United States Patent

Blakeslee

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[54] **AUTOMATIC FASTENING MACHINE**

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[52] **U.S. Cl.**.....**29/430**, 29/200 A, 29/211 D

[51] **Int. Cl.**.....**B23p 19/00**, B23q 7/10

[58] **Field of Search**.....29/430, 211, 211 D, 208 D, 29/200 A

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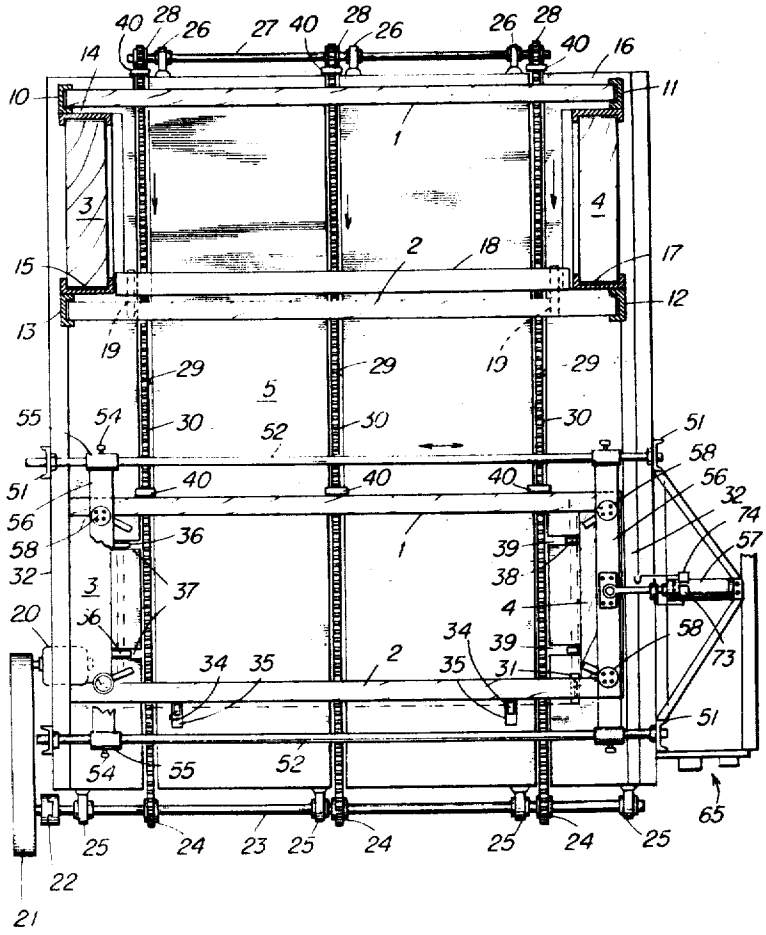
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[57] **ABSTRACT**

A machine for automatically assembling members into a frame and placing fasteners such as nails, staples, or the like in predetermined locations includes means to collect the frame members into an assembly, means to move the assembly to be fastened to a work station where it is positioned against retractable stops and means to position and drive a plurality of fasteners in a first location and to reposition and actuate the fastener driving means in at least one other location.

13 Claims, 9 Drawing Figures



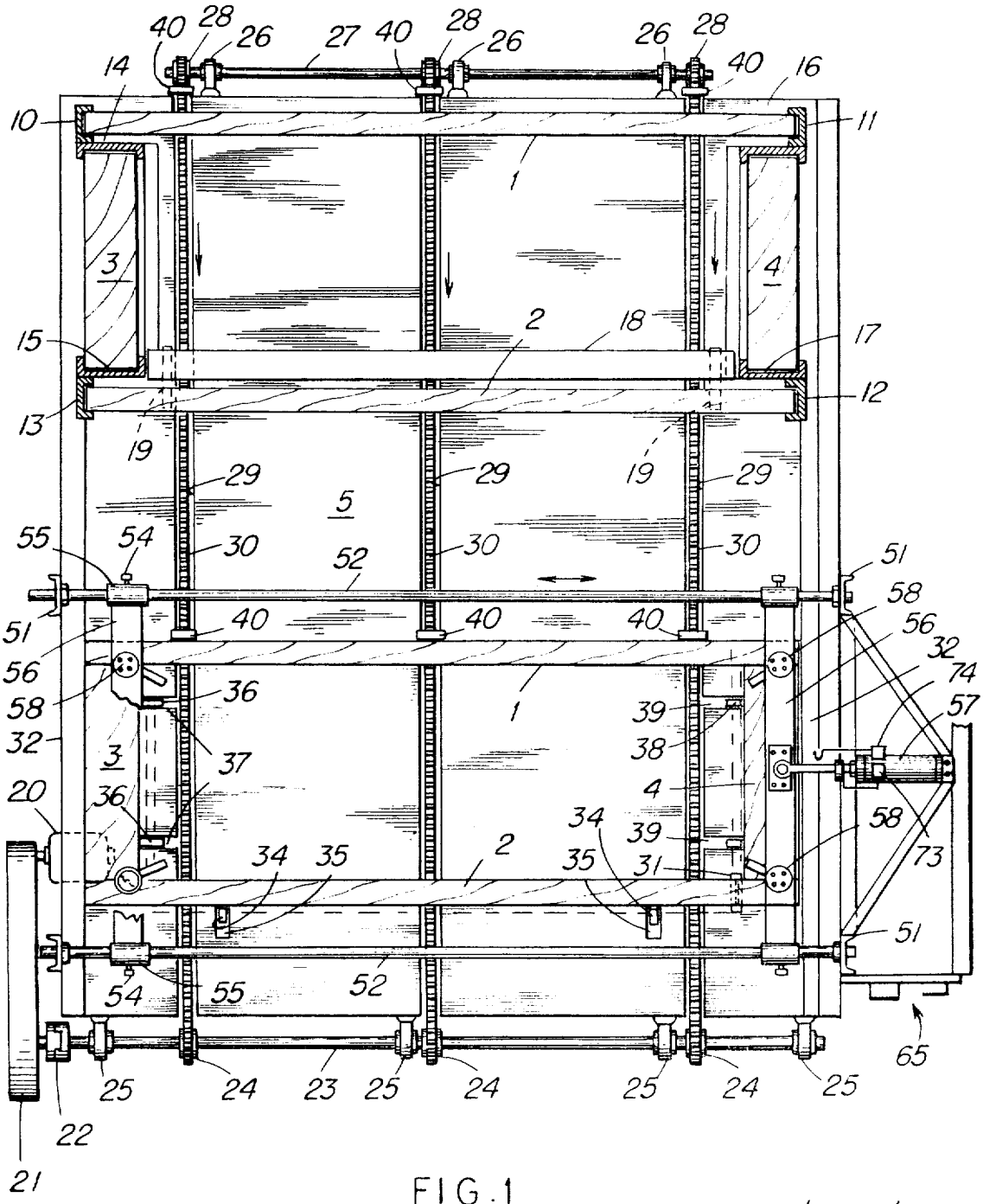


FIG. 1

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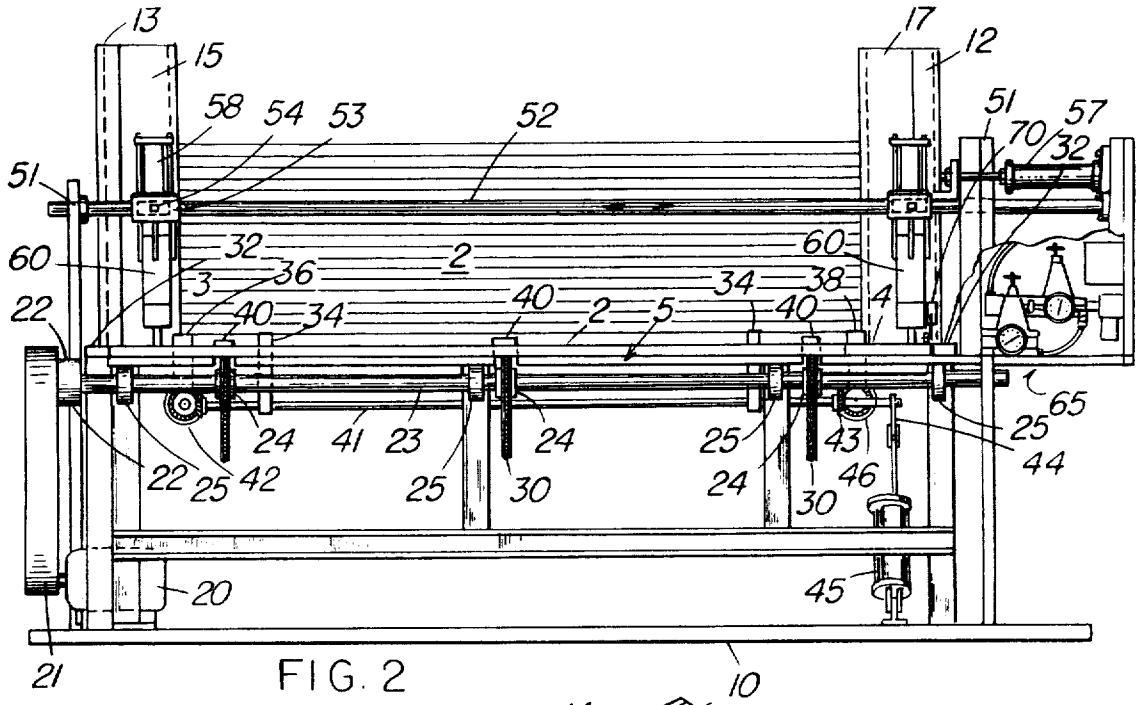


FIG. 2

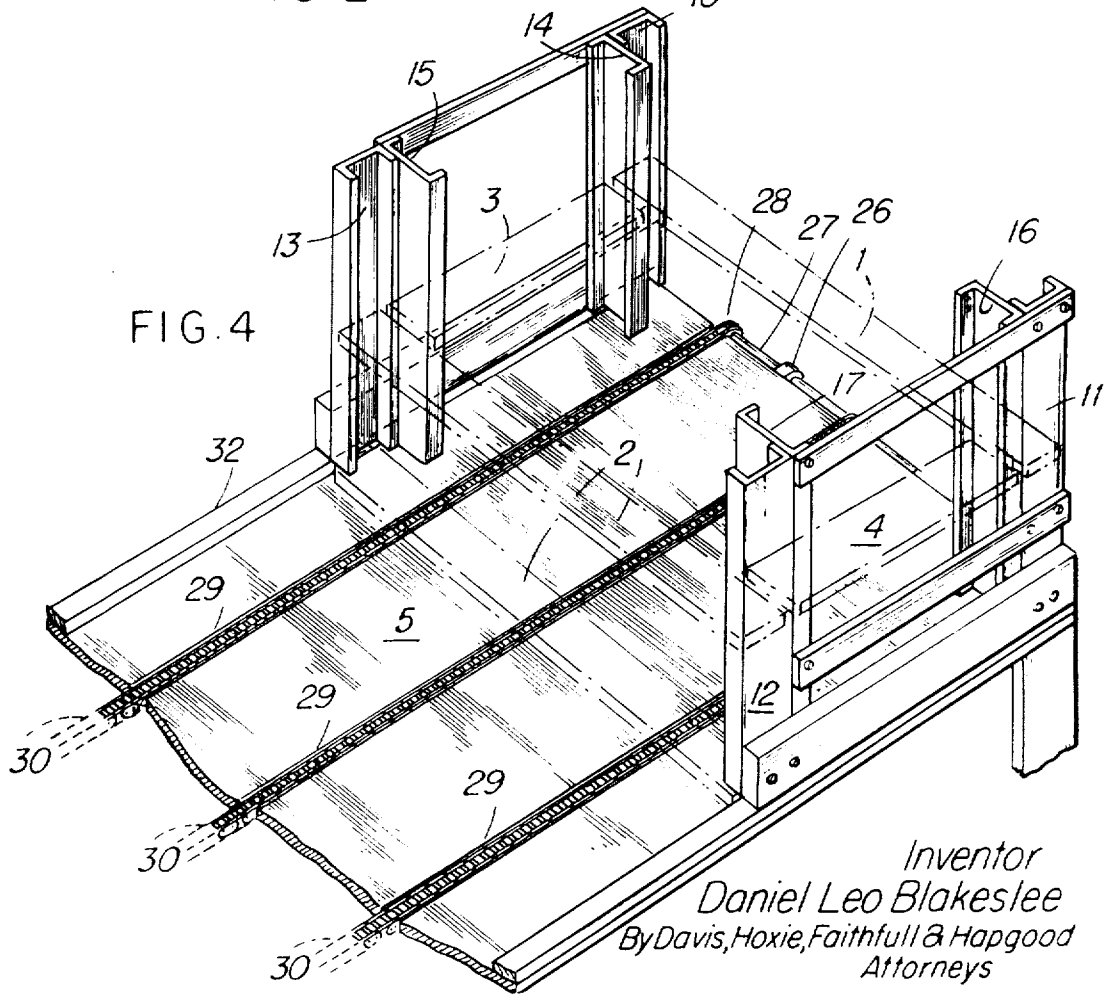
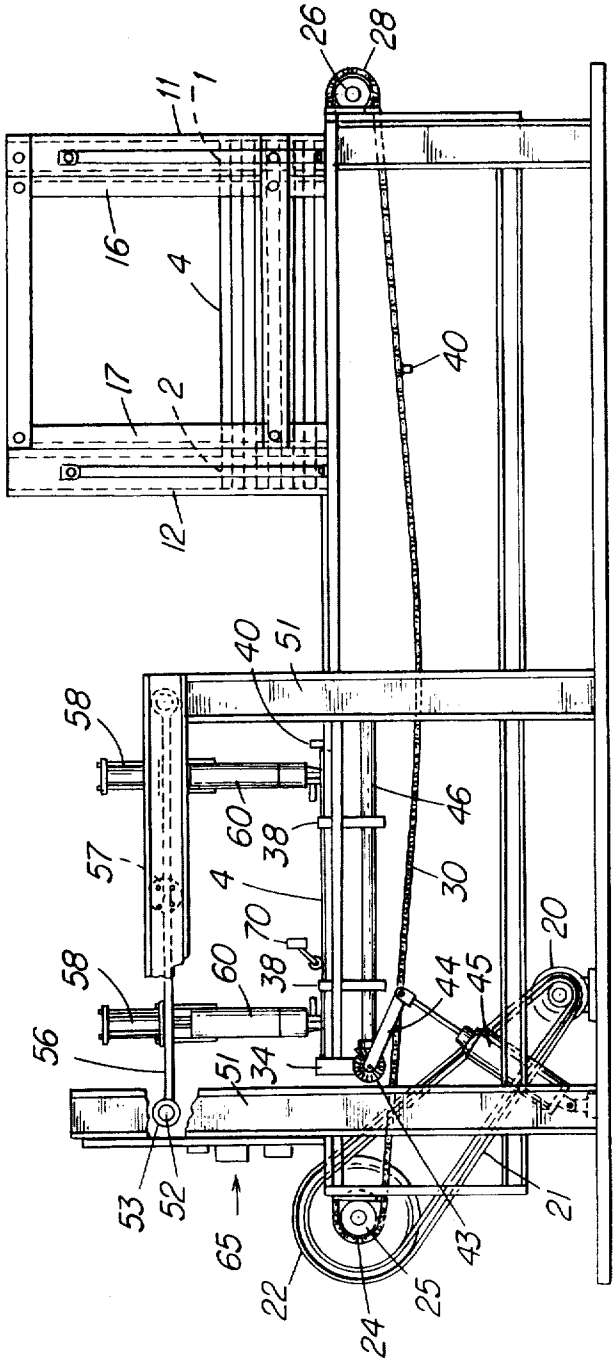


FIG. 4

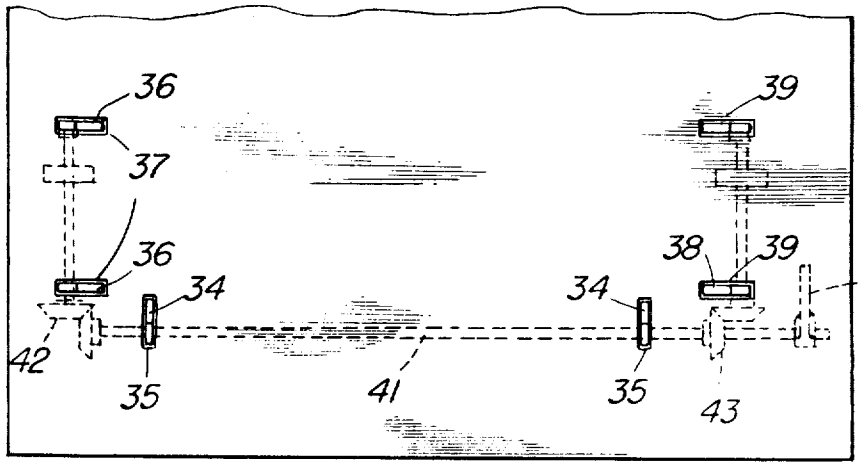
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FIG. 3



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FIG. 7



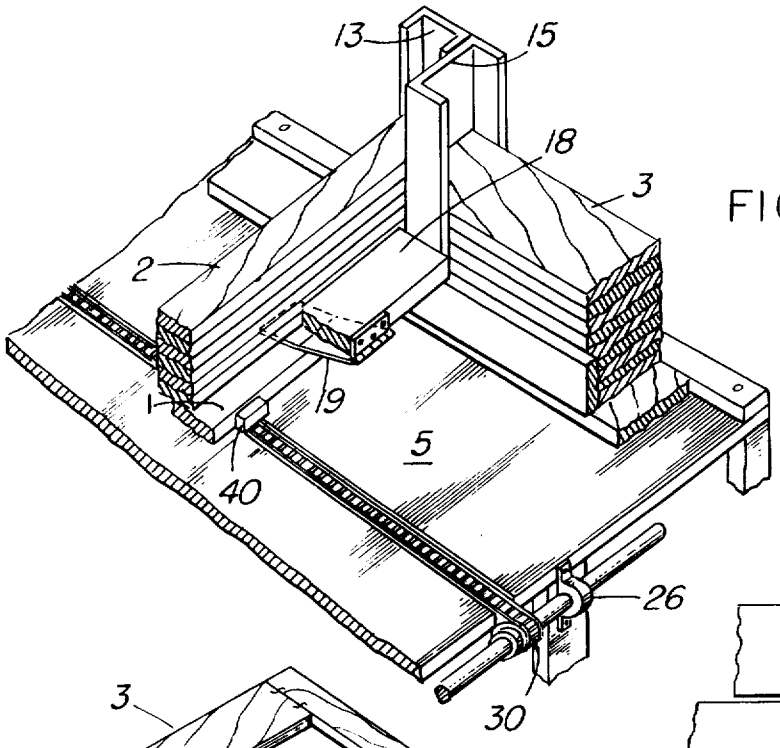
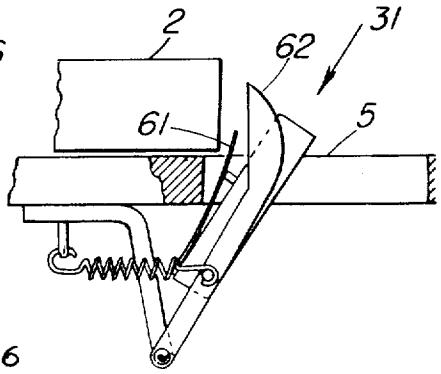


FIG. 5

FIG. 8



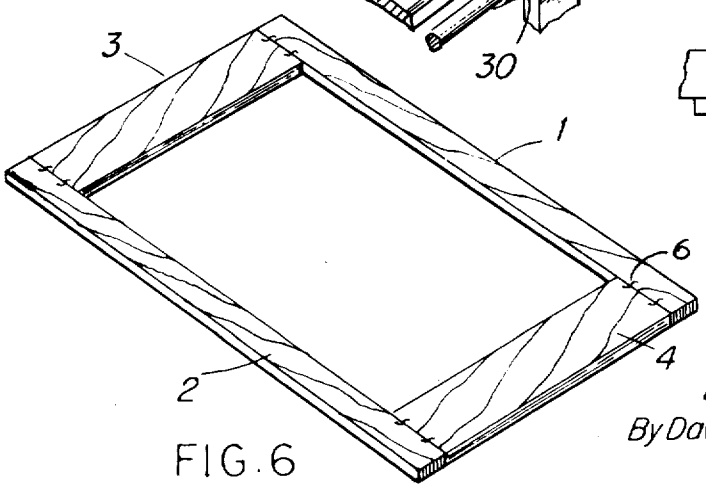
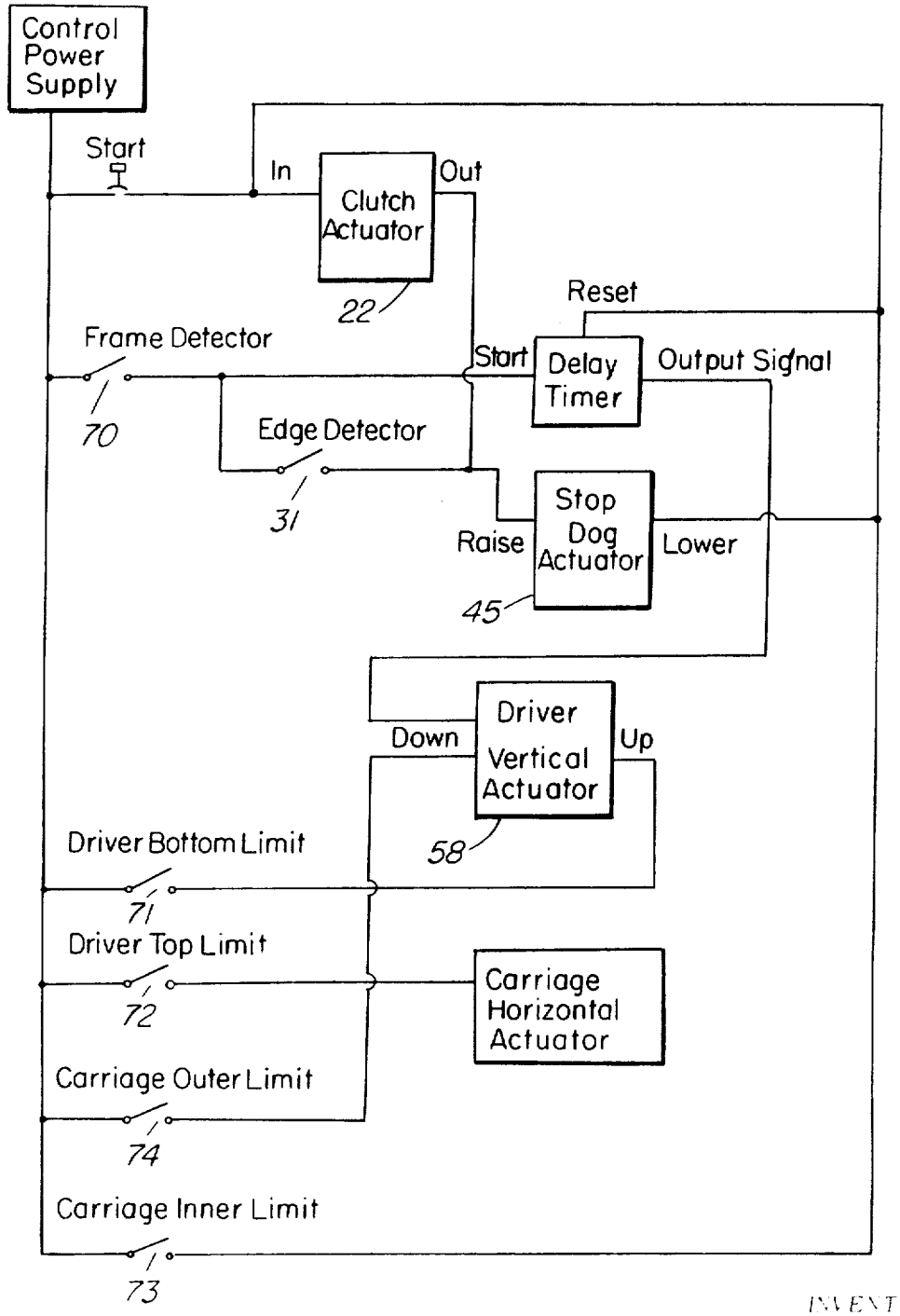


FIG. 6

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FIG. 9



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AUTOMATIC FASTENING MACHINE

The present invention is concerned with a machine for assembling and fastening with pneumatically driven corrugated fasteners or the like a frame of four pieces. Such frames may be of wood. The assembled frames may be faced with panels of plywood, composition board, metal or plastic to become drawing boards, flush doors, partition panels, shelving, table tops, or the like. The particular machine herein described in detail is intended to fabricate wooden frames for use in flush doors or desk tops. Operation of the machine is entirely automatic. It is provided with a supply of appropriately dimensioned board members and fasteners and it produces finished frames therefrom without requiring a human operator. The machine replaces manual assembly and alignment of the boards and manual fastener insertion. The resulting frames are lower in labor cost and more uniform in dimensions and quality than the hand assembled frames which they replace.

IN THE DRAWINGS

FIG. 1 is a plan view of a machine in accordance with the present invention;

FIG. 2 is an elevational view of the front end of the machine of FIG. 1;

FIG. 3 is an elevational view of the right side of the machine;

FIG. 4 is a perspective view of the frame member magazines toward the rear of the machine;

FIG. 5 is a perspective detail view of a portion of the board magazines;

FIG. 6 is a perspective view of a frame made by the machine;

FIG. 7 is a simplified schematic of the stop actuating mechanism;

FIG. 8 is a detail view of the edge detector switch, and

FIG. 9 is a schematic of machine controls.

Referring now to the drawings, there is shown an embodiment of the machine of the present invention which is particularly suited for fabrication of frames of wood to which panel faces are to be laminated to form flush doors or drafting table tops.

The frame fabricated by the machine is shown assembled and fastened in FIG. 6. The frame is composed of two styles or side member boards 1 and 2 and top and bottom end member boards 3 and 4. All four pieces are fastened together by means of conventional staples or corrugated fasteners 6 driven so as to bridge the joints between the pieces. Two such fasteners 6 are driven spanning each joint.

The machine is in the form of a table having a flat work surface 5 supported by legs. The supplies of frame members 1–4 are stored toward the rear of the machine in vertical stacks with their ends received in vertical channel magazines 10–17. The portion of the work surface 5 toward the front of the machine constitutes a work station at which the members 1–4 are joined with corrugated fasteners by means of pneumatic driver mechanisms 60. The drivers 60 are essentially conventional units available from such manufacturers as Bostitch Division of Textron, Inc., Carlstadt, New Jersey. The drivers 60 are arranged to be actuated whenever they contact a work piece by a contact trigger mechanism.

The work surface 5 is traversed from back to front by several parallel roller chains 30 which move in tracks depressed below the surface 5 in slots 29. The roller chains are simultaneously driven by a plurality of drive sprockets 24 affixed to a drive shaft 23 which is supported in bearings 25. The rear end of each chain loop is carried by a driven sprocket 28 affixed to a back shaft 27 supported by bearings 26. The drive shaft is driven by a motor 20 and chain, belt, or gear drive within a safety housing 21. The driving power is transmitted through pneumatically disengageable clutch 22. Mechanical linkage, hydraulic, or electrical actuation could be employed for this clutch.

The drive chains include sets of mutually alligned pusher blocks 40 which may be short rectangular metal bars affixed to links of the roller chains. The pusher blocks move in unison to advance a set of four frame members 1–4 from the supply magazines 10–17 to the work station for fastening together.

The supply magazines hold vertical stacks of frame members 1–4 by confining the ends of the frame members in facing pairs of vertical channel hoppers such that longitudinal and lateral motion of the frame members is prevented, but vertical movement of the members is permitted. Each such facing pair of channels constitutes a magazine. The magazine for frame side members 1 is constituted by channel pair 10 and 11; that for frame side member 2 by channel pair 12 and 13; that for frame top member 3 by channel pair 14 and 15; and that for frame bottom member 4 by channel pair 16 and 17. The lowest frame member in each magazine stack rests on the work surface 5. The lower ends of the channel pairs of each magazine are spaced above the work surface 5 by a distance exceeding the thickness of a frame member, but less than the sum of the thickness of two frame members. The lowest frame members of each magazine collectively constitute a complete set of frame members for one frame. That set rests on the work surface below the lower ends of the magazines so that the set can be moved longitudinally forward on the work surface.

The pusher blocks 40 on the roller chains 30 move with the chains and come to abut and bear against the rear edge of side frame member 1. The pushing force exerted by the pusher blocks 40 causes frame member 1 to move forwardly of the machine to advance from the magazine 10, 11. The end portions of frame member 1 advance to abut the rearmost ends of top and bottom frame members 3 and 4 to cause them to slide forwardly along the work surface 5. The forward ends of frame members 3 and 4 advance to abut the end portions of the other side member 2 and cause its forward advance. In this fashion the pusher blocks slide a complete set of frame members 1–4 from the bottom of the stacks of frame members in the magazines. When this assembled set clears the magazines, gravity causes the stacked supply of frame members to drop toward the work surface 5 to provide a new set of frame members in the space below the magazines to be advanced when the pusher blocks 40 again appear at the rear of the machine.

After side frame member 2, the leading member of the frame set, is moved from beneath its magazine 12, 13 the remaining boards in that stack are supported above the work surface solely by the presence of top

and bottom members 3 and 4 as they slide along. As a consequence of this end support, the stack of side frame members 2 may sag in the middle thereby creating an obstruction to the passage of side frame member 1, the rear member of the set. Side frame member 1 must pass beneath the stack of side frame members 2. This problem is solved, as is best seen in FIG. 5, by providing means to lift the stack of side frame members 2 as member 1 approaches. The means for lifting the stack are several hinge-like members 19 affixed by one hinge leaf on a transverse support bar 18. The other leaf of hinge 19 is long enough to extend from the hinge axis beneath the lowest member in the stack of members 2. This long hinge leaf constitutes an inverted pivoted ramp. As frame member 1 advances toward the stack of members 2, the leading edge of frame member 1 strikes the long hinge leaf and cams the leaf upwardly thereby lifting the stack of members 2 by the sum of the thickness of frame member 1 and the hinge leaf. Since this sum is greater than the thickness of frame member 1 alone, there is sufficient clearance for the frame member 1 to slide beneath the stack of members 2 without interference. FIG. 5 illustrates the condition just after member 1 has cammed the long hinge leaf upwardly to lift the stack of members 2 to allow member 1 to pass beneath.

The assembled set of frame members 1–4 is advanced forwardly toward the work station on the front portion of work surface 5 by the pusher blocks 40 on the roller chains 30. The assembled frame set is guided by guide bars 32 laterally spaced by the length of frame members 1 and 2 with some clearance to allow sliding of the frame set.

The forward progress of the frame set is arrested by contact of the leading edge side frame member 2 with cam actuated frame detector switch 70. Switch 70 starts a timer. While the timer is cycling the frame continues to move forward until it strikes the actuator lever 61 of edge detector switch 31 which protrudes through work surface 5 as is shown in FIG. 8. An electrical pulse released by contacting switch 31 causes actuation of a solenoid valve which controls air under pressure which causes disengagement of clutch 22 to stop the chains 30 and also causes actuation of pneumatic cylinder linear actuator 45. Actuator 45 is linked via lever 44 to rocker shaft 41 to cause partial rotation thereof. A pair of stop dogs 34 is affixed to the rocker shaft 41. They rotate with the shaft 41 to a raised position in which the dogs 34 protrude above the work surface 5. Stop dogs 34 stop the forward motion of side frame member 2 to locate it with precision in the work station. Some forward motion persists after disengagement of clutch 22 to force the four members of the frame set tightly together against the stop dogs 34 to eliminate joint gaps.

Rocker shafts 46 and 47 raise top member stop dogs 36 and bottom member stop dogs 38 simultaneously with the raising of side member stop dogs 34 by rocker shaft 41. As is schematically illustrated in FIG. 7, rocker shafts 46 and 47 are driven from rocker shaft 41 by bevel gears 42 and 43 respectively. Thus, the side, top, and bottom member stop dogs rise simultaneously upon actuation of linear actuator 45 on signal from switch 31. The top and bottom stop dogs bear outwardly on the top and bottom members to urge their outer edges against guide rails 32. Operation of the several stop dogs in conjunction with some residual push from pusher blocks 40 insures precise location and tight abutment of the four members of the frame set. The frame set is thereby assembled and located in the work station.

The frame members are fastened together by corrugated fasteners 6 automatically driven by pneumatic drivers 60 after elapse of the timer function started by tripping switch 70. The four fastener drivers 60 are secured to a laterally shiftable carriage comprising driver support members 56 and lateral rods 52. The four drivers are located so as to span the joints between frame members with the fasteners 6. The location of the driver support members 56 is adjustably fixed by means of set screws 54. The lateral rods 52 are carried in bushings affixed to vertical support members 51 to permit lateral sliding motion of the carriage.

The lateral position of the driver support frame is under control of pneumatic cylinder linear actuator 57. This lateral movement permits a first group of four fasteners to be simultaneously driven in a first position and then the carriage be moved to a second position to the left of the first where a second group of four fasteners is driven.

The fastener drivers 60 are carried by vertically movable pneumatic linear actuators 58 to lower the drivers 60 to the frame assembly for driving each of the two groups of fasteners 6. Actuators 58 retain the drivers 60 in a retracted condition during movement of the frame assembly into or out of the work station where fastening occurs.

The several pneumatic linear actuators 45, 57 and the pneumatic clutch 22 are operated by air pressure controlled by conventional electrically actuated solenoid valves. The valves respond to an electrical signal pulse. The control of the sequence of operation of the machine is accomplished by switches which release a pulse of electrical energy from conventional pulse generating capacitor discharge devices. Switches 31 and 70–73 are conventional limit switches activated by contacting an actuator arm with the object whose position is to be sensed. Such switches may be equipped with rollers on the actuator arm. The operation of these actuators and control switches will not be described in relation to the sequence of machine operations. FIG. 9 is a simplified schematic of these operations.

Frame detector switch 70 is located near the right-hand edge of the work station at a position rearward of the side member stop dogs 34. The actuator arm roller of frame detector switch 70 is raised by the frame assembly as it approaches the fastening position in the work station. Actuation of frame detector switch 70 starts the delay timer.

Edge detector switch 31 is located in a position where it is actuated by the frame only when it is in proper position for fastening. FIG. 8 is a detail view of edge detector switch 31. The actuator arm 61 is contacted by the leading edge of frame member 2. Slight further travel of frame member 2 causes it to contact the cam surface 62 to move the body of switch 31 about a pivot thereby disengaging actuator arm 61 from the frame edge. Thus, edge detector switch provides a momentary electrical signal when the leading edge arrives at the proper position for fastening. Edge

detector switch **31** controls a solenoid air valve which disengages pneumatic drive clutch **22** and also activates linear actuator **45** to raise the stop dogs **34**, **36** and **38** to lock the frame assembly in position.

The delay timer started by actuation of frame detector switch **70** allows adequate time for the clutch disengagement and stop dog raising functions to occur before elapse of the delay time. Upon elapse of the delay time, a circuit is completed to provide a pulse to the solenoid valve which controls the vertical driver linear actuators **58** to cause the drivers **60** to descend to the surface of the frame assembly where the drivers **60** are triggered by contact with the workpiece to drive fasteners **6** in the first position.

When vertical driver linear actuators **58** reach the bottom of their stroke, bottom limit switches **71** are actuated. Limit **71** switches cause the actuators **58** to reverse direction and raise the drivers **60** from the frame assembly. Upon reaching the top of the stroke, top limit switches **72** are actuated to provide a pulse which activates a solenoid valve to cause horizontal linear actuator **57** to shift the driver support carriage **56**, **52** to the left.

Upon reaching the leftward position, the left limit switch **74** is actuated. Actuation of the left limit switch **74** completes a circuit to the solenoid valve controlling the vertical driver actuators **58** to again lower the drivers **60** to the frame assembly for driving fasteners **6** in the second position.

Vertical actuator bottom limit switches **71** cause the driver actuators to again ascend. Activation of vertical actuator top limit switch **72** causes the carriage to return to the right. Upon return to the right, right limit switch **73** is actuated to reset the delay timer associated with frame detector switch **70** and also to actuate the solenoid valve to drop the stop dogs **34**, **36**, and **38** and engage chain drive clutch **22**. The now completed frame is pushed forward from the machine by the chain driven pusher blocks **40** and the cycle repeats.

Switches **72** and **73** are of the latching type which are actuated by motion in one direction only and are reset by motion in the opposite direction. In this way, switches **72** and **73** are ineffective at the start of the cycle and are rendered effective by resetting by the first direction motion of the sensed element so as to become effective on return motion of the sensed element. This is a conventional limit switch configuration.

Edge detector switch **31** is wired in series with frame detector switch **70** so that switch **31** is effective to raise the stop dogs only when switch **70** bears on a frame. Rearward side frame member **1** will not result in raising of the stop dogs as that member contacts switch **31** as the assembled frame is being delivered from the machine because the circuit to switch **31** is broken when switch **70** no longer detects the presence of a frame.

It is apparent that the machine can be adjusted to accept a wide range of frame sized by moving the magazines **10–17**, guides **32**, stop dogs **36**, **38** and adjusting the driver carriage to position the drivers for a new frame size. Frames with additional members can be assembled by providing appropriately positioned additional magazines and drivers. Three or more fastener positions can be had by appropriate additional limit switches **74** wired for a progressive sequence of carriage positions.

I claim:

1. A machine for assembling and fastening together a flat frame from individual frame members comprising;
- a work surface including a fastening station,
- dispenser means for delivering to the work surface a set of the individual members of the frame arranged in the approximate relative positions occupied in the finished frame,
- means to move the set of frame members along the work surface to the fastening station,
- stop means at the fastening station operable to position and hold the individual members of the set in their final relative positions, and
- fastener driving means at the fastening station arranged to drive at least one fastener to secure each of the joints between members of the set.

2. The machine of claim **1** wherein the dispenser means comprises orthogonally arranged magazines for holding vertically stacked supplies of each frame member, the magazines being positioned above the work surface and spaced therefrom by a distance greater than the thickness of the frame members for gravity feeding and delivering a set of frame members from the bottoms of the magazines to the work surface.

3. The machine of claim **1** wherein the means to move the set of frame members comprises a plurality of flexible endless driven bands traversing the work surface from the dispensing means to the fastening station.

4. The machine of claim **3** wherein the flexible endless bands are sprocket driven roller chains in channels in the work surface and pusher blocks are affixed to the chains in transverse alignment to engage and move the set of frame members in unison.

5. The machine of claim **1** wherein the stop means comprise members which are pivoted to be raised above the work surface.

6. The machine of claim **5** wherein the pivoted stop members serve to arrest the movement of the set of frame members by abutting the advancing edge of the leading member of the set, and wherein further pivoted stop members serve to bear outwardly against the inner edges of the end members of the set to force those end members against guide members affixed to the work surface to position the several frame members.

7. The machine of claim **1** wherein the fastener driving means comprise a set of work piece contact actuated automatic fastener drivers borne by a carriage which locates one such driver at each frame joint, and including means to lower the drivers into contact with the set of frame members to actuate the drivers to drive first fasteners to fasten the frame joints, and means to traverse the carriage and drivers to a second position to there drive second fasteners to fasten the joints.

8. The machine of claim **7** wherein the automatic fastener drivers, the means to lower the drivers, and the means to traverse the carriage are pneumatic actuators.

9. The machine of claim **1** wherein the magazines each comprise pairs of facing vertical channels which receive the end portions of the stack of frame members, there being a magazine for each of at least top and bottom end members and first and second side members, the magazine for the first side member also including means to lift the stack of first side members to provide adequate clearance for the second side member to freely pass beneath the stack of first side members as the set of frame members is moved to the fastening station.

10. The machine of claim 9 wherein the means to lift the stack first side members comprises a hinge leaf pivoted on a horizontal axis above the work surface and sloping downwardly from the axis to beneath the stack of first side members to engage and ride upon the second side member of the set as the set moves thereby lifting the stack of remaining first side members.

11. A machine for assembling and fastening together a flat frame from individual frame members including at least top and bottom end members and first and second side members comprising;

a work surface including a fastening station,

orthogonally arranged magazines for holding vertically stacked supplies of each frame member and for gravity feeding and delivering from the bottom of the magazines to the work surface a set of individual frame members arranged in the approximate relative positions occupied in the finished frame,

sprocket driven endless roller chains traversing the work surface in channels from the magazines to the fastening station,

pusher means affixed to the chains to engage the rearmost edge of the second side member of the set to move the set from the magazines to the fastening station,

disengageable clutch means in the drive for the chain sprockets,

pivoted stop members in the fastening station to position and hold the members of the frame set in their final relative positions, and

a set of automatic work piece contact actuated fastener drivers borne by vertically reciprocable actuators affixed to a laterally reciprocable driver carriage moved by a horozontal actuator, the set of drivers being positioned over the joints in the frame set, and capable of driving joint spanning fasteners across each frame joint at laterally spaced position along the joints.

12. The machine of claim 11 including an edge detector switch to sense the presence of the leading edge of the first side frame member, a frame detector switch which senses the presence of a frame set in the fastening station, a delay timer, a driver lower limit switch, a driver upper limit switch, and carriage lateral motion limit switches, the edge detector switch being connected to disengage the sprocket drive clutch and to raise the stop members, the frame detector switch being in series with the edge detector switch such that the stop members raise only when a frame set is approaching the fastening station, the frame detector switch also being connected to the delay timer to initiate the delay function, upon expiration of which there is released a signal to cause the vertically reciprocable actuators to lower the drivers to a first position on the frame set, the driver lower limit switch being connected to cause the driver actuators to return upwardly, the driver upper limit switch being connected to the driver carriage lateral actuator to cause the driver carriage to traverse, one of the carriage lateral motion limit switches being connected to the vertically reciprocable actuators to reciprocate the drivers to and from a second position on the frame set, the driver upper limit switch causing the driver carriage to return traverse, the other of the driver carriage limit switches being connected to reset the delay timer to lower the stop members and to re-engage the sprocket clutch.

13. A method of assembling and fastening together a frame from individual frame members comprising;

delivering from supply magazines to a work surface a set of individual members of the frame arranged in the approximate relative positions occupied in the finished frame,

moving the set of frame members along the work surface to a fastening station,

accurately positioning the frame members with respect to each other and with respect to the fastening station,

holding the frame members in position,

advancing plural automatic contact actuated fastener driving means into contact with the frame members at a first position for driving first fasteners to fasten the joints between frame members,

driving the fasteners,

retreating the fastener driving means from the frame,

advancing the fastener driving means into contact with the frame members at a second position for driving second fasteners to fasten the joints,

retreating the fastener driving means, and

releasing the holding of the frame members.

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