket 60 on the infeed shaft 61 of a speed reducer unit 62. The speed reducer unit 62 has an output shaft 63 equipped with a sprocket 64 engaged to a chain 65 that drives a sprocket 66 mounted on a cam shaft 67, which extends lengthwise through the machine to control the time of actuation of various equipment located along the strip travel path.

The cam shaft 67 is driven through one revolution every 56 stitch cycles as required by the fact that the strip length is 56 groove pitches. Therefore, there are 56 stitch cycles per strip cycle. The cam shaft 67 has a mitre gear 68 driving a mitre gear 69 to rotate a drive shaft 70 at the strip storage and feed station 20. The shaft 70 is also equipped with a sprocket 71 engaged to a chain 72 to drive a sprocket 73 carried on a drive shaft 74 that operates the infeed means 21 at the entry to the strip travel path.

The strip storage and feed station 20 has upstanding end walls 20W defining a storage magazine for a stack of carrier strips S. The lowermost carrier strip S stored at station 20 is fed from the bottom of the stack under the control of a push-type feeder element 75 that is reciprocable in the fore and aft direction of the strip travel path. The mechanism for driving the feeder element 75 includes an eccentric link 76 pivoted to a disc cam 77 that is drivingly mounted on shaft 70. The eccentric link 76 is drivingly connected to a rocking link 78 to operate a connection link 79 that drives the feeder element 75.

The infeed means 21 includes a pair of superposed feed roller wheels 80 and 81. Lower roller wheel 80 is mounted in a friction unit (not shown) fastened to shaft 74. Upper roller wheel 81 is moutned in a friction unit (not shown) fastened to shaft 83. The shafts 74 and 83 are driven from mating gears 82 by means of sprocket 73 which is carried on shaft 74.

The roller wheels 80 and 81 normally operate to advance each strip more rapidly than the advance of the preceding strip through the work station 22 as controlled by the needle 30N. This enables the strips to be fed continuously so as to avoid gaps between strips. The approaching strip is advanced solely by the action of the roller wheels 80 and 81 until the lead groove in the strip can be picked up and controlled by the indexing pawl 39. At this point the feed roller wheels will begin to slip and leave further strip advance to the pawl 39 for effecting accurate registry of each strip as it approaches the work station.

The cam 86 is configured to completely disengage the rollers 80 and 81 after the pawl 39 takes control of strip advance. This is accomplished by the cam 86 causing the frame 85 to pivot in a fashion to elevate the upper roller wheel 81 once during each strip cycle for a time interval sufficient to permit the final two inches of the

strip to clear the roller wheels as the strip is advanced up to and into the work station **22**.

(A) Nail hold down device

During the indexing of the carrier strip from the nail delivery point **24**, wherein a nail is injected into the groove momentarily aligned therewith, to the stitch point **25**, it is necessary to retain the injected nail in its groove to guard against the possibility of the nail popping out. The work table **22T** at the work station mounts a clamp **90** that anchors the delivery end of the feed tube **29** at the prescribed orientation for alignment with each successive groove that is to be progressed therethrough. Thus, the tube **29** is aligned in a particular direction at a particular location to define the nail delivery point **24**.

The details of the structure for retaining a nail against popping out are best shown in FIGS. 7A, 7B, 8A and 8B. At its outboard end, the work table **22T** is provided with a bracket **91** that extends crosswise above the travel path of the strips S to mount a retaining shoe **92**. An upstanding bifurcated post **92P** is mounted on the bracket and carries a pivot axle **92A** that mounts the shoe **92** for swinging movement about a horizontal axis. A compression spring **92S** reacts between the bracket **91** and the shoe **92** normally to urge the shoe into nail contacting engagement. The head **32** of the stitcher machine is provided with a vertically reciprocal rod **93** that carries a presser foot **94** at its lower end. The under face **94F** of the presser foot is provided with three grooves, **95**, **96** and **97** (See FIG. 8A), one **95** for alignment with the delivery tube **29** to serve in conjunction with the corresponding strip groove as a guide conduit during nail entry; a second **96** to hold the previously injected nail in place during looping of a stitch thereabout; and a third **97** engageable upon the previously stitched nail to align and position the strip after each index movement thereof.

The operating sequence of these elements may now be described. The presser foot **94** moves downwardly and its actuating rod **93** includes a laterally projecting finger **93F** that overhangs the retaining shoe **92** to move downwardly against the shoe and cause the shoe to be lifted at the time that the presser foot goes down upon the nail strip (see FIG. 7A). At this position of the parts, a nail is supplied through the tube **29** and guided into place by the rightmost groove **95** of the presser foot **94** which is in mating coaction with the corresponding strip groove. Thereafter the presser foot rises to permit the retaining shoe **92** to come down and engage the delivered nail to prevent its popping out as the needle **30N** moves first upwardly and then to the left to advance the strip to bring the deposited nail to the stitch point. The presser foot then comes down again and the cycle is repeated. A presser foot lift pedal **142** is provided, and is connected to the presser foot mechanism in such a manner that, upon depression of the treadle, the presser foot is caused to lift a sufficient amount to permit removal of, or insertion of a strip or a nail, or both.

(B) Nail counting control

As mentioned previously, the sense elements **34** and **35** shown in FIGS. 6A, 6B, and 9 are provided to control turn-on and turn-off of the nail feed unit **28**. The sense elements **34** and **35** are in alignment crosswise of the strip travel path and are arranged normally to ride upwardly against the strip S to engage and be deflected downwardly in the presence of the strip groove portions. Sense element **34** is associated with a control switch **100** and sense element **35** is associated with a control switch **101**. Each of the control switches are open when the sense elements are uppermost and are closed when the sense elements move downwardly in response to the presence of the strip grooves.

The sense elements **34** and **35** are aligned crosswise of the strip travel path and are spaced apart so that the inclination of the strip grooves causes sense element **34** to be operated one groove pitch sooner than sense element **35** upon the arrival of the lead groove of the strip S and so that sense element **34** returns to normal one groove pitch prior to sense element **35** upon departure of the final strip groove.

The control switches are connected in series in an energizing circuit for a solenoid **102** as shown in FIG. 9. The circuit is open unless both sense elements **34** and **35** are actuated by engagement with a strip groove region. Thus, as the lead strip groove approaches the sense elements as indicated in FIG. 9, both switches **100** and **101** are open prior to the arrival of the first groove. As indicated in sequence A of FIG. 9, the lead groove actuates sense element **34** to close its control switch, and at this time, sense element **35** is not yet actuated. As shown in sequence B of FIG. 9, the second strip groove holds sense element **34** actuated to maintain its control switch **100** closed, this being insured by providing the contact face **34F** of a length of one groove pitch. At this time the lead strip groove has now actuated sense element **35** which has a contact face **35F** also of one groove pitch in length. Thus, in sequence B, both control switches are closed and the solenoid is energized and remains energized while the intermediate grooves of the strip move by. Finally, as shown in sequence C the final strip groove moves clear of sense element **34**, first allowing the control switch **100** to open and de-energize the solenoid.

This nail counting control counts accurately the number of grooves in each strip and functions as a safety device in that nails will start to feed only when a strip is present. If a single sense element were used, one extra nail would be fed and this would foul up the entire operation.

The solenoid **102** has an armature **102A** reciprocably movable to control the positioning of a link **103** that regulates the condition of engagement of an overrunning clutch **104** which drives the nail feed unit **28**. The overrunning clutch **104** (FIG. 5) includes a driving element **105** connected to be operated by the sprocket **58**, and a driven element **106** which is connected to drive an input shaft **107** to the nail feed unit **28**. Since the sprocket **58** normally operates continuously, the clutch members **105** and **106** normally rotate continuously to transmit driving torque to this input shaft **107**.

The driven clutch element carries with it an abutment stop **106A** (see FIGS. 5 and 9), which is to be engaged by the link **103** under the control of the solenoid **102**. As shown in FIG. 9, the link **103** is mounted to pivot about an axis **103A** and is biased upward by tension spring **103T** normally to hold the link **103** in engagement with the abutment stop **106A** on the driven member **106** of the clutch, so that driving contact of the internal clutch rollers (not shown) is relieved and rotation of the shaft **107** is stopped, permitting the driving clutch element **105** and its sprocket **58** to "free-wheel."

When a nail receiving groove is sensed through the elements **34** and **35** to energize the solenoid **102**, the link **103** is swung free and permits the driven element of the clutch **106** to rotate and drive the nail feed input shaft **107** continuously until such time as the solenoid **102** is de-energized to allow the spring **103T** to pivot the link **103** into blocking engagement with the abutment stop **106A**. To prevent objectionable rebound action during this stop sequence, the input shaft **107** is equipped with an outboard cam **108** as shown in FIGS. 5 and 9. A shock lever **109** is spring biased towards the position illustrated in FIG. 9 to engage a shoulder on the cam **108** and block rebound at the time that the driven clutch element **106** is stopped by the solenoid controlled link **103**.

(C) Nail metering and feed unit

The feed unit **28** is shown generally in FIGS. 4 and 5 and includes an upper pair of twin screws **110** and **111** of

opposite leads (FIG. 10A) and a lower pair of twin screws 112 and 113 of opposite leads, all rotating in the directions indicated in FIG. 10A. In FIGS. 2, 3, 5, 11A and 11B, the nail raceway 27 is shown leading into the rear of the feed screw assembly. Each of the feed screws is mounted on a corresponding shaft 110S, 111S, 112S and 113S, the rearmost ends of which are equipped with intermeshing spur gears 110G, 111G, 112G, and 113G, respectively, operating at a 1 to 1 ratio. The shaft 112S for the lower spur gear 112G is aligned axially with the input drive shaft 107 which is engaged in the spur gear 112G for driving the entire nail metering and feed unit. Power is transmitted from gear 112G to the other gears to rotate all of the feed screws in synchronism.

The nail receiving ends of the feed screws are shaped and tapered to positively pick up one nail from the raceway 27 for each revolution of the shaft 107. The nails are thus conveyed in single file side-by-side positively spaced relation through the screws to enter a transfer block 115 that is provided with a discharge chamber in the form of a bore 116 that receives the nail in snug sliding relation for movement endwise into and through the delivery tube 29 which is connected into the lower end of the block 115. The entry face 115F of the transfer block 115 has a slot to enable each nail to move laterally into the bore 116.

For high speed nail handling applications, for example, 500 per minute, it is required to force feed the nails from the discharge chamber 116 through the delivery tube 29. For this purpose, an air supply line 117 is connected to the block 115 at the top of the discharge chamber and is controlled by an air valve 118 to apply air at a pressure on the order of 80 p.s.i. for forcibly driving each nail through the delivery tube 29. Operation of the air valve is synchronized by means of a cam 119 that rotates on the end of the feed screw shaft 112S as shown in FIG. 11A to actuate a follower roller 120 associated with the valve 118. This cam actuates the operating roller 120 to trigger the air supply once for each stitch cycle at a time phase following delivery of a nail into the discharge chamber 116.

For most effective utilization of the air, a snug fit with the nail head is provided and it is important to seal the entry slot through the face 115F of the transfer block 115 during application of air under pressure. For this purpose, the transfer block 115 mounts a slidable block 121 that carries a plate-like gate 122 or shutter to block the entrance slot intermittently. Normally, the slide block 121 is held at a slot closing position by means of a compression spring 123 as illustrated in FIG. 11C. A roller 124 is mounted outboard of the slide block and is engageable by a cam 125 carried on the feed screw shaft 112S to control closure and opening of the gate 122.

In general, the sequence for each stitch cycle or for each nail feed cycle is to close the gate 122 immediately after delivery of a nail into the discharge chamber, then to open the air valve 118 for a predetermined part of the cycle and then to close the valve 118 and open the gate 122 for the remainder of the revolution. This is illustrated at the bottom of the timing chart of FIG. 12.

(D) Thread cut-off unit

The thread cut-off unit is illustrated at 33 in FIGS. 3, 4, 6A, and 6B, and it is operated in synchronized relation from the camshaft 67 the left hand end of which, as pictured in FIGS. 4 and 4A, is equipped with a cam 126 that controls the time of activation of arms 127 and 128 that are equipped with knife-edge elements 127K and 128K respectively to sever the thread at a location between successive carrier strips. The surface on cam 126 is configured to maintain the cutting arms open for $^{55}/_{56}$ of a revolution.

On the 56th increment, the cam 126 frees the lever arm 130 carried at one end of a shaft 131 which is journaled in a frame-mounted bearing structure 132. The other end of shaft 131 carries a knife element 127 and also drives a spur gear 133 which meshes with a cooperating spur gear 134 carried on a stub shaft 135 that pivots knife-element 128 in synchronism with element 127.

Internal springs (not shown) act to swing the knife elements together when the cam 126 frees the lever arm 130 and this occurs at a time when the strip is not moving, so that the thread may easily be severed to free the completed strip for higher speed travel through the delivery conveyor 23.

Thus, while preferred constructional features of the invention are embodied in the structure illustrated herein, it is to be understood that changes and variations may be made by those skilled in the art without departing from the spirit and scope of the appending claims.

What is claimed is:

1. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a given number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation therealong and a separate nail secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means to advance the strip in single groove pitch steps along a travel path that includes a work station having thereat a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, a stitcher at said work station and repeatedly operable through a stitch cycle in synchronism with strip movement steps to form successive stitch loops in encircling relation to strip material at the stitch point, and nail counting and feed means operable in synchronism with said stitcher to supply one nail for each stitch cycle to discharge in predetermined orientation into the particular groove located at said nail delivery point, and said apparatus including means operable once during each stitch cycle for advancing said strip endwise in single groove pitch steps through said work station to establish each of successive grooves therein in registry with the nail delivery point at the time of nail discharge therefrom and in registry with the stitch point at the time of stitch loop forming.

2. The apparatus of claim 1 and including presser foot means at said work station and cyclically movable in synchronism with the strip movement steps to occupy a clearance position relative to the strip portion at said work station when the strip is in motion and to occupy a nail holding position relative to the strip portion at said work station when the strip is stationary.

3. The apparatus of claim 2 and including a nail contacting retainer means at said work station and cyclically movable in synchronism with said presser foot means to occupy a clearance position relative to the strip grooves at the nail delivery point and the stitch point when the strip is stationary and to occupy a nail contacting position relative to nails in the strip grooves that are departing from the said points when the strip is in motion.

4. The apparatus of claim 1 and including a nail contacting retainer means at said work station and cyclically movable in synchronism with the strip movement steps to occupy a clearance position relative to the strip grooves at the nail delivery point and the sitch point when the strip is stationary and to occupy a nail contacting position relative to nails in the strip grooves that are departing from said points when the strip is in motion.

5. The apparatus of claim 1 wherein the nail counting and feed means has its nail delivery point alongside the strip travel path and oriented in a direction for endwise aligned registry with each strip groove and wherein the nail counting and feed means includes means to feed nails individually at high speed and in endwise orientation along a nail travel path leading to the nail delivery point to enable endwise entry of each nail into its corresponding receiving groove.

6. Apparatus in accordance with claim 1 wherein the

strip travel path extends generally horizontally and each strip moving therealong has an upper exposed face provided with said receiving grooves and said nail counting and feed means discharges each nail individually in a direction for endwise aligned registry with its corresponding groove.

7. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a given number of succesive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation therealong a separate nail secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means to advance the strip in single groove pitch steps along a travel path that includes a work station having thereat a nail delivery point and a stitch point located in succesive integer groove pitch spaced relation along the strip travel path, a stitcher at said work station and repeatedly operable through a stitch cycle in synchronism with strip movement steps to form successive stitch loops in encircling relation to strip material at the stitch point, nail feed means operable in synchronism with said stitcher to supply one nail for each stitch cycle to discharge in predetermined orientation to the particular groove located at said nail delivery point, and count control means sensing the passage of each strip through said work station and actuating the nail feed means for metering said number of nails for sequential deposit individually in successive grooves of said strip, and said apparatus including means operable once during each stitch cycle for advancing said strip endwise in single groove pitch steps through said work station to establish each of successive grooves therein in registry with the nail delivery point at the time of nail discharge therefrom and in registry with the stitch point at the time of stitch loop forming.

8. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation along an intermediate section of such strip and a separate nail individually secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means providing a strip travel path and including a work station providing a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, a stitcher at said work station and repeatedly operable through a stitch cycle to form successive stitch loops in encircling relation to strip material at the stitch point, said stitcher including a stitch loop forming needle cyclically movable through the plane of a strip, then forwardly along the strip travel path to advance the strip one groove pitch, then oppositely through the plane of the strip and then rearwardly along the strip travel path, and nail counting and feed means operable in synchronism with said stitcher to supply one nail for each stitch cycle to discharge such nail endwise through the nail delivery point along a direction of endwise aligned registery with a corresponding receiving groove during a time period following strip advancing movement of said needle.

9. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation along an intermediate section of such strip and a separate nail individually secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means providing a strip travel path and including a work station having thereat a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, a stitcher at said work station and repeatedly operable through a stitch cycle to form successive stitch loops in encircling relation to strip material at the stitch point, said stitcher including a stitch loop forming needle cyclically movable through the plane of a strip, then forwardly along the strip travel path to advance the strip one groove pitch, then oppositely through the plane of the strip and then rearwardly along the strip travel path, an elongated air chamber having a lateral entrance slot and a travel passage capable of accommodating endwise nail travel exiting from one end of said chamber and leading to said nail delivery point to discharge each nail endwise along a direction of endwise aligned registry with a corresponding receiving groove, positive motion feed means operating in timed relation with said stitcher for feeding nails in distinctly spaced side-by-side relation to supply nails into said chamber through said slot individually at discrete intervals, and valve means operating in timed relation with said positive motion feed means to inject a momentary high pressure blast at the other end of said chamber after each nail is supplied thereto and eject each nail endwise from said chamber to travel through said passage and exit from said nail delivery point when an empty strip groove is in registry therewith.

10. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a given number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation along an intermediate length section thereof and a corresponding number of nails individually secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means providing a strip travel path and including a work station providing a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, a stitcher at said work station and repeatedly operable through a stitch cycle to form successive stitch loops in encircling relation to strip material at the stitch point, means for metering said number of nails for each strip and including positive motion feed means operating in timed relation with said stitcher to supply one nail for each stitch cycle to discharge in predetermined orientation at said nail delivery point, a circuit connected to control the time of operation of said metering means and including a first sense element responsive to leading portions of each strip groove and a second sense element responsive to trailing portions of each groove and spaced from groovewise alignment with the first sense element a single groove pitch distance, and means responsive only when both sense elements are responding to actuate said circuit, and said apparatus including means operable once during each stitch cycle for advancing said strip endwise in single groove pitch steps through said work station to establish each of successive grooves therein in registry with the nail delivery point at the time of nail discharge therefrom and in registry with the stitch point at the time of stitch loop forming.

11. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a given number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation along an intermediate length section thereof and a corresponding number of nails individually secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means providing a strip travel path and including a work station providing a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, a stitcher at said work station and repeatedly operable through a stitch cycle to form sucessive stitch loops in encircling relation to strip material at the stitch point, an elongated air chamber having a lateral entrance slot and a travel passage capable of accommodating endwise nail travel exiting from one end of said chamber and lead-

ing to said nail delivery point to discharge each nail endwise along a direction of endwise aligned registry with a corresponding receiving groove, means for metering said number of nails for each strip and including positive motion feed means operating in timed relation with said stitcher to supply one nail for each stitch cycle to discharge in predetermined orientation at said nail delivery point, a circuit connected to control the time of operation of said metering means and including a first sense element responsive to leading portions of each strip groove and a second sense element responsive to trailing portions of each groove and spaced from groovewise alignment with the first sense element a single groove pitch distance, and means responsive only when both sense elements are responding to actuate said circuit, and valve means operating in timed relation with said positive motion feed means to inject a momentary high pressure blast at the other end of said chamber after each nail is supplied thereto and eject each nail endwise from said chamber to travel through said passage and exit from said nail delivery point, and said apparatus including means operable once during each stitch cycle for advancing said strip endwise in single groove pitch steps through said work station to establish each of successive grooves therein in registry with the nail delivery point at the time of nail discharge therefrom and in registry with the stitch point at the time of stitch loop forming.

12. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a given number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation therealong and a corresponding number of nails individually secured in each groove along an intermediate length section of the strip by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means providing a strip travel path and including a work station providing a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, means to advance the strip in single groove pitch steps to register each receiving groove thereof successively with each said point and including a stitcher at said work station and repeatedly operable through a stitch cycle to form successive stitch loops in encircling relation to strip material with said stitcher to supply one nail for each stitch cycle to discharge in predetermined orientation into the particular groove located at said nail delivery point, and count control means sensing the passage of each strip through said work station and actuating the nail feed means for metering said number of nails for sequential deposit individually in successive grooves of said strip, and said apparatus including means operable once during each stitch cycle for advancing said strip endwise in single groove pitch steps through said work station to establish each of successive grooves therein in registry with the nail delivery point at the time of nail discharge therefrom and in registry with the stitch point at the time of stitch loop forming.

13. Apparatus for assembling loaded clips each comprised of an elongated carrier strip having a given number of successive generally crosswise directed receiving grooves disposed in regularly spaced side-by-side relation therealong and a separate nail secured in each groove by lengthwise stitching that includes a distinct loop encircling a separate strip portion adjacent each groove, said apparatus comprising means providing a strip travel path and including a work station providing a nail delivery point and a stitch point located in successive integer groove pitch spaced relation along the strip travel path, strip storage and supply means operable cyclically to supply strips successively to said strip travel path, means to advance each strip through said work station in single groove pitch steps to register each receiving groove thereof successively with each said point and including a stitcher at said work station and repeatedly operable through a stitch cycle to form successive stitch loops in encircling relation to strip material at the stitch point, nail feed means operable in synchronism with said stitcher to supply one nail for each stitch cycle to discharge in predetermined orientation into the particular groove located at said nail delivery point, and count control means sensing the passage of each strip through said work station and actuating the nail feed means for metering said number of nails for sequential deposit individually in successive grooves of said strip, and said apparatus including means operable once during each stitch cycle for advancing said strip endwise in single groove pitch steps through said work station to establish each of successive grooves therein in registry with the nail delivery point at the time of nail discharge therefrom and in registry with the stitch point at the time of stitch loop forming.

14. Apparatus of claim 13 and including thread cut-off means following said work station and operable in synchronism with said strip storage and supply means to sever the stitching at the trailing end of each strip after such strip clears the work station.

15. The apparatus of claim 13 and including a nail contacting retainer means at said work station and cyclically movable in synchronism with said presser foot means to occupy a clearance position relative to the strip grooves at the nail delivery point and the stitch point when the strip is stationary and to occupy a nail contacting position relative to nails in the strip grooves that are departing from the said points when the strip is in motion.

16. The apparatus of claim 15 and including a rail contacting retainer means at said work station and cyclically movable in synchronism with the strip movement steps to occupy a clearance position relative to the strip grooves at the nail delivery point and the stitch point when the strip is stationary and to occupy a nail contacting position relative to nails in the strip grooves that are departing from said points when the strip is in motion.

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